Journal of Health Sciences

RESEARCH ARTICLE Open Access

Effectiveness of intradialytic muscle stretching exercise on muscle cramps among patients undergoing maintenance hemodialysis in Oman - A randomized controlled trial

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ABSTRACT

Introduction: Patients with end-stage renal disease (ESRD) typically exhibit symptoms of the "uremic" syndrome and lower quality of life. Intradialytic muscle stretching exercise has been proposed as a method to improve activity levels by reducing uremic symptoms. In Oman, hypertension and diabetes increase the risk of ESRD, the sixth leading cause of death. ESRD patients in Oman require more dialysis, straining healthcare financial burden.

Methods: A pre- and post-test randomized controlled trial was conducted at the tertiary hospital in Oman, involving 78 individuals (n1 = 39 and n2 = 39). The study included demographic data and a muscle cramp questionnaire chart.

Results: In the third observation, the intervention group experienced less pain in hour III ($p = 0.012$) and hour IV muscle cramps ($p = 0.004$). Heart disease was associated with 2nd-h muscle cramps ($p = 0.032$). Prior cramp episodes were significant, whereas 2nd-h cramp patterns were not ($p = 0.079$). The timing of 2nd, 3rd, and 4th-h muscle cramps was associated ($p = 0.006$, $p = 0.02$, $p = 0.01$). Coping evaluations in the 3rd and 4th h were associated ($p = 0.003$, $p = 0.313$).

Conclusion: Intradialytic stretching exercise may serve as a non-pharmacological treatment for maintenance hemodialysis patients. This low-risk, cost-effective method has the potential to improve patient care, reduce symptoms, hospitalization rates, and enhance physical and mental performance.

Keywords: Effectiveness; intradialytic muscle stretching exercise; muscle cramps; maintenance hemodialysis; Oman

INTRODUCTION

Improving global outcomes clinical practice guideline (2012) defines chronic kidney disease (CKD) as a decline in kidney function (glomerular filtration rate [GFR] <60 mL/min/1.73 m^2) or signs of kidney damage lasting at least 3 months, with five stages independent of GFR ("below 15 mL/min/1.73m^2" implies end-stage renal disease [ESRD]) (1-3). CKD has plagued humans for 200 years. Globally, the all-age CKD prevalence rose by 29.3% since 1990 (4), with 697.5 million people and 1.2 million deaths in 2017. At the same time, the prevalence of ESRD is reported to be 1.1 million, and this will rise by 7% annually at the global level (5,6).

The cause of death due to premature renal-related disease moved from 32nd in 1990 to 24th in 2020 (7,8). By 2030, 2.62 million people will need dialysis because kidney failure is projected to affect 5-10 million people annually. The burden of ESRD globally is predicted to have increased by 29.3% and 32% since 1990 and 2005, respectively (9). The Ministry of Health's annual health report states that chronic ESRD has become a severe health issue in Oman, affecting millions of people globally, with the number of dialysis patients rising from 618 to 2264 from 2015 to 2020, increasing the cost of treatment in Oman (10,11). Globally, dialysis or transplantation is life-saving options for ESRD patients diagnosed with stage 5 ESRD, with renal replacement therapy (RRT) exceeding 2.5 million, and the need projected to increase by about 8.0% per year (5,12). In 2009, risk factors for ESRD were reported as overweight, hypertension (HTN), diabetic kidney disease with reduced GFR to 60 mL/min/1.73 m^2 or below among Omani individuals aged 40 years and older who need RRT, especially those with diabetes and HTN (13-15). The majority of the 340,000 ESRD patients in the United States receive regular hemodialysis (HD), with HD accounting for 92% of these patients. In 2013, 18 renal dialysis facilities had 216 machines serving 1,206 HD patients and 92 peritoneal patients (14).

