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Efficacy of a Nurse-Led Exercise Intervention in Improving Lower Limb Cramps and Fatigue among Patients Undergoing Hemodialysis: A Randomized Controlled Trial

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ABSTRACT:

Background: Patients undergoing maintenance haemodialysis frequently experience lower limb cramps and fatigue, which can adversely affect physical functioning and daily activities. Structured exercise interventions may provide a supportive non-pharmacological approach to managing these symptoms.

Aim: To evaluate the efficacy of a nurse-led exercise intervention in improving lower limb cramps and fatigue among patients undergoing haemodialysis.

Methods: A quantitative approach with a randomized controlled trial and parallel-group design was adopted. A total of 120 patients undergoing haemodialysis were included, with 60 participants allocated to the experimental group and 60 to the control group. Participants were recruited using purposive sampling, followed by block randomization. The experimental group received a structured nurse-led exercise intervention comprising educational sessions, intradialytic exercise demonstrations, and home-based renal exercise guidance over three months, while the control group received routine care. Data were collected at baseline and on Days 30, 60, and 90. Lower limb cramps and fatigue were assessed using the Lower Limb Cramps Assessment Tool and Fatigue Assessment Scale, respectively. Data were analysed using descriptive and inferential statistics.

Results: The mean lower limb cramps score in the experimental group decreased from 13.42 ± 4.06 at baseline to 8.15 ± 1.46 on Day 90. The corresponding fatigue score decreased from 32.41 ± 3.28 to 20.38 ± 2.14. Repeated-measures ANOVA demonstrated statistically significant changes in lower limb cramps ($F = 210.65$, $p < 0.001$) and fatigue ($F = 62.43$, $p < 0.001$) across the observation periods in the experimental group. Significant associations were identified between baseline lower limb cramps and age ($\chi^2 = 19.73$, $p < 0.001$) and sex ($\chi^2 = 11.02$, $p < 0.001$), and between baseline fatigue and dietary habits ($\chi^2 = 13.81$, $p = 0.001$). A significant positive correlation was observed between lower limb cramps and fatigue at baseline ($r = 0.815$, $p = 0.017$), Day 30 ($r = 0.697$, $p = 0.028$), Day 60 ($r = 0.707$, $p = 0.027$), and Day 90 ($r = 0.726$, $p = 0.004$).

Conclusion: The findings demonstrated progressive reductions in lower limb cramps and fatigue scores among patients receiving the nurse-led exercise intervention. Structured intradialytic and home-based exercise guidance may be a useful supportive nursing strategy for managing these symptoms among patients undergoing haemodialysis.

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1. INTRODUCTION

Chronic kidney disease (CKD) is a major global public health concern characterized by the progressive and irreversible deterioration of renal function, resulting in significant physiological, psychological, and socioeconomic consequences. The increasing prevalence of diabetes mellitus, hypertension, cardiovascular diseases, obesity, and population ageing has contributed to the growing burden of CKD worldwide. Advanced stages of the disease frequently require renal replacement therapy to sustain life, among which maintenance haemodialysis remains one of the most widely used treatment modalities. Although haemodialysis effectively removes metabolic waste products and excess fluid from the circulation, it cannot completely replace the complex physiological functions of healthy kidneys. Consequently, individuals undergoing long-term haemodialysis frequently experience multiple physical complications that adversely affect their functional independence and overall well-being (Kalantar-Zadeh et al., 2020; Graham-Brown et al., 2020).

Among the various complications associated with maintenance haemodialysis, lower limb cramps are particularly distressing and frequently reported symptoms. Lower limb cramps are characterized by sudden, involuntary, and painful contractions of skeletal muscles, commonly involving the calf, foot, and thigh muscles. These episodes may occur during or immediately after dialysis and are associated with fluid shifts, intravascular volume depletion, electrolyte disturbances, and impaired muscle perfusion. Recurrent muscle cramps can cause considerable discomfort, interfere with dialysis tolerance, restrict physical activity, and occasionally necessitate premature termination of dialysis sessions. The frequency and severity of these episodes may vary according to individual characteristics and dialysis-related factors, making their assessment and management important components of comprehensive haemodialysis care (Johansen, 2020; Alshammari et al., 2024).

