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Effect of the combination of stretching exercise and warm compress on leg cramps and discomfort in hemodialysis patients: A randomized clinical study

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Abstract. Patients undergoing hemodialysis have a variety of negative effects on their quality of life, health, and comfort, including physical dysfunction, alterations to their diet, and limits on fluid intake. This study aimed to determine the effects of intradialytic exercise and heat compression on alleviating discomfort and leg cramps in individuals receiving hemodialysis.

Methods. A multicenter randomized clinical study was conducted in Iraqi hemodialysis facilities. A total of 205 patients receiving hemodialysis were randomized into four groups: warm compress group ($n = 53$), stretching exercise group ($n = 43$), combined warm compress and exercise group ($n = 57$), and control group ($n = 52$). The intervention was applied during hemodialysis sessions over four weeks. Comfort was assessed using the Hemodialysis Comfort Scale, while leg cramps were evaluated using the Cramp Questionnaire Chart. Pre- and post-intervention scores were compared using paired-sample t -tests and repeated-measures ANOVA.

Results. The combined intervention group demonstrated the greatest improvement in comfort scores, increasing from 61.74 ± 20.24 before the intervention to 100.99 ± 7.21 after the intervention ($p < 0.001$). The exercise group also showed a significant increase in comfort scores, from 62.30 ± 25.17 to 85.19 ± 3.92 ($p < 0.001$), whereas no significant change was observed in the warm compress group (66.43 ± 21.20 to 67.38 ± 18.26 ; $p = 0.816$) or the control group (61.15 ± 21.88 to 60.62 ± 18.39 ; $p = 0.902$). Repeated-measures ANOVA showed significant effects of time, group, and time \times group interaction on comfort scores ($F = 148.62, 96.13, \text{ and } 192.39$, respectively; $p = 0.001$; partial $\eta^2 = 0.64$). Cramp scores decreased significantly in the warm compress group (9.23 ± 2.76 to 3.66 ± 4.98 ; $t = 7.567$; $p < 0.001$), exercise group (8.35 ± 3.61 to 5.44 ± 2.67 ; $t = 5.839$; $p < 0.001$), and combined intervention group (9.37 ± 2.46 to 3.68 ± 0.73 ; $t = 17.544$; $p < 0.001$), while no significant improvement was observed in the control group (8.13 ± 2.44 to 8.81 ± 2.42 ; $p = 0.171$). Repeated-measures ANOVA confirmed significant time, group, and time \times group effects for cramp scores ($F = 112.47, 28.90, \text{ and } 134.21$, respectively; $p = 0.001$; partial $\eta^2 = 0.57$).

Conclusions. The combination of warm compresses and stretching exercise was the most effective non-pharmacological nursing intervention for reducing leg cramps and improving comfort among hemodialysis patients. These procedures are safe, non-invasive, cost-effective, and may be incorporated into routine nursing care during hemodialysis.

Trial registration: WHO International Clinical Trials Registry Platform / TrialSearch, Main ID: IRCT20240828062892N1.

Key words: hemodialysis, muscle cramp, muscle stretching exercises, hot temperature, patient comfort.

Conflict of interest. The author declares no conflict of interest.

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Вплив поєднання вправ на розтягування та теплового компресу на зменшення дискомфорту та судом ніг у пацієнтів, які лікуються гемодіалізом: рандомізоване клінічне дослідження

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Резюме. Пацієнти, які лікуються гемодіалізом, мають низку негативних впливів на якість життя, здоров'я та комфорт, зокрема фізичну дисфункцію, зміни в харчуванні та обмеження споживання рідини. Метою цього дослідження було визначити вплив інтрадіалітичних фізичних вправ і теплових компресів на зменшення дискомфорту та судом ніг в осіб, які лікуються гемодіалізом.

Методи. Проведено багатоцентрове рандомізоване клінічне дослідження. Загалом 205 пацієнтів, які лікувались гемодіалізом, були рандомізовані до чотирьох груп: група теплового компресу ($n = 53$), група вправ на розтягування ($n = 43$), група комбінованого застосування теплового компресу та вправ ($n = 57$) і контрольна група ($n = 52$). Втручання застосовували під час сеансів гемодіалізу протягом чотирьох тижнів. Комфорт оцінювали за допомогою шкали комфорту під час гемодіалізу, тоді як судомні ніг оцінювали за допомогою карти-опитувальника судом. Показники до та після втручання порівнювали з використанням парного t -критерію та дисперсійного аналізу для повторних вимірювань.