CKD and physiochemical alterations primarily contribute to uremia in end-stage ESRD, leading to the harmful impact

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Submitted: 15 November 2025/Accepted: 23 May 2025

DOI: https://doi.org/10.17532/jhsci.2025.2777

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of toxins and uremic syndrome on various organs (16). The most noticeable symptoms encompass neurological, gastrointestinal, cardiovascular, hematological, immune system, hormonal, and metabolic issues, whereas hypotension, cramping, nausea, disequilibrium syndrome, and weariness may result from HD. Muscle cramps are a common issue for maintenance HD (MHD) patients, and those undergoing MHD often discontinue exercise after 4-6 months (3). Dialysis patients frequently experience arm, hand, and stomach cramps, ranging from 33% to 78% (17,18). HD-induced muscle cramps are attributed to contraction, hypotension, plasma osmolality, hyponatremia, and tissue hypoxia, according to Vimala (19). In addition, dialysis patients commonly exhibit 92% exhaustion related to ESRD and MHD (20).

Globally, more people need RRT due to CKD, and in Oman, HTN and diabetes increase the risk of ESRD, the sixth leading cause of death. ESRD patients in Oman require more dialysis, straining healthcare financial burden. ESRD patients lack rehabilitation programs despite frequent HD, underscoring the need for comprehensive care (21). Studies proved that the intradialytic muscle stretching exercise (IDMSE) seems to have beneficial impact on muscle cramps and overall comfort of the patient during MHD (19) and suggest that regularly using IDMSE is associated with an appreciable decrease of muscle cramp attacks and a higher quality of life (19-26). For example, Shraida et al. in a study (2021) revealed that patients who did IDMSE reported 40% decrease in muscle cramping compared to no therapy (4). Further study of Albadr et al. (2020) also demonstrated improved flexibility in muscles and dialysis-related discomfort after doing IDMSE (25). These results emphasize that IDMSE not only effectively helps to reduce muscle cramps, but might also improve the dialysis experience itself, which is important for patients undergoing MHD and may be beneficial by implementing it in routine care. This study explores the efficacy of IDMSE in reducing uremic symptoms, including muscle cramps, in ESRD patients on MHD in Oman. The study provides vital insights into intradialytic exercise's potential benefits and addresses MHD concerns. Cost-effective and efficient ESRD treatments are important due to their economic impact, and intermittent dialysis modalities, such as IDMSE, may be considered as viable options. The study aims to inform Oman and Gulf Cooperation Council healthcare practitioners, researchers, and policymakers about future research and emphasizes the importance of exercise regimens for ESRD patients on HD with the following objectives:

1. Assess muscle cramp severity in MHD patients before and after IDMSE in both groups
2. Evaluate the effectiveness of IDMSE on muscle cramps in MHD patients
3. Analyze the relationship between demographic variables and muscle cramps in MHD patients.

METHODS

This study employed a randomized controlled trial (RCT)-pretest/posttest design to assess the effectiveness of IDMSE on muscle cramps among patients undergoing MHD in Oman. Participants who met the inclusion criteria were randomly assigned to either the intervention group, which received IDMSE during dialysis sessions, or the control group, which continued with standard care. Muscle cramp severity was evaluated using a validated scale before and after the intervention, allowing for a strong comparison of outcomes between the two groups as detailed in Table 1.

The study was conducted at the dialysis unit (DU) in the Muscat region, which is part of the Ministry of Health hospitals. It is a government hospital with a bed capacity of 52 beds and serves 345 patients (21). DU operates 24 h a day, 7 days a week, and receives groups of patients in blocks on alternate days for three shifts: Morning (7-11 am), afternoon (12-4 pm), and evening (5-9 pm).

The accessible population consisted of all ESRD patients on MHD presenting to DU and chosen using a block sampling technique. The participants for this study were adult ESRD patients (18 years of age and above) who met the inclusion criteria and had been undergoing MHD for not <3 months. They were receiving regular dialysis at DU, 2-3 times/week, for approximately 4 h daily. The exclusion criteria were patients with malignancy or hepatic and liver failure, patients with any lower limb disability, altered sensorium, fracture, or bone disease, and patients undergoing emergency or their first HD, as well as patients referred from other hospitals for temporary dialysis.

The sample size was estimated using power analysis, considering the relationship between sample size, statistical power, significance level, and effect size (27). After accounting for a 10% non-response rate, the total sample size will be 80 participants (n1 = 40 participants and n2 = 40 participants).