Fatigue is another major and commonly experienced symptom among patients undergoing maintenance haemodialysis. It is characterized by persistent physical, emotional, and cognitive exhaustion that may not be adequately relieved by rest. Several factors, including anaemia, chronic inflammation, nutritional deficiencies, metabolic disturbances, sleep disturbances, and physical deconditioning, may contribute to fatigue in this population. Persistent fatigue can considerably restrict patients' ability to perform activities of daily living, maintain employment, participate in social activities, and fulfil family responsibilities. It may also reduce exercise tolerance, physical functioning, and the capacity to maintain independence. The multifactorial nature of fatigue highlights the need for comprehensive assessment and appropriate supportive interventions among individuals receiving long-term haemodialysis (Johansen, 2020; Urquhart et al., 2021).

Lower limb cramps and fatigue are closely related clinical problems that may contribute to increased symptom burden among patients undergoing haemodialysis. Recurrent painful muscle contractions can interfere with physical activity and contribute to discomfort, while persistent fatigue may further reduce physical endurance and functional capacity. The coexistence of these symptoms can affect patients' ability to participate in routine activities and maintain an acceptable level of physical functioning. Therefore, identifying practical and effective nursing interventions to address lower limb cramps and fatigue is an important aspect of holistic renal nursing care.

In recent years, non-pharmacological interventions, particularly structured exercise programmes, have gained increasing attention as supportive approaches for managing haemodialysis-related complications. Exercise interventions may include stretching, flexibility exercises, resistance training, and aerobic activities performed during dialysis sessions or at home. Regular physical activity can improve muscular strength, circulation, physical endurance, and functional capacity. Appropriate exercise may also help reduce physical deconditioning and improve patients' ability to perform daily activities. Intradialytic exercise offers an additional practical advantage by utilizing the otherwise sedentary period of dialysis treatment, potentially reducing barriers associated with transportation, scheduling, and adherence to separate exercise sessions. Previous research has demonstrated beneficial effects of exercise interventions on physical performance and fatigue among individuals receiving dialysis (Debnath et al., 2021; Bossola et al., 2022; Battaglia et al., 2023).

Nurses play a pivotal role in promoting and implementing exercise-based interventions among patients undergoing haemodialysis. Through continuous patient assessment, health education, individualized exercise instruction, supervision, and monitoring, nurses can facilitate safe participation in structured physical activity. Nurse-led exercise interventions can be integrated into routine dialysis care and supplemented with prescribed home-based activities to encourage continuity of exercise participation. Such interventions provide an opportunity to strengthen patient involvement in self-care, promote

healthy behaviours, and improve physical functioning. Furthermore, nursing supervision enables the identification of exercise-related discomfort and the modification of activities according to individual tolerance and clinical stability.

Despite the growing evidence supporting the benefits of physical activity among individuals with chronic kidney disease, the implementation of structured nurse-led exercise interventions remains limited in several haemodialysis settings. Existing investigations have frequently focused on individual outcomes, such as fatigue, muscle strength, or physical functioning, while the combined assessment of lower limb cramps and fatigue requires further attention. The need for integrated nursing interventions addressing these important symptoms is particularly relevant in resource-constrained healthcare settings, where feasible and cost-effective strategies can be incorporated into routine clinical practice.

Therefore, the present study was undertaken to evaluate the efficacy of a nurse-led exercise intervention in improving lower limb cramps and fatigue among clients undergoing haemodialysis in selected hospitals in Coimbatore, Tamil Nadu, India. By examining these two important clinical outcomes, the study aims to contribute evidence regarding the role of structured nurse-led exercise interventions in symptom management and support the integration of exercise-based approaches into routine haemodialysis nursing practice.

2. MATERIALS AND METHODS

2.1 Study Design

An evaluative study was conducted using a quantitative research approach and a randomized controlled trial design with a parallel-arm structure and repeated measurements. The study was designed to evaluate the efficacy of a nurse-led exercise intervention in improving lower limb cramps and fatigue among clients undergoing maintenance haemodialysis. Participants were assigned to either an experimental group receiving the nurse-led exercise intervention or a control group receiving routine care.