Результати. Група комбінованого втручання продемонструвала найбільше покращення показників комфорту: зростання з $61,74 \pm 20,24$ до втручання до $100,99 \pm 7,21$ після втручання ($p < 0,001$). У групі вправ також спостерігали достовірне підвищення показників комфорту – з $62,30 \pm 25,17$ до $85,19 \pm 3,92$ ($p < 0,001$), тоді як у групі теплового компресу (з $66,43 \pm 21,20$ до $67,38 \pm 18,26$; $p = 0,816$) і контрольній групі (з $61,15 \pm 21,88$ до $60,62 \pm 18,39$; $p = 0,902$) достовірних змін не виявлено. Дисперсійний аналіз для повторних вимірювань показав достовірний вплив часу, групи та взаємодії час \times група на показники комфорту ($F = 148,62; 96,13$ і $192,39$ відповідно; $p = 0,001$; часткова $\eta^2 = 0,64$). Показники судом достовірно знижувалися в групі теплового компресу (з $9,23 \pm 2,76$ до $3,66 \pm 4,98$; $t = 7,567$; $p < 0,001$), групі вправ (з $8,35 \pm 3,61$ до $5,44 \pm 2,67$; $t = 5,839$; $p < 0,001$) і групі комбінованого втручання (з $9,37 \pm 2,46$ до $3,68 \pm 0,73$; $t = 17,544$; $p < 0,001$), тоді як у контрольній групі достовірного покращення не спостерігали (з $8,13 \pm 2,44$ до $8,81 \pm 2,42$; $p = 0,171$). Дисперсійний аналіз для повторних вимірювань підтвердив достовірний вплив часу, групи та взаємодії час \times група на показники судом ($F = 112,47; 28,90$ і $134,21$ відповідно; $p = 0,001$; часткова $\eta^2 = 0,57$).

Висновки. Поєднання теплих компресів і вправ на розтягування було найефективнішим немедикаментозним сестринським втручанням для зменшення судом ніг і покращення комфорту серед пацієнтів, які лікуються гемодіалізом. Ці процедури є безпечними, неінвазивними, економічно доступними та можуть бути включені до рутинної сестринської допомоги під час гемодіалізу.

Реєстрація дослідження: WHO International Clinical Trials Registry Platform / TrialSearch, Main ID: IRCT20240828062892N1.

Ключові слова: теплий компрес, вправи на розтягування, судомні, дискомфорт, гемодіаліз.

Introduction. End-stage kidney disease (ESKD) is an increasing public health burden, particularly in developing countries [1]. Hemodialysis remains the most widely used modality of kidney replacement therapy. Although it is life-sustaining, patients receiving maintenance hemodialysis often experience multiple physiological and psychosocial problems [2, 3].

Hemodialysis removes excess fluid and uremic solutes and reduces the risk of death in patients with kidney failure [4]. However, rapid fluid and electrolyte shifts during treatment may contribute to intradialytic

symptoms. Muscle cramps are among the most frequent and distressing complications. They usually affect the lower limbs and may occur during dialysis or after the session. Their reported prevalence ranges from 25% to 50% [5].

Hemodialysis is also associated with several treatment-related burdens and complications [6]. Patients may experience dietary and fluid restrictions, physical limitations, discomfort, dependence on treatment, loss of work capacity, financial stress, recurrent hospitalization, and fear of death [7]. Pain is another common symptom in this population. Chronic pain has been reported in a high proportion of patients receiving maintenance hemodialysis [8]. Pain is clinically important because it is associated with poor sleep, reduced adherence to dialysis, more frequent hospitalization, lower quality of life, and increased mortality [9].

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Several non-pharmacological methods have been proposed to reduce leg pain and muscle cramps in hemodialysis patients. These include hot or cold compresses, stretching exercises, massage, and local anesthetic approaches. Exercise interventions may reduce muscle discomfort, improve physical function, and limit muscle wasting in this population [10, 11]. Stretching and intradialytic exercise may also reduce muscle stiffness, improve local blood flow, decrease fatigue, and support endogenous pain-modulating mechanisms [12, 13].

Heat therapy is another simple intervention that may be useful during hemodialysis. Warm compresses increase local blood flow, promote muscle relaxation, reduce tension, and may improve flexibility. Previous studies suggest that intradialytic stretching exercises can be added to routine nursing care and that heat application may reduce dialysis-related discomfort and improve patient comfort [14, 15].

