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Effects of Nurse-Led Multidisciplinary Holistic Nonpharmacological Interventions on Fatigue in Hemodialysis Patients: A Randomized Controlled Trial

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Abstract

Fatigue is a common and debilitating symptom among patients undergoing hemodialysis, often causing both mental and physical exhaustion that negatively affects daily functioning, social engagement, and overall quality of life. Despite its impact, the significance of fatigue in this population is often underrecognized, and strategies for its management remain limited. Most prior studies have focused primarily on physical fatigue, with limited consideration of mental fatigue. This study aimed to evaluate the effectiveness of nurse-led, multidisciplinary nonpharmacological integrated care interventions (NICIs) in reducing fatigue among hemodialysis patients. The intervention combined walking exercises, motivational interviewing (MI), and educational sessions on behavioral self-management. A single-center randomized controlled trial was conducted at the dialysis unit of a tertiary university-affiliated hospital from January to June 2019. A total of 118 patients were randomly assigned to the intervention group (IG, n=60) or control group (CG, n=54). Four patients withdrew during the study, leaving 114 participants for analysis. The IG received routine nursing care supplemented with NICIs, while the CG received routine care alone. The intervention lasted six months. Participants in the IG experienced significant improvements compared with the CG, including reductions in overall fatigue (2.26 vs. 0.48), mental fatigue (1.41 vs. 0.54), and muscular fatigue (2.13 vs. 0.75). Additionally, some biochemical parameters, such as serum urea levels, showed significant improvement (P<0.05). The findings demonstrate that nurse-led multidisciplinary NICIs effectively alleviate both mental and physical fatigue and contribute to improved clinical outcomes in patients undergoing hemodialysis. This highlights the vital role of nurses and interprofessional collaboration in the management of chronic conditions.

Keywords: Nurse-led, Fatigue, Nonpharmacological interventions, Multidisciplinary, Hemodialysis

Introduction

Fatigue is highly prevalent among patients receiving hemodialysis, with reported rates ranging from 60% to 97% [1]. This symptom often results in substantial mental and physical debilitation, adversely affecting social participation, overall quality of life, and well-being [2-4]. Despite its widespread impact, the importance of fatigue in this population has not been fully recognized, and strategies for its prevention and management remain limited [5, 6]. Patients' self-management abilities are closely linked to dialysis adherence. However, limited knowledge and cognitive skills related to self-management can lead to inadequate care practices, including poor dietary adherence, which may exacerbate fatigue symptoms [7]. Interventions targeting self-management have been effectively used in chronic conditions, such as diabetes, to enhance patients' cognitive skills and promote healthy behaviors [8]. Fatigue often leads to physical inactivity, reduced mobility, and a sedentary lifestyle, ultimately impairing quality of life [9].

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Health authorities recommend approximately 30 minutes of daily physical activity for individuals with kidney disease, including those undergoing hemodialysis [10, 11]. Exercise has demonstrated beneficial effects on overall health [12], and programs involving mild- to moderate-intensity walking have been shown to alleviate fatigue and enhance life quality in hemodialysis patients [13]. Accordingly, walking was incorporated in this study as a practical lifestyle intervention to mitigate fatigue.

Fatigue can be categorized into muscular and mental components [9, 14]. Interventions targeting mental fatigue are scarce, largely because psychological therapies require specialized expertise, and few dialysis nurses possess qualifications in psychotherapy. This highlights the need for nonpsychologist-led interventions suitable for addressing mental fatigue [15]. Motivational interviewing (MI), conducted by trained personnel without formal psychotherapy credentials, has been increasingly used to modify health behaviors in chronic disease populations [16]. Helena *et al.* [17] demonstrated that MI improves dialysis adherence and associated biochemical outcomes, including serum phosphorus and albumin levels.

Previous research has primarily focused on managing muscular fatigue [18], and there are currently no pharmacological treatments that reliably prevent or treat fatigue in hemodialysis patients [19]. Nonpharmacological interventions are preferred by patients and have been widely applied in chronic disease management [20]. Moreover, a multidisciplinary approach is recommended for effective symptom management [18], and nurses can employ diverse strategies to address fatigue [21]. Therefore, this study aimed to evaluate nurse-led multidisciplinary nonpharmacological integrated care interventions (NICIs), considering social and psychophysiological factors, and to assess their effects on overall fatigue and other clinical indicators in patients undergoing hemodialysis compared with standard nursing care.

Materials and Methods

A single-center, parallel-group, randomized, and single-blind trial was conducted to assess the effectiveness of nurse-led NICIs tailored for hemodialysis patients experiencing fatigue. The study took place at the dialysis unit of a tertiary university-affiliated hospital from January to June 2019.