2.2 Study Setting

The pilot study was conducted at St. Mary's Hospital, Podanur, Coimbatore, Tamil Nadu, India. The main study was conducted at Sri Bala Medical Centre and Hospital, Ramanathapuram, and Coimbatore Kidney Centre and Specialty Hospitals, Coimbatore. These institutions provide specialized haemodialysis services to individuals with end-stage renal disease.

2.3 Study Population and Participants

The study population comprised clients undergoing maintenance haemodialysis in Coimbatore district, Tamil Nadu, India. Participants were selected using a purposive sampling technique based on predefined eligibility criteria.

Inclusion criteria:

- Patients aged 18 years and above.
- Patients who were physically stable and capable of participating in intradialytic and home-based exercise interventions.
- Patients with a minimum history of three months of regular haemodialysis.
- Patients willing to participate and provide informed consent.
- Patients with severe cognitive impairment, acute or chronic psychiatric illness, severe physical disabilities, bedridden conditions, or recent major surgery or medical interventions restricting physical activity were excluded.

2.4 Sample Size and Group Allocation

The sample size was estimated using G*Power software for repeated-measures analysis of variance, considering an effect size of 0.40, a significance level of 0.05, statistical power of 0.95, two study groups, and repeated measurements. The calculated sample size was 120 participants, with 60 participants allocated to each group.

Purposive sampling was used for participant recruitment. Block randomization with variable block sizes of 4, 6, and 8 was employed for group allocation. Allocation concealment was maintained using sequentially numbered opaque sealed envelopes, administered by a staff nurse who was not involved in delivering the intervention.

2.5 Study Variables

The independent variable was the nurse-led exercise intervention.

The dependent variables were:

Severity of lower limb cramps.

Level of fatigue.

Demographic and clinical characteristics, including age, gender, educational status, occupation, monthly family income, religion, marital status, dietary habits, body mass index, personal habits, and duration of haemodialysis, were also assessed.

2.6 Assessment Instruments

Data were collected using a structured assessment schedule comprising three relevant sections.

Part I: Demographic and Clinical Information

This section collected information regarding participants' sociodemographic and clinical characteristics.

Part II: Lower Limb Cramps Assessment Tool (LLCAT)

Lower limb cramps were assessed using a structured instrument covering four dimensions: frequency, intensity, duration, and impact on daily activities. Each dimension was scored from 0 to 4, producing a total score ranging from 0 to 16. Higher scores indicated greater severity and impact of lower limb cramps.

Part III: Fatigue Assessment Scale (FAS)

Fatigue was evaluated using a 10-item Fatigue Assessment Scale. Each item was scored from 0 to 4, generating a total score ranging from 0 to 40, with higher scores indicating greater fatigue.

2.7 Validity and Reliability of the Instruments

Content validity was assessed by seven subject experts comprising nursing and medical professionals. The instruments were evaluated for relevance, clarity, simplicity, and ambiguity. The reported item-level content validity index and scale-level content validity index were 1.00 for the assessment instruments.

Internal consistency reliability was evaluated using Cronbach's alpha. The reported reliability coefficients were 0.83 for the Lower Limb Cramps Assessment Tool and 0.79 for the Fatigue Assessment Scale. These coefficients indicated acceptable internal consistency of the assessment instruments in the study.

2.8 Nurse-Led Exercise Intervention

The experimental group received a structured nurse-led exercise intervention designed to improve lower limb cramps and fatigue. The intervention incorporated educational sessions, demonstrations of intradialytic exercises, and instructions regarding home-based renal exercises.