Most previous studies have evaluated stretching exercises or heat application separately. Evidence on their combined effect remains limited. A combined approach may be clinically relevant because stretching may improve neuromuscular relaxation, while local heat may improve tissue perfusion and reduce muscle tension. Therefore, this study aimed to compare the effects of combined warm compresses and stretching exercises with each intervention alone on leg cramps and patient comfort during hemodialysis.

Patients and methods. *Study design and setting.* This randomized controlled clinical study was conducted in hemodialysis units in Al-Muthanna, Iraq, including Al-Hussain Teaching Hospital and Al-Rummaitha Hospital. The study was approved by the Council of the College of Nursing, University of Baghdad (Approval No. 24, March 2, 2025). Written informed consent was obtained from all participants before enrollment. The trial is listed in the WHO International Clinical Trials Registry Platform / TrialSearch under Main ID IRCT20240828062892N1.

Participants. Patients undergoing maintenance hemodialysis were screened for eligibility. The inclusion criteria were: age ≥ 18 years, treatment with hemodialysis three times per week for at least 6 months, ability to speak and understand Arabic, ability to lie flat without respiratory distress, full orientation to time and place, no major hearing or visual impairment, and hemoglobin level ≥ 8 g/dL.

Patients were excluded if they had femoral vascular access, irregular attendance at hemodialysis sessions, critical illness limiting cooperation, musculoskeletal disorders, lower-limb amputation, cognitive impairment, or refusal to participate. Patients with long-standing diabetes and clinically relevant diabetic peripheral neuropathy were also excluded because neuropathy could affect leg symptoms and interfere with outcome assessment.

Sample size and recruitment. The sample size was estimated before recruitment based on previous studies evaluating interventions for leg cramps in hemodialy-

sis patients [10, 11, 14]. A minimum of 21 participants was considered necessary for each intervention arm in each of the two participating hemodialysis facilities. Therefore, the minimum required sample size was 168 participants. Although the registered target sample size was 104 participants, recruitment was continued beyond this number to increase the precision of the estimates and allow for possible exclusions or incomplete data. Finally, 205 eligible participants were enrolled and included in the analysis.

A total of 324 patients undergoing hemodialysis were screened for eligibility. After explanation of the study aims and procedures, 16 patients declined to participate. Another 103 patients were excluded because they met at least one exclusion criterion: Toronto Clinical Scoring System score < 6 ($n = 23$), age < 18 years ($n = 19$), lower-limb amputation ($n = 7$), cognitive impairment ($n = 10$), femoral access for dialysis ($n = 28$), irregular dialysis schedule ($n = 3$), musculoskeletal disease ($n = 4$), or severe anemia ($n = 9$). The final study sample included 205 participants.

Randomization. A statistician generated the random allocation sequence using a computerized random number program. Participants were assigned in a 1:1:1:1 ratio to one of four groups: stretching exercise, warm compress, combined stretching exercise and warm compress, or control. No stratification by center was performed.

Interventions. Participants in the stretching exercise group performed intradialytic stretching exercises targeting the calf muscles, gastrocnemius, soleus, hamstrings, and quadriceps. The program included ankle flexion, gastrocnemius stretching, soleus stretching, hamstring stretching, and quadriceps stretching. Each session lasted 20 minutes and was performed three times per week for 4 weeks. The exercises were conducted with the support of physical therapists.

Participants in the warm compress group received warm compresses applied to the calf muscle during hemodialysis. Warm water bags were used for 20 minutes. Water temperature was monitored with a thermometer and maintained at 35–37.5°C. The intervention was applied three times per week for 4 weeks.

Participants in the combined intervention group received both interventions during the same hemodialysis session. Stretching exercises were performed for 20 minutes after the start of dialysis, followed by application of a warm compress to the calf muscle for 20 minutes at 35–37.5°C.

Participants in the control group received standard care only and did not receive stretching exercises or warm compresses.

Outcome measures. Leg cramps and patient comfort were assessed before and after the intervention period.

Leg cramps were assessed using the Cramp Questionnaire Chart [16]. This instrument evaluates the characteristics of muscle cramps during hemodialysis, including frequency, duration, pain intensity, tempera-

ture, and discomfort. The total score ranges from 0 to 13. Scores are interpreted as follows: 0, no cramps; 1–4, mild cramps; 5–8, moderate cramps; and 9–13, severe cramps.