This study focused on MHD patients with ESRD, recruiting 78 participants who met the inclusion criteria. Block randomization sampling, a double-blinding technique, was utilized for unbiased allocation. Patients were categorized into Block I (Saturday, Monday, and Wednesday) and Block II (Sunday, Tuesday, and Thursday) as mentioned in Figure 1.

The muscle cramps questionnaire used a modified numerical pain rating scale to assess pain severity on five items: frequency, intensity, quality, muscle cramp intensity, and muscle tone. Responses were scored on a scale of five possibilities: No pain (0), Normal (1), Mild (2), Moderate (3), and Severe (4). The cumulative score interpretation categorized responses as Normal (0-5), Mild (6-8), Moderate (9-14), and Severe (15-20). After the intervention, participants completed the cramps questionnaire and were scored up to 20 points. The tool's reliability was established by other studies (r = 0.89) (22,23). After obtaining approval from the Research and Ethics Committee and before commencing the study, a pilot study was conducted to test the instrument's appropriateness.

A registered nurse specialized in HD led IDMSE for the intervention group during the 2nd and 3rd h of MHD. The IDMSE intervention included ankle dorsiflexion, gastrocnemius, soleus, hamstring, and quadriceps stretching. Patients began by flexing and stretching their lower limbs. The nurse supported the patient's flexed knee joint and gently extended the foot downwards using her inner forearm until the calf was stretched. The support for the knee joint

TABLE 1. Study design and intervention timeline for intervention and control groups

Groups	Pre-test	Intervention 4 weeks period (weeks 1-4)	Post-test 1 after 4 weeks (weeks 5)	Intervention 4 weeks period (weeks 6-9)	Post-test 2 after 9 weeks (weeks 10)
Intervention group	O1	X*	O2	X*	O3
Control group	O1	*	O2	*	O3

O1: Demographic variables and pretest, O2: Posttest, X: Intervention of intradialytic muscle stretching exercises, *: Routine care at the dialysis unit