The educational component consisted of the following sessions:

- **Kidney anatomy and chronic renal failure (30 minutes):** Information regarding normal kidney anatomy and physiology, chronic renal failure, risk factors, stages, clinical manifestations, diagnostic investigations, and treatment modalities.
- **Dialysis and haemodialysis (30 minutes):** Education regarding dialysis procedures, haemodialysis, vascular access, fistula care, relevant investigations, and general patient management.
- **Intradialytic exercise demonstration (30 minutes):** Demonstration and instruction regarding prescribed exercises performed during haemodialysis sessions.
- **Home-based renal exercise demonstration (15 minutes):** Demonstration and instruction regarding prescribed home-based exercises.

Interaction sessions of 10, 10, 5, and 5 minutes, respectively, were incorporated to facilitate participant engagement and clarify doubts.

The intervention was implemented over three months, with supervision and follow-up to encourage adherence. Participants in the control group continued to receive routine care according to hospital protocols.

2.9 Data Collection Procedure

The main study data were collected between 5 January 2026 and 28 March 2026. Following administrative permission and ethical clearance, eligible participants were identified and recruited from the selected haemodialysis centres.

The purpose and procedures of the study were explained to the participants, and informed consent was obtained. Baseline assessments were conducted on Day 1 in both groups using the Lower Limb Cramps Assessment Tool and Fatigue Assessment Scale.

Following baseline assessment, the experimental group received the nurse-led exercise intervention, while the control group continued routine care. The experimental group was guided to participate in the prescribed exercises during haemodialysis sessions and at home throughout the three-month intervention period.

Follow-up assessments were conducted using the same instruments at three time points:

Post-test I: Day 30.

Post-test II: Day 60.

Post-test III: Day 90.

The repeated assessments enabled evaluation of changes in lower limb cramps and fatigue over the intervention period.

2.10 Ethical Considerations

Ethical approval was obtained from the Ethical Clearance Committee of Desh Bhagat University, Mandi Gobindgarh. Administrative permission was obtained from the concerned hospital authorities in Coimbatore district. Participants were informed about the purpose and procedures of the study, their right to voluntary participation and withdrawal, and the confidentiality of their information. Informed consent was obtained before data collection. The principles of beneficence, respect for human dignity, justice, and confidentiality were followed throughout the research process.

2.11 Statistical Analysis

Data were organized and analysed using IBM SPSS Statistics, version 26. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to summarize demographic characteristics and outcome measures.

The Kolmogorov–Smirnov test was used to assess normality. Mauchly's test of sphericity and Levene's test were included in the analysis plan to assess relevant statistical assumptions. Repeated-measures analysis of variance (ANOVA) was used to examine changes in lower limb cramps and fatigue scores across assessment periods. Pearson's correlation coefficient was used to examine the relationship between lower limb cramps and fatigue. The chi-square test was used to examine associations between demographic characteristics and baseline outcome categories. Statistical significance was considered at $p < 0.05$.

3. RESULTS

A total of 120 clients undergoing maintenance haemodialysis were included in the study, comprising 60 participants in the experimental group and 60 participants in the control group. The outcomes were assessed at baseline and on Days 30, 60, and 90 following the nurse-led exercise intervention. The findings are presented in terms of lower limb cramps, fatigue, associations with demographic variables, and the relationship between the study variables.

3.1. Changes in Lower Limb Cramps and Fatigue

Table 1. Comparison of mean lower limb cramps and fatigue scores between the experimental and control groups

Outcome variable	Assessment	Experimental group Mean ± SD	Control group Mean ± SD
Lower limb cramps	Baseline	13.42 ± 4.06	13.34 ± 3.94
	Day 30	10.41 ± 3.33	12.41 ± 4.47
	Day 60	9.27 ± 2.60	12.27 ± 3.56
	Day 90	8.15 ± 1.46	11.52 ± 3.24
Fatigue	Baseline	32.41 ± 3.28	32.31 ± 3.41
	Day 30	29.24 ± 2.56	31.27 ± 3.38
	Day 60	25.56 ± 2.34	29.96 ± 3.16
	Day 90	20.38 ± 2.14	28.68 ± 3.09

The experimental group demonstrated a progressive reduction in lower limb cramps scores from 13.42 ± 4.06 at baseline to 8.15 ± 1.46 at Day 90. Similarly, fatigue scores decreased from 32.41 ± 3.28 to 20.38 ± 2.14. The control group demonstrated comparatively smaller reductions in both outcome measures.