Comfort was assessed using the Hemodialysis Comfort Scale-II (HDCS-II) [17]. The scale includes 26 items rated on a five-point Likert scale. It evaluates several dimensions of comfort, including physical relief, physical ease, psychosocial ease, psychosocial transcendence, environmental transcendence, and sociocultural ease. The reported Cronbach's alpha coefficient for the total scale was 0.79.

Data collection. Demographic and clinical data were collected by interview and review of patient information before the intervention. Baseline leg cramp and comfort scores were recorded before starting the intervention program. The same instruments were used again after completion of the 4-week intervention period.

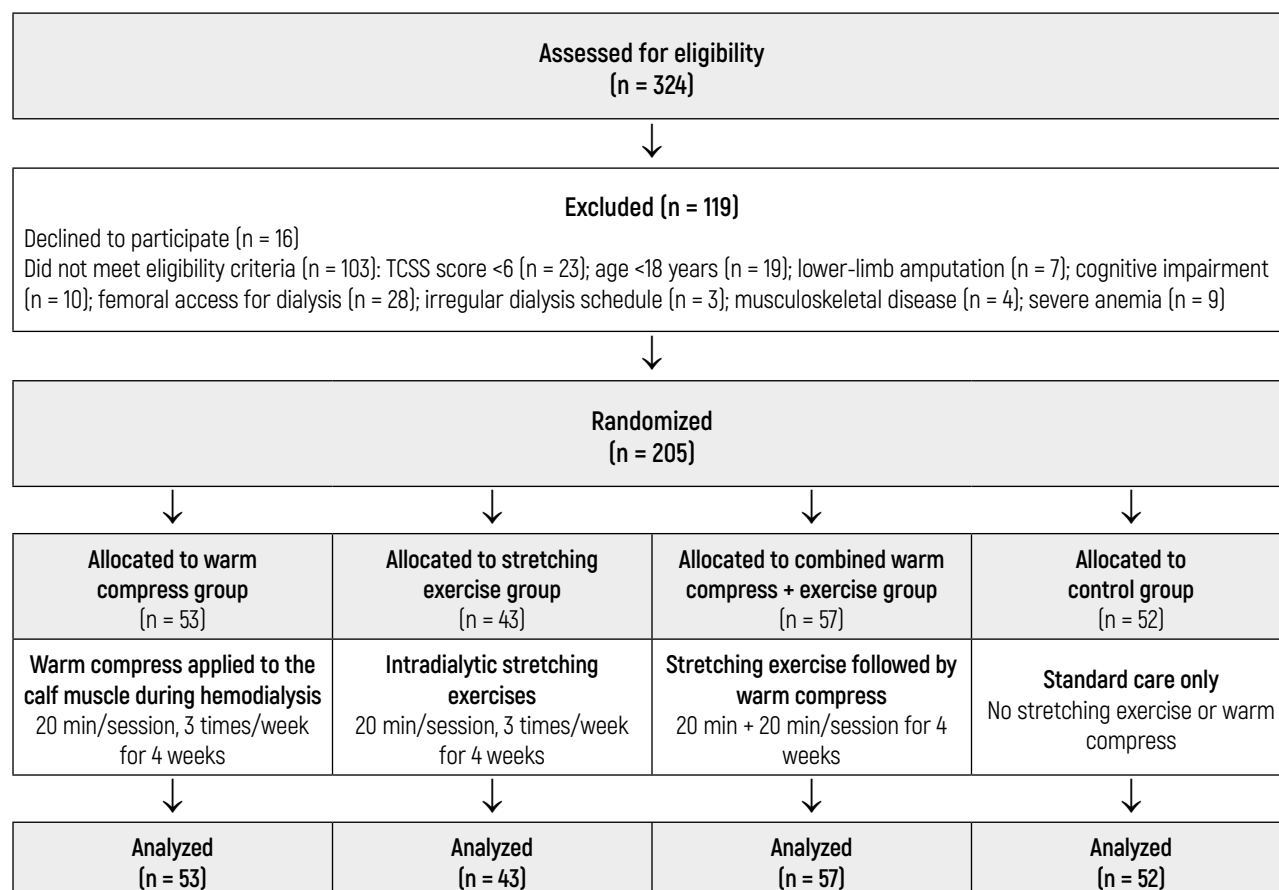
All participants received information about the study objectives and procedures before enrollment. Verbal and written informed consent were obtained. Patient privacy and confidentiality were maintained

throughout the study, and all identifying information was anonymized.