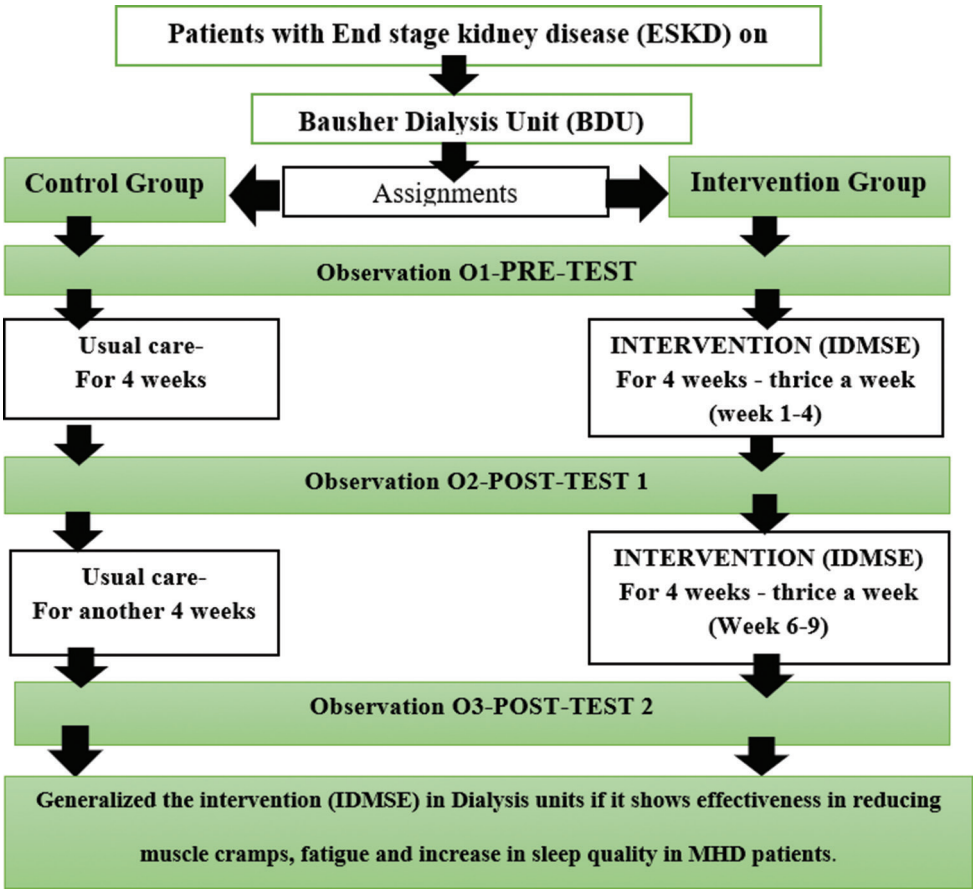

FIGURE 1. Diagram showing the process of implementing the intervention.

was then released, and the foot was steadily pushed from a flexed to a flat position. After 20-30 s, the stretch was gradually released. This exercise was repeated 3 times with a 1-min pause between each repetition for both legs. The average duration of the workout was 20-30 min. The intervention group performed this IDMSE 3 times a week on alternate days for 10 weeks. Meanwhile, during the same period, the control group received usual procedures and routine care as per the DU protocols.

The study commenced with a recruitment week (August 1-6, 2022) followed by a 2-week training session for HD staff nurses (August 7-21, 2022) at Oman's dialysis facility, running from August 21 to November 05, 2022. Data from computerized medical records and 15-20-min questionnaires were collected. Nurses and the principal investigator (PI) administered post-tests to the intervention and control groups. The RCT commenced with IDMSE for the intervention group over 10 weeks, instructed by nurses and monitored by the PI after another training course, whereas the control group received only routine treatment. Both groups completed the questionnaire at pre-test (week 1), post-test 1 (week 5), and post-test 2 (week 10). No events or dropouts occurred during the research.

The study was approved by the Sultan Qaboos University College of Nursing Research and Ethics Committee (CON/MSN/2022/3 dated April 26th, 2022) and the Ministry of Health (MOH/CSR/22/25893 dated September 01st, 2022). Participants were informed that their participation was voluntary and that they could opt out at any time before or during the trial. Before signing the informed consent, participants were briefed on the study's purpose, potential benefits, risks, and the voluntary nature of their participation. They were assured that there were no serious risks associated with the trial, and no payment was required from the participants. Data collection tools ensured anonymity, with patient-identifying hospital record numbers masked with study-specific code numbers to protect participant privacy.

Data were entered and analyzed into Statistical Packages for the Social Sciences using version 26. Frequencies and percentages were calculated for each categorical variable, while continuous variables were described using the mean and standard deviation. Comparisons between different categorical variables were conducted using Chi-square tests, and comparisons between different numerical variables were conducted using t-tests, repeated-measures analysis of variance, and Friedman tests. A significance level of 0.05 was used for all tests.

RESULTS

A total of 78 patients participated in the study. Patients were randomly assigned to one of two groups: Control (n = 39) or intervention (n = 39). The demographic characteristics of the participants are summarized in Table 2. Questionnaires were collected from all MHD patients, and there was no dropout rate throughout the intervention. Most participants in the control (34%) and intervention (36%) groups were aged 40-49. In addition, most participants in both the control (69%) and intervention (79%) groups were male. Many participants in the control (64%) and intervention (72%) groups completed at least high school. More than half of the participants in the control (72%) and intervention (62%) groups were married. Furthermore, 66% of the intervention group were unemployed, compared to 41% of the control group.

Demographic characteristics showed no significant differences between the control and intervention groups, as determined by a Chi-squared test with a significance level of 0.05. Regarding kidney-related comorbidities, out of the total sample, the majority of patients (n = 51) had HTN, while (n = 42) had diabetes mellitus (DM). There were only six patients with cardiovascular disease (CVS), three with systemic lupus erythematous, two with other kidney diseases, and one with cancer and high cholesterol.