Repeated-measures ANOVA revealed statistically significant changes in lower limb cramps scores in the experimental group ($F = 210.65$, $p < 0.001$) and fatigue scores ($F = 62.43$, $p < 0.001$). Significant changes were also reported in the control group for lower limb cramps ($F = 10.72$, $p < 0.05$) and fatigue ($F = 5.061$, $p = 0.036$).

Figure 1. Progressive reduction in lower limb cramps scores

Mean lower limb cramps scores at baseline, Day 30, Day 60, and Day 90. Lower scores indicate improvement.

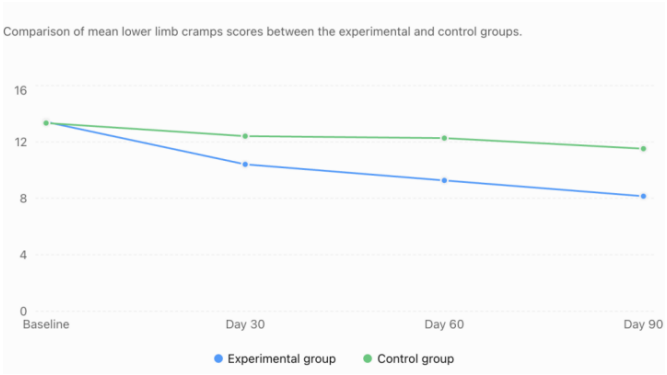


Figure 2. Progressive reduction in fatigue scores

Mean fatigue scores at baseline and follow-up assessments. Lower scores indicate improvement.



3.2. Association Between Demographic Characteristics and Baseline Outcome Variables

Table 2. Statistically Significant Associations Between Demographic Characteristics and Baseline Outcome Variables in the Experimental Group

Baseline outcome variable	Demographic characteristic	χ^2 value	p-value
Lower limb cramps	Age	19.73	less than 0.001
Lower limb cramps	Sex	11.02	less than 0.001
Fatigue	Dietary habits	13.81	0.001

The analysis revealed significant associations between selected demographic characteristics and baseline outcome variables. Age and sex were significantly associated with lower limb cramps, whereas dietary habits were significantly associated with fatigue.

3.3. Relationship Between Lower Limb Cramps and Fatigue Among Clients Undergoing Haemodialysis

Table 3. Correlation Between Lower Limb Cramps and Fatigue in the Experimental Group

Assessment period	Pearson's correlation coefficient (r)	p-value
Baseline	0.815	0.017
Day 30	0.697	0.028
Day 60	0.707	0.027
Day 90	0.726	0.004

Pearson's correlation analysis demonstrated a significant positive relationship between lower limb cramps and fatigue across the pre-test and successive post-tests ($r = 0.697–0.815$, p less than 0.05), indicating that greater severity of lower limb cramps was associated with increased fatigue among clients undergoing haemodialysis.

3.4. Summary of Major Findings

The findings demonstrated progressive improvement in both lower limb cramps and fatigue among participants in the experimental group over the 90-day assessment period. The experimental group showed a greater reduction in mean lower limb cramps and fatigue scores compared with the control group. Significant associations were identified between selected demographic characteristics and baseline outcome variables. A significant positive correlation was also observed between lower limb cramps and fatigue across all assessment periods.

4. DISCUSSION

The present study was conducted to evaluate the efficacy of a nurse-led exercise intervention in improving lower limb cramps and fatigue among patients undergoing haemodialysis. The intervention included educational sessions on chronic renal failure and haemodialysis, demonstration of intradialytic exercises, and guidance on home-based renal exercises. The outcomes were assessed at baseline and on Days 30, 60, and 90. The findings demonstrated progressive reductions in lower limb cramps and fatigue scores among participants in the experimental group.