Statistical analysis. Data were analyzed using IBM SPSS Statistics, version 26. Descriptive statistics were used to summarize demographic and clinical characteristics. Categorical variables were presented as frequencies and percentages, while continuous variables were presented as means and standard deviations ($M \pm SD$).

Within-group pre- and post-intervention changes were analyzed using paired-sample t-tests. Between-group differences and time-dependent changes were assessed using repeated-measures ANOVA, including the effects of time, group, and time \times group interaction. A p-value <0.05 was considered statistically significant.

Results. A total of 324 patients undergoing hemodialysis were assessed for eligibility. Of these, 119 patients were not included: 16 declined to participate and 103 met at least one exclusion criterion. The final sample included 205 patients, who were randomized into four groups: warm compress group ($n = 53$), stretching exercise group ($n = 43$), combined warm compress and stretching exercise group ($n = 57$), and control group ($n = 52$). The participant flow is shown in Figure 1.



Note. TCSS, Toronto Clinical Scoring System.

Fig. 1. Flow diagram of participant recruitment, randomization, intervention, and analysis

Table 1 presents the statistical comparison of comfort scores among the study groups at the pre- and post-test phases. The combination of warm compress and

exercise group ($n = 57$) demonstrated the greatest improvement, with mean comfort scores rising from 61.74 ± 20.24 at pre-test to 100.99 ± 7.21 at post-test.

Table 1

Comparison of comfort scores among study groups at pre- and post-test phases

Group	n	Pre-test M ± SD	Post-test M ± SD	Mean difference	Paired t	p-value
Warm compress	53	66.43 ± 21.20	67.38 ± 18.26	-0.94	-0.234	0.816
Stretching exercise	43	62.30 ± 25.17	85.19 ± 3.92	-22.88	-5.940	<0.001
Warm compress + stretching exercise	57	61.74 ± 20.24	100.99 ± 7.21	-39.26	-13.123	<0.001
Control	52	61.15 ± 21.88	60.62 ± 18.39	0.54	0.124	0.902

Table 2 illustrates the comparison of cramp scores among the study groups before and after the intervention. The combination of warm compress and exercise group (n = 57) showed the greatest improvement, with

mean cramp scores decreasing markedly from 9.37 ± 2.46 at pre-test to 3.68 ± 0.73 at post-test; this reduction was highly statistically significant (t = 17.544, p < 0.001).

Table 2

Comparison of leg cramp scores before and after intervention

Group	n	Pre-test M ± SD	Post-test M ± SD	Paired t	p-value
Warm compress	53	9.23 ± 2.76	3.66 ± 4.98	7.567	<0.001
Stretching exercise	43	8.35 ± 3.61	5.44 ± 2.67	5.839	<0.001
Warm compress + stretching exercise	57	9.37 ± 2.46	3.68 ± 0.73	17.544	<0.001
Control	52	8.13 ± 2.44	8.81 ± 2.42	-1.388	0.171

Table 3 shows a repeated-measures analysis of variance revealed a significant effect of time on comfort scores, indicating a marked change in comfort levels from pre-test to post-test (p < 0.001). Furthermore, the interaction between time and group was sta-

tistically significant, indicating that the improvement in comfort differed across study groups. The group that combined warm compresses with exercise showed the greatest increase in comfort scores compared to the other groups.

Table 3

Repeated-measures ANOVA for comfort scores

Group	n	Pre-test mean	Post-test mean	
Warm compress	53	66.43	67.38	
Stretching exercise	43	62.30	85.19	
Warm compress + stretching exercise	57	61.74	100.99	
Control	52	61.15	60.62	
Effect	F value	df	p value	Partial η ²
Time	148.62	1, 201	0.001	0.64
Group	96.13	3, 201	0.001	–
Time × group interaction	192.39	3, 201	0.001	–

Note: F, F statistic; df, degrees of freedom; partial η², partial eta-squared.

Time had a significant impact on cramp scores, according to repeated-measures analysis of variance (Table 4). The interaction between time and group was also significant, indicating that the intervention

groups' reductions in cramp were different. While the control group only slightly improved, the warm compress and combo groups had the biggest decrease in cramping.