Table 3 presents the clinical characteristics of the participants, revealing that over half of the participants in the control group (51%) had an illness duration between 1 and 3 years, while over half of the participants in the intervention group had an illness duration exceeding 3 years (51%). However, both groups had been on HD for over 3 months. The majority of participants had previous experience with muscle cramps, displaying an irregular pattern. Most hemodialyzed patients experienced muscle cramps during the last hours of their sessions. Significant differences were observed between participants in the control and intervention groups concerning the duration of illness and HD. These differences were observed with $\chi^2 = 7.51$, $p < 0.05$, and $\chi^2 = 6.86$, $p < 0.05$, respectively. In addition, there was a distinction in previous experience with muscle cramps ($\chi^2 = 8.41$, $p < 0.01$) and frequency of muscle cramps during HD per week ($\chi^2 = 11.13$, $p < 0.01$) between participants in the control and intervention groups.

Table 4 presents post-test muscular cramp levels for the control and intervention groups, consisting of 78 individuals (post-test 1, O2). The majority of control group members reported minor muscle cramps in hours II (84.6%), III (82.1%), and IV (71.8%). Only 12.8-23.1% experienced moderate cramps, and 2.6-5.1% reported severe cramps. Conversely, most intervention group members experienced minor cramps in hours II (92.3%), III (97.4%), and IV (79.5%). Moderate cramps were observed in 7.7-20.5% of cases, but severe cramps were not reported. Chi-square testing revealed no significant differences in cramp occurrences between the control and intervention groups in hours II ($p = 0.433$), III ($p = 0.075$), and IV ($p = 0.209$).

Table 4 also presents the comparison of post-test 1 (O2) muscular cramp levels for the 78 participants in the control and intervention groups. Only a few control group

TABLE 2. Demographic characteristics of the participants (n=78)

Characteristics	Category	Intervention group n=39 (%)	Control group n=39 (%)	χ^2 *p*-value
Age in years	18-28 years	02 (5)	00 (0)	χ^2=10.54
	29-39 years	04 (10)	13 (11)	*p*=0.061
	40-49 years	14 (36)	15 (34)	
	50-59 years	10 (26)	05 (26)	
	60-70 years	07 (18)	06 (18)	
	Above 70	02 (5)	00 (0)	
Gender	Male	31 (79)	27 (69)	χ^2=1.067
	Female	08 (21)	12 (20)	*p*=0.300
Education	No formal education	04 (10)	08 (21)	χ^2=2.501
	Primary education	07 (18)	06 (15)	*p*=0.644
	High school education	12 (31)	11 (28)	
	Higher secondary school	06 (15)	03 (8)	
	Graduates	10 (26)	11 (28)	
Marital status	Married	24 (62)	28 (72)	χ^2=3.86
	Unmarried	11 (28)	07 (18)	*p*=0.277
	Widow	04 (10)	02 (5)	
	Divorce	00 (0)	02 (5)	
Occupation	Self employed	03 (8)	01 (3)	χ^2=7.631
	Government employee	07 (18)	07 (18)	*p*=0.106
	Unemployed	16 (41)	26 (66)	
	Private employee	11 (28)	05 (13)	
	Retired	02 (5)	00 (0)	

χ^2: Chi-square, *: Statistically significant $p<0.05$

TABLE 3. Clinical characteristics of the participants (n=78)

Characteristics	Category	Intervention n=39 (%)	Control n=39 (%)	χ^2 *p*-value
Duration of illness	0-1 year	6 (15)	0 (0)	χ^2=7.51
	1-3 years	13 (33)	20 (51)	*p*=0.023*
	Above 3 years	20 (51)	19 (49)	
Duration of hemodialysis	>4 months	36 (92)	27 (69)	χ^2=6.68
	<4 months	3 (8)	12 (31)	*p*=0.010*
Previous experience of muscle cramps	Yes	35 (90)	24 (62)	χ^2=8.41
	No	4 (10)	15 (38)	*p*=0.004*
Patterns of muscle cramps	Constant	6 (15)	12 (31)	χ^2=2.600
	Intermittent	33 (85)	27 (69)	*p*=0.107
Frequency of muscle cramps hemodialysis per week.	Once	11 (28)	6 (15)	χ^2=11.13
	Twice	12 (31)	3 (8)	*p*=0.004*
	Thrice	16 (41)	30 (77)	
When do you experience the muscle cramps during hemodialysis?	First hour	2 (5)	4 (10)	χ^2=2.11
	Mid hours	9 (23)	13 (33)	*p*=0.348
	Last hours	28 (72)	22 (56)	
Measures taken to cope with muscle cramps	Walking	6 (15)	4 (10)	χ^2=5.34
	Distraction	16 (41)	8 (21)	*p*=0.148
	Massaging	14 (36)	22 (56)	
	Medications	3 (8)	5 (13)	