4.1 Effect of Nurse-Led Exercise Intervention on Lower Limb Cramps

The findings of the present study revealed that severe lower limb cramps were present among 86.7% of participants in the experimental group and 81.7% in the control group at baseline. Following the intervention, the experimental group demonstrated progressive improvement in lower limb cramps. The proportion of participants experiencing moderate cramps decreased across the successive assessments, while the proportion experiencing mild cramps increased to 35.0% by Day 90.

The mean lower limb cramps score in the experimental group decreased from 13.42 ± 4.06 at baseline to 10.41 ± 3.33 on Day 30, 9.27 ± 2.60 on Day 60, and 8.15 ± 1.46 on Day 90. In comparison, the control group showed a smaller reduction, with mean scores decreasing from 13.34 ± 3.94 at baseline to 11.52 ± 3.24 on Day 90. These findings indicate a greater progressive reduction in lower limb cramps scores among participants who received the nurse-led exercise intervention.

The repeated-measures ANOVA demonstrated a statistically significant difference in lower limb cramps scores across the observation periods in the experimental group ($F = 210.65$, $p < 0.001$). A statistically significant variation was also observed in the control group ($F = 10.72$, $p < 0.05$), although the reduction in mean scores was comparatively smaller. The substantial reduction observed in the experimental group supports the potential benefit of structured exercise in managing lower limb cramps among patients undergoing haemodialysis.

The findings are consistent with Parlak and Akgün Şahin (2024), who reported improvement in lower-extremity cramps following an intradialytic intervention among haemodialysis patients. Similarly, Panchiri et al. (2017) reported a reduction in muscle-cramp severity following intradialytic stretching exercises. Shehata et al. (2026) also reported reductions in cramp intensity and frequency following nurse-led intradialytic stretching. These findings support the role of structured, non-pharmacological interventions in the management of dialysis-associated muscle cramps.

4.2 Effect of Nurse-Led Exercise Intervention on Fatigue

The present study findings revealed that fatigue was commonly experienced by patients undergoing haemodialysis at baseline. In the experimental group, the mean fatigue score decreased progressively from 32.41 ± 3.28 at baseline to 29.24 ± 2.56 on Day 30, 25.56 ± 2.34 on Day 60, and 20.38 ± 2.14 on Day 90. In contrast, the mean fatigue score in the control group decreased from 32.31 ± 3.41 at baseline to 28.68 ± 3.09 on Day 90.

The proportion of participants in the experimental group classified as having no fatigue increased progressively, reaching 23.3% on Day 30, 33.3% on Day 60, and 50.0% on Day 90. This progressive improvement suggests that regular participation in the nurse-led exercise intervention may have contributed to reducing fatigue among patients undergoing haemodialysis.

The repeated-measures ANOVA revealed a statistically significant difference in fatigue scores across the observation periods in the experimental group ($F = 62.43$, $p < 0.001$). A statistically significant variation was also observed in the control group ($F = 5.061$, $p = 0.036$). However, the reduction in mean fatigue scores was greater in the experimental group than in the control group.

The findings are supported by Bossola et al. (2022), who discussed fatigue among patients receiving chronic haemodialysis and highlighted its importance as a significant clinical concern. The findings also correspond with the broader evidence presented in the study regarding the potential benefits of physical activity in improving muscle strength, physical endurance, and functional capacity. Regular and appropriately supervised exercise may help patients manage physical exhaustion and improve their ability to perform daily activities.

The progressive reduction in fatigue scores observed in the present study highlights the potential value of incorporating nurse-led intradialytic and home-based exercise activities into the routine care of patients undergoing haemodialysis.

4.3 Association Between Demographic Characteristics and Baseline Outcome Variables

The present study findings revealed statistically significant associations between selected demographic characteristics and baseline lower limb cramps and fatigue among participants in the experimental group.

A significant association was observed between baseline lower limb cramps and age ($\chi^2 = 19.73$, $p < 0.001$) and sex ($\chi^2 = 11.02$, $p < 0.001$). These findings indicate that the distribution of lower limb cramps differed according to age and sex among the study participants. Such variations highlight the importance of considering individual demographic characteristics while assessing and planning nursing interventions for patients undergoing haemodialysis.