Table 4

Repeated-measures ANOVA for leg cramp scores

Group		n	Pre-test mean	Post-test mean
Warm compress		53	9.23	3.66
Stretching exercise		43	8.35	5.44
Warm compress + stretching exercise		57	9.37	3.68
Control		52	8.13	8.81
Effect	F value	df	p value	Partial η^2
Time	112.47	1, 201	0.001	0.57
Group	28.90	3, 201	0.001	–
Time \times group interaction	134.21	3, 201	0.001	–

Note: *F*, *F* statistic; *df*, degrees of freedom; partial η^2 , partial eta-squared.

Discussion. This study highlights key findings on reducing muscle cramps and discomfort in hemodialysis patients. The results show that, compared to the control group, patients who received the combined intervention of warm compresses and stretching exercises experienced a statistically significant reduction in leg cramps ($T=17.544$, $P<0.000$), discomfort ($T=11.409$, $P<0.000$), and fatigue. These findings suggest that the combination of stretching and heat therapy is an effective, nurse-led, non-pharmacological method for reducing muscle cramps during hemodialysis.

Patients with HD who experience muscle-related symptoms can benefit from exercise methods and massage, which can reduce tense muscles, improve local blood flow, and reduce inflammation [18]. According to Baggetta et al. (2018), because exercise improves fluid transfer, it is a useful nonpharmacological strategy for reducing chills or muscle spasms in HD patients [19]. Mooventhan A & Nivethitha (2014) noted in a related study that exercise influences lymph flow, blood circulation, muscle spasm, and endogenous endorphin release [20]. For HD patients, the goal of the physical activity program is to preserve or enhance physical fitness in order to facilitate social integration, foster independence, and enhance quality of life. Programs for physical activity should incorporate exercises that maintain muscle strength and joint flexibility, prevent muscle imbalances, enhance muscle coordination, and improve cardio-respiratory functions. Other advantages of physical activity include greater mental health, more independence, and improved management of chronic illnesses and the necessary therapy (reduced hospital stays, morbidity, and death). For the majority of HD people, reaching the objectives of physical activity programs is vital [21]. Additionally, studies show that intradialytic exercise can boost dialysis effectiveness, which in turn reduces inflammation and enhances nutrition and bone mineral density [22]. Hemodialysis treatments last roughly four hours each, and patients usually get two or three each week. Intradialytic exercise may be a helpful strategy to enhance patients'

health without taking up more time during the interdialytic phase, as many patients remain bedridden during hemodialysis sessions. Intradialytic exercise makes the most of the MHD time period, despite the fact that there is little variation in exercise during hemodialysis sessions. Furthermore, it has been noted that intradialytic exercise improves patient compliance [23].

Also, in terms of reducing discomfort, this research demonstrates that stretching exercises for the legs are a successful nurse-led, non-pharmacological intervention. This result was in line with other previous studies [2, 24, 25] that showed stretching exercises could reduce discomfort without increasing complications. Similarly, Fauzi and Triaswati showed that intradialytic stretching exercise may be important for reducing RLS and enhancing sleep quality, which in turn improves patient comfort [26]. Additionally, research conducted in Oman by Al Rahbi et al. to evaluate the impact of intradialytic muscular stretching exercises on muscle cramps supports our findings, as for patients on maintenance hemodialysis, intradialytic stretching exercises may be used as a non-pharmacological therapy. This low-risk, economical approach may enhance physical and mental performance, lower hospitalization rates, lessen symptoms, and improve patient care [27]. Additionally, Vyas et al. conducted a quasi-experimental research study about the impact of leg workouts on muscular cramps in hemodialysis patients. The study suggested that leg exercises may significantly lower the frequency and intensity of muscle cramps in hemodialysis patients. These exercises can significantly improve patient comfort and general well-being when they are incorporated into the usual care protocol in dialysis units [28].