χ^2: Chi-square, *: Statistically significant $p<0.05$

TABLE 4. Comparison between control group and intervention group in level of muscle cramps (pre-test [O1], post-test 1 [O2] and post-test 2 [O3])

Pre-test	No.	Level of muscle cramps	Hour II n (%)	Hour III n (%)	Hour IV n (%)
Control group (n=39)	1	No pain	36 (92.3)	30 (76.9)	28 (71.8)
	2	Mild	2 (5.1)	8 (20.5)	9 (23.1)
	3	Moderate	1 (2.6)	1 (2.6)	2 (5.1)
	4	Severe	-	-	-
Intervention group (n=39)	1	No pain	33 (84.6)	35 (89.7)	22 (56.4)
	2	Mild	5 (12.8)	4 (10.3)	12 (30.8)
	3	Moderate	1 (2.6)	-	5 (12.8)
	4	Severe	-		-
p-value			0.493	0.129	0.296
Post-test 1					
Control group (n=39)	1	No pain	-	-	-
	2	Mild	33 (84.6)	32 (82.1)	28 (71.8)
	3	Moderate	5 (12.8)	5 (12.8)	9 (23.1)
	4	Severe	1 (2.6)	2 (5.1)	2 (5.1)
Intervention group (n=39)	1	No pain	-		-
	2	Mild	36 (92.3)	38 (97.4)	31 (79.5)
	3	Moderate	3 (7.7)	1 (12.6)	8 (20.5)
	4	Severe	0 (0.0)	0 (0.0)	0 (0.0)
p-value			0.433	0.075	0.209
Post-test 2					
Control group (n=39)	1	No pain	-	-	-
	2	Mild	32 (82.1)	31 (79.5)	29 (74.4)
	3	Moderate	6 (15.4)	7 (17.9)	7 (17.9)
	4	Severe	1 (2.6)	1 (2.6)	3 (7.7)
Intervention group (n=39)	1	No pain	-	-	-
	2	Mild	38 (97.4)	39 (100)	38 (97.4)
	3	Moderate	1 (2.6)	0 (00.0)	0 (0.0)
	4	Severe	0 (0.0)	0 (00.0)	1 (2.6)
p-value			0.079	0.012*	0.004*

χ^2: Chi-square, *: Statistically significant $p<0.05$, *: Statistically significant $p<0.05$, –: No one selected it; conducted using independent sample t-test

members experienced moderate or severe cramps in hours II (84.6%), III (82.1%), and IV (71.8%). In contrast, the intervention group predominantly reported mild cramps in hours II (92.3%), III (97.4%), and IV (79.5%), with few instances of moderate cramps and none of severe cramps. Chi-square tests showed no significant group differences (p: 0.433, 0.075, and 0.209).

In addition, post-test 2 (O3) muscular cramp levels are compared in Table 4. In hours II (82.1%), III (79.5%), and IV (74.4%), the control group predominantly experienced mild cramps, with occasionally moderate and severe instances. On the other hand, the intervention group reported mild cramps in hours II (97.4%), III (100%), and IV (97.4%), with significantly reduced occurrences of moderate and severe cramps in hours III (p = 0.012*) and IV (p = 0.004*). However, there was no significant difference observed in hour II (p = 0.079).