The study also demonstrated a statistically significant association between baseline fatigue and dietary habits ($\chi^2 = 13.81$, $p = 0.001$). This finding suggests that fatigue levels varied according to the dietary habits of the participants. Nutritional assessment and appropriate dietary counselling may therefore be important components of comprehensive nursing care for patients undergoing haemodialysis.

These findings emphasize the need for individualized assessment of symptoms among patients receiving maintenance haemodialysis. Nurses should consider relevant demographic and lifestyle characteristics while identifying patients who may require additional monitoring, counselling, and supportive interventions.

4.4 Relationship Between Lower Limb Cramps and Fatigue

The present study demonstrated a statistically significant positive correlation between lower limb cramps and fatigue among participants in the experimental group across all assessment periods. At baseline, a strong positive correlation was observed between lower limb cramps and fatigue scores ($r = 0.815$, $p = 0.017$). Similar positive correlations were identified on Day 30 ($r = 0.697$, $p = 0.028$), Day 60 ($r = 0.707$, $p = 0.027$), and Day 90 ($r = 0.726$, $p = 0.004$).

The positive correlation indicates that higher lower limb cramps scores were associated with higher fatigue scores. Since higher scores on both assessment tools represent greater symptom severity, the findings suggest that patients experiencing more severe lower limb cramps also tended to report greater fatigue.

This relationship highlights the interconnected nature of physical symptoms experienced by patients undergoing haemodialysis. Persistent muscle cramps may contribute to physical discomfort and interfere with normal movement and daily activities, while fatigue may further limit physical functioning. Therefore, the simultaneous assessment of lower limb cramps and fatigue is important when planning comprehensive nursing care.

The findings support the importance of addressing both symptoms through structured nursing interventions. The nurse-led exercise programme used in the present study focused on intradialytic and home-based exercises, providing a practical approach to symptom management. The observed positive correlation further emphasizes the need for integrated assessment and management of lower limb cramps and fatigue rather than considering these symptoms independently.

4.5 Overall Interpretation of the Findings

Overall, the present study demonstrated progressive reductions in lower limb cramps and fatigue scores among patients who received the nurse-led exercise intervention. The improvement was observed across the successive assessments over the three-month intervention period. The findings also revealed significant associations between selected demographic characteristics and baseline symptoms, along with a positive relationship between lower limb cramps and fatigue.

The results suggest that nurse-led exercise interventions may serve as a useful supportive strategy for managing selected physical symptoms among patients undergoing haemodialysis. Nurses can play an important role in educating patients, demonstrating appropriate exercises, encouraging adherence, and monitoring changes in symptom severity. Incorporating structured intradialytic and home-based exercise guidance into routine haemodialysis care may contribute to improved symptom management and support patient participation in self-care.

5. CONCLUSION

The present study was conducted to evaluate the efficacy of a nurse-led exercise intervention in improving lower limb cramps and fatigue among patients undergoing haemodialysis. The findings demonstrated progressive improvement in both outcome variables among participants in the experimental group over the three-month intervention period.

The mean lower limb cramps score in the experimental group decreased from 13.42 ± 4.06 at baseline to 8.15 ± 1.46 on Day 90. Similarly, the mean fatigue score decreased from 32.41 ± 3.28 to 20.38 ± 2.14 during the same period. Repeated-measures ANOVA revealed statistically significant changes in lower limb cramps ($F = 210.65$, $p < 0.001$) and fatigue scores ($F = 62.43$, $p < 0.001$) across the successive assessments in the experimental group.

The study also identified significant associations between baseline lower limb cramps and age and sex, and between baseline fatigue and dietary habits. A significant positive correlation was observed between lower limb cramps and fatigue at baseline and during all subsequent assessments, indicating that greater severity of lower limb cramps was associated with higher fatigue scores.

Based on these findings, the nurse-led exercise intervention demonstrated potential benefits in reducing lower limb cramps and fatigue among patients undergoing haemodialysis. The study highlights the important role of nurses in providing structured exercise education, demonstrating appropriate exercises, encouraging adherence, and monitoring patients'

responses. Incorporating supervised intradialytic and home-based exercise guidance into routine haemodialysis care may provide a useful supportive approach to symptom management.