This research confirms that using a warm compress to relieve cramps is a successful non-pharmacological intervention. This result is in line with the results of numerous other research [29-31]. A warm compress may reduce cramps without raising leg skin complications, according to all of the previously cited research. In the same way, Salah El-Deen and Mohammed demonstrated that the study groups show a greater decrease in the se-

verity of pain and muscle cramps than the control group. Furthermore, for hemodialysis patients, the moist heat therapy group was more successful than the cold therapy group in reducing the severity of pain and muscular cramps [32]. Furthermore, Abohashima et al.'s research showed a statistically significant difference between the study and control groups, with the study group that underwent moist heat treatment seeing a greater decrease in their overall mean pain score. Many factors, including hypovolemia, electrolyte imbalances, hypotension, dialysis prescription (blood flow rate and ultrafiltration), and dialysate composition, have been linked to muscle cramps in hemodialysis patients; the exact cause is unknown [33]. By increasing the temperature in a specific area, heat therapy improves circulation, which can alleviate pain and improve muscle flexibility. Additionally, it has the ability to mend injured tissue and calm and soothe muscles [34]. Heat therapy can also improve tissue metabolism, reduce nerve sensitivity, enhance blood flow, relax muscles, improve flexibility, and lower muscle spindle sensitivity to strain [35]. According to Kesik et al. [29], who examined the effects of warm and cold compresses on cramps, fatigue, and patient comfort during hemodialysis, both intervention groups showed reduced cramp severity and fatigue and improved comfort compared with the placebo control group during the intervention and follow-up periods. Warm compresses were more effective than cold compresses. In that placebo-controlled randomized trial, 69 participants were stratified and randomly assigned to three groups, two of which received active interventions.

Anggraeni et al. [36] conducted a quasi-experimental study evaluating the use of warming gowns in patients with chronic kidney disease undergoing hemodialysis. The intervention was intended to improve comfort and reduce shivering. The findings showed that warming gowns improved patient comfort by reducing shivering and increasing body temperature during hemodialysis.

The study's findings indicate that Katharine Kolcaba's Comfort Theory provides a useful framework for comprehending how stretching exercises and warm compresses affect the severity, discomfort, and exhaustion of leg cramps in hemodialysis patients. Kolcaba defines comfort as a holistic condition that includes ease, relief, and transcendence. The study's results, which show that the warm therapy and stretching exercise groups experienced less pain and suffering as well as improved intradialytic fatigue, are consistent with the idea of comfort as alleviation. Additionally, stretching exercises and warm compresses can foster a relaxed atmosphere that makes the treatment more comfortable for the patient. Finally, by improving the patient's ability to handle the operation, warm application and stretching exercises can assist the patient in overcoming any pain or discomfort. According to the concepts of Kolcaba's theory, this implies that stretching exercises and warm compresses not only reduce physical discomfort but may also enhance overall well-being.

Limitations. The findings may not be equally applicable to commercial healthcare facilities or to diverse geographic populations with varying clinical practices, given the study's exclusive focus on three government institutions. Furthermore, because the intervention period was short, it is difficult to assess whether the effects will persist over time or reach a plateau. Methodologically, the use of warm compresses and exercises without anonymizing participants or researchers increases the potential for bias, or the Hawthorne effect. Finally, because individuals perceive pain and fatigue differently, using self-reported outcome measures for cramps and discomfort introduces subjectivity. To more thoroughly evaluate these nurse-assisted treatments, future research should focus on large-scale, multicenter longitudinal trials that incorporate objective physiological indicators.

Conclusions. The combination of warm compresses and stretching exercises had a positive effect on leg cramps and discomfort in patients undergoing hemodialysis. This combined approach can be considered a safe, non-invasive, and cost-effective nursing intervention. The findings support the use of simple non-pharmacological interventions, such as warm compresses and stretching exercises, to reduce leg cramps and discomfort during hemodialysis. These interventions are easy to apply, inexpensive, and suitable for routine nursing care. Clinical nurses should be aware of these methods and consider using them to improve patient comfort and tolerance of hemodialysis sessions.

Competing interests. The authors declare that they have no competing interests.

Fundings. This research received no external funding.

Ethics approval and consent to participate. The study was approved by the Council of the College of Nursing, University of Baghdad (Approval No. 24, March 2, 2025). Written informed consent was obtained from all participants before enrollment. The trial is listed in the WHO International Clinical Trials Registry Platform / TrialSearch under Main ID IRCT20240828062892N1.

Availability of data and materials. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions.

Maitam Shawwat: investigation, data curation, formal analysis, writing – original draft.

Rajaa Ibrahim Abed: conceptualization, methodology, supervision, writing – review & editing.

Both authors read and approved the final manuscript.

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Use of artificial intelligence. Artificial intelligence tools were used only to improve the language, grammar, and readability of the manuscript. They were not used to create data, analyze results, or make scientific conclusions. The authors reviewed the final manuscript and take full responsibility for its content.

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