Post-test 1 muscular cramps and demographic factors in the intervention group are shown in Table 5. Age and gender did not affect muscular cramping in any observation hour ($p > 0.05$). Marital status became significant in the 4th h (p = 0.279). Education was associated with 4th-h muscle cramps (p = 0.044*), although occupation and HD

TABLE 5. Association Between level of muscle cramps and demographic variables in intervention group from hour II to IV (n=39)

S. No.	Demographic variables	*p*-value		
		Hour II	Hour III	Hour IV
1.	Age	0.220	0.497	0.949
2.	Gender	0.55	0.453	0.493
3.	Marital status	0.056	0.072	0.279
4.	Education	0.681	0.062	0.044*
5.	Occupation	0.944	0.846	0.138
6.	Duration of hemodialysis	0.350	0.530	0.885
7.	Comorbidities DM	0.671	0.383	0.502
8.	Comorbidities HTN	0.347	0.531	0.268
9.	Comorbidities CVS	0.032*	0.958	0.294
10.	Previous experience of muscle cramps	0.00*	0.942	0.018*
11.	Patterns of muscle cramps	0.463	0.884	0.196
12.	Frequency of hemodialysis per week	0.207	0.101	0.322
13.	When do you experience the muscle cramps during hemodialysis?	0.006*	0.02*	0.00*
14.	Measures taken to cope with muscle cramps	0.696	0.313	0.003*

*:Statistically significant $p<0.05$, conducted using *t*-test, repeated-measures ANOVA, and Friedman test

duration were not ($p > 0.05$). DM and HTN did not substantially affect muscle cramps in the 2nd h ($p > 0.05$), but CVS did (p = 0.032).

In the 2nd h, cramp patterns did not indicate a significant association, although previous cramp episodes did (p = 0.076). In the 2nd, 3rd, and 4th h of HD, muscle cramp timing was strongly associated (p = 0.006*, p = 0.02, p = 0.012). Coping measures indicated significant relationships in the 3rd and 4th h (p = 0.003, p = 0.313). These findings reveal how demographic characteristics affect muscular cramps in the intervention group over observation periods.

With regard to statistically significant associations ($p < 0.05$) between different time intervals for several demographic and clinical variables. Specifically, level of education displayed significance at hour III (p = 0.062) and hour IV (p = 0.044), indicating a potential influence on muscle cramp severity; the presence of comorbidities related to CVS exhibited significance at hour II (p = 0.032), suggesting a link between these conditions and muscle cramp severity during HD; previous experiences of muscle cramps were significantly associated with the severity at both hour II (p = 0.023) and hour IV (p = 0.018), indicating a consistent influence across the intervention period; the timing of muscle cramp occurrences during HD sessions showed significance at all-time points (hour II: p = 0.006, hour III: p = 0.02, hour IV: p = 0.002), implying its consistent impact on the severity of cramps; and measures taken to cope with muscle cramps demonstrated significance at hour IV (p = 0.003), suggesting an association between coping strategies and cramp severity towards the later stages of the intervention period.

DISCUSSION

The intervention and control groups exhibited significantly different levels of muscle cramps in the 3rd and

4th h, with $p = 0.012$ and 0.004, respectively. This contradicted the hypothesis that IDMSE did not produce any changes before IDMSE. IDMSE reduced HD -related muscular cramps, as indicated by investigations conducted by Elsedawy et al. (24), Albadr et al. (25), Jayasrikannan et al. (26), Kaur et al. (28), Shraida et al. (4), Kamaraj and Rachel (29), and Vimala (19) discovered that IDMSE significantly reduced severe muscular cramps, while IDMSEs significantly reduced mild to no discomfort, as observed by Shraida et al. (4). Despite variations in sample size and duration across different studies, the overall findings support the effectiveness of intermittent dialysis modalities, specifically IDMSE.

The study highlighted IDMSE's safety, practicality, and positive effects on exercise adoption and adherence, as mentioned by Albadr et al. (25), who emphasized that IDMSE is a nonpharmacological treatment for muscle cramps. According to Merline et al. (30), intradialytic exercise improves many health indices. Mohmmed et al. (31) also noted that intradialytic stretching activities reduce muscle cramps, emphasizing the necessity of incorporating different stretching exercises, a point supported by the current study using the muscle cramp questionnaire chart. Other research by Jancy and Parimala (32) demonstrates that diverse exercise regimes reduce muscle cramps and increase participant satisfaction. The study's findings regarding the timing of muscle cramps align with Mohmmed et al. (31), Chavda and Singh (33), and Elavally et al. (34), indicating that muscle cramps tend to occur in the latter hours of treatment, especially after IDMSE, possibly due to fast fluid elimination during HD.