Further studies involving larger samples, longer follow-up periods, and appropriate between-group statistical comparisons are recommended to strengthen the evidence regarding the effectiveness of nurse-led exercise interventions in haemodialysis care.

6. STRENGTHS AND LIMITATIONS

6.1 Strengths of the Study

The present study adopted a randomized controlled trial design with parallel experimental and control groups to evaluate the efficacy of a nurse-led exercise intervention among patients undergoing haemodialysis. Block randomization and allocation concealment using sequentially numbered opaque sealed envelopes were employed to minimize selection bias.

The intervention incorporated both intradialytic exercises and home-based renal exercises, providing a structured approach to managing lower limb cramps and fatigue. Repeated assessments at baseline and on Days 30, 60, and 90 enabled the evaluation of changes in symptom severity throughout the three-month intervention period.

The use of standardized assessment instruments, including the Lower Limb Cramps Assessment Tool and Fatigue Assessment Scale, strengthened the consistency of outcome measurement. The study also emphasized the role of nurses in patient education, exercise demonstration, supervision, and follow-up, highlighting the potential applicability of nurse-led exercise interventions in haemodialysis settings.

6.2 Limitations of the Study

The study was conducted in selected hospitals in Coimbatore, Tamil Nadu, which may limit the generalizability of the findings to patients undergoing haemodialysis in other geographical and healthcare settings.

The intervention was limited to three months, and long-term follow-up was not undertaken to determine whether the observed improvements in lower limb cramps and fatigue were sustained after completion of the programme.

The study included medically stable adult patients who were physically capable of performing exercises. Consequently, the findings may not be applicable to patients with severe physical disabilities, significant cognitive impairment, or other conditions restricting participation in exercise.

Lower limb cramps and fatigue were assessed using symptom-rating instruments, which may be influenced by individual perceptions and reporting differences. Furthermore, the reported repeated-measures analyses primarily examined changes within each group; additional between-group analyses are required to establish the magnitude and statistical significance of the intervention effect relative to routine care.

7. IMPLICATIONS FOR NURSING

7.1 Nursing Practice

The findings highlight the potential importance of integrating structured exercise interventions into routine nursing care for patients undergoing haemodialysis. Nurses can assess lower limb cramps and fatigue systematically, identify patients who may benefit from exercise-based interventions, and provide individualized guidance regarding intradialytic and home-based exercises.

Regular supervision, symptom monitoring, and patient education may encourage adherence to exercise programmes and support the management of dialysis-associated physical symptoms.

7.2 Nursing Education

Nursing education programmes should emphasize the assessment and non-pharmacological management of lower limb cramps and fatigue among patients undergoing haemodialysis. Demonstration and return-demonstration of appropriate renal exercises may be incorporated into clinical teaching to strengthen nursing students' competencies in haemodialysis care.

7.3 Nursing Administration

Nursing administrators may consider developing institutional protocols for exercise education and symptom monitoring in haemodialysis units. Appropriate staff training, interdisciplinary collaboration, and regular evaluation of exercise programmes may facilitate their safe implementation in clinical practice.

7.4 Nursing Research

Further nursing research is recommended to evaluate nurse-led exercise interventions among larger and more diverse haemodialysis populations. Future randomized controlled trials should include appropriate between-group comparisons, longer follow-up periods, and standardized intervention protocols to establish the effectiveness and sustainability of exercise-based symptom management.

8. RECOMMENDATIONS

Further multicentre randomized controlled trials with larger sample sizes are recommended to improve the generalizability of the findings. Future studies may compare different exercise modalities, intervention frequencies, and durations to identify effective approaches for reducing lower limb cramps and fatigue.

Longitudinal studies are also recommended to assess the sustainability of symptom improvement after completion of nurse-led exercise programmes. Additional research may explore exercise adherence, feasibility, patient acceptability, and barriers to implementation in haemodialysis units.

CONFLICT OF INTEREST

The author declares that there are no conflicts of interest related to the conduct, findings, or publication of this study.

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