The study confirms IDMSE's role in minimizing muscle cramps in HD patients. Its holistic approach, uniform protocol, and social support can assist healthcare providers in promoting IDMSE. Patients' comfort and satisfaction support IDMSE as a simple and effective treatment for muscle spasms. To improve patient outcomes and access, the study recommends widespread utilization of social support and technology. The Omani patient research sheds light on both Middle Eastern and Western perspectives. Future research should explore the impact of IDMSE on HD patients' quality of life, focusing on exercise and nonpharmacological therapies. This study lays the groundwork for global research and implementation of IDMSE.

Implication for clinical practice

The study demonstrates that intradialytic muscle stretching in dialysis centers prevents muscle cramps, indicating that stretching should be incorporated into training, patient education, and HD sessions. Nursing professionals and students require ongoing training and awareness campaigns led by nurses. Nurse administrators should lead in-service instruction for HD nurses based on the study findings. Intradialytic stretching ought to be included in nursing curricula conducted by nurse educators. The study establishes the groundwork for evidence-based methods in intradialytic stretching, including sample size considerations, biochemical tests, training sequences, and comparative studies on alternative therapies.

Strengths and limitations of the study

Oman's first RCT study, and one of the few in the Middle East, to test the effectiveness of intradialytic muscular stretching exercise on muscle cramps among patients undergoing MHD, is its strength. No other study has examined this intervention in Oman and the Middle East. The findings are bolstered by recruiting from BDU, a large government dialysis center. Strong recommendations from the study can enhance MHD worldwide. Arabic-translated, reliable chronic illness research methodologies increase the study's internal and external validity. The study contributes to strengthening global MHD.

Despite its virtues, the study has drawbacks. First, many people in both groups used massage for muscle pain, but the study did not specify whether this was an inclusion/exclusion factor. The findings may have been less generalizable since individuals preferred IDMSEs. Both groups initially struggled with IDMSE, presumably due to a sedentary lifestyle, but improved subsequently.

Recommendation

The dialysis center in Muscat, Oman, conducted an RCT involving 78 MHD patients, evenly divided into control and intervention groups. The findings suggest that nursing care should include IDMSE. Key points identified from the study include:

1. Long-term safety and efficacy of IDMSE: Given the positive impact of IDMSE on reducing muscle cramp severity in the intervention group, future research should explore the long-term safety and efficacy of IDMSE across various healthcare institutions, particularly in under-researched regions such as the Middle East and the Gulf.
2. Enhancing quality of life: Further studies should investigate how these reductions contribute to overall improvements in quality of life for patients, as the findings indicate that IDMSE significantly reduced the occurrence of moderate and severe muscle cramps during MHD.
3. Improving treatment protocols: Analyzing the relationship between IDMSE and patient outcomes, including mortality rates, can inform better treatment decisions and enhance MHD protocols, as the associations between demographic factors and muscle cramp severity suggest a need for personalized treatment regimens in the current study.

CONCLUSION

The typical difficulties experienced by individuals undergoing HD treatment include muscle cramps related to ESRD and ongoing MHD. Although there are multiple therapies available, none of them offer complete relief. An IDMSE was implemented for patients undergoing MHD at DU as part of an RCT. Administered 3 times/week during dialysis, IDMSE effectively decreased muscle cramp. The study highlights the significance of healthcare workers, particularly HD nurses, in incorporating IDMSE into regular practice. Further large-scale studies are needed to validate and improve patient outcomes by examining a holistic strategy, IDMSE methodology, and prolonged intervention periods.

DATA AVAILABILITY

The supporting data will be available from the first author upon request.

FUNDING

The study claims no funding resources.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

ACKNOWLEDGMENT

The authors would like to acknowledge the participants of the study, and experts involved, and all the research assistants.

DECLARATION OF INTEREST

The authors declare no conflict of interest.

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