Inclusion and exclusion criteria were consistent with our previous study [22]. A total of 118 patients were enrolled and randomly assigned to the intervention group (IG) or control group (CG). The IG received nurse-led nonpharmacological holistic care interventions (NHCIs) in addition to routine care, whereas the CG received standard nursing care alone. During the trial, four participants (one withdrawal and one death per group) were excluded; ultimately, 114 patients were analyzed after the six-month intervention.

Sample size calculation was based on the expected differences in fatigue scores assessed by the RPFS, using δ and σ^2 values ranging from 1.05–2.10 and 2.11–3.43, respectively. With a two-tailed test, power of 0.8, and α of 0.05, the required total sample was 80–120 participants. Considering practical constraints, 100 participants were regarded as the minimum sample size. Accounting for an 18% attrition rate, 118 patients were enrolled, satisfying study requirements.

The NICIs were implemented by a multidisciplinary team of trained experts **(Figure 1)**. Prior to the main trial, the team received three half-day training sessions. All participants provided informed consent. The intervention components included health education on behavioral self-management [23], walking exercises [13, 24], and MI [16, 17]. Educational sessions employed audiovisual presentations, brochures, and interactive simulations. Walking activity was monitored using pedometers (Meilen, **Figure 2**), worn daily except during sleep or bathing, with a minimum target of 6,000 steps per day. MI sessions were conducted monthly for 20 minutes. Standard care for the CG consisted of routine nursing, including diet, hydration, medication adherence, and general health education. The intervention period lasted six months.

Outcome assessment

The primary outcome of this study was fatigue, which was evaluated using the 22-item Revised Piper Fatigue Scale (RPFS) with a 10-point scoring system, as detailed in our previous report [22]. Secondary outcomes encompassed participants' sociodemographic characteristics, vitality levels assessed via the SF-36 scale [25], psychological status measured by the Hospital Anxiety and Depression Scale (HADS) [26], sleep quality assessed with the Pittsburgh Sleep Quality Index (PSQI) [27], perceived social support using the PSSS [28], and self-management behaviors captured through the Behavioral Self-Management Scale [29]. The SF-36 instrument, comprising 36 items distributed across eight subdomains, was utilized to quantify overall health-related quality of life, generating total scores ranging from 0 to 145, with higher scores reflecting better health [30, 31]. Additional details on secondary measures are provided in our previous publication [22].

Statistical analysis

Data were analyzed according to distribution characteristics. Continuous variables with approximately normal distribution were expressed as mean ± standard deviation (SD), while skewed variables were reported as median ± interquartile range (IQR). Categorical variables were summarized as counts and percentages. Inter-group and

intra-group comparisons of continuous variables were performed using independent t-tests or Mann–Whitney U tests, depending on normality. Differences in categorical variables were analyzed with Pearson's chi-square test, McNemar's test for paired samples, or the McNemar-Bowker test for multi-category cross-tabulations. Statistical significance was defined as $p < 0.05$.

Study population and baseline characteristics

During the six-month study period, 216 patients received treatment at the dialysis center. Among these, 98 patients declined participation, leaving eligible patients with fatigue to be randomized into the intervention group (IG, n=62) or control group (CG, n=56). Four participants (two from each group) were lost to follow-up, resulting in a final analysis cohort of 114 patients.

The study cohort consisted of 45.61% female and 54.39% male participants, with an average age of 56.39 ± 15.95 years **(Table 1)**. Fatigue prevalence was 60.00% in the IG and 62.96% in the CG. In terms of age distribution, 33.33% of participants in the IG and 44.44% in the CG were aged 60 years or older. No statistically significant differences were observed between the groups for baseline sociodemographic or clinical parameters, indicating comparable starting conditions for both groups **(Table 1)**.

Table 1. Baseline characteristics of the two groups before intervention (categorical data, n=114)

Variable	Type	Overall sample	Experimental group	Control group	P
Fatigue**#		70	36	34	0.863
Age (years)**#	≥60	44	20	24	0.175
Ethnicity**#	Han	42	23	19	0.851
Gender**#	Male	62	30	32	0.158
Comorbidities**#	≥3	45	23	22	0.275
Employment**#	Yes	5	3	2	0.886
Exercise**#	No	65	33	32	0.511
Exercise time**#	<30 min	85	43	42	0.226
Living situation*#	Alone	14	6	8	0.186
	Hybrid living	100	55	45	
Marital status*#	Separated	19	12	7	0.763
	Married	91	47	44	
	Divorced	4	2	2	
Education**#	Below elementary school	13	4	9	0.104
	Elementary school	29	15	14	
	Junior middle school	37	21	16	
	Senior High school or above	35	21	14	
Family income (RMB/month)**#	≤900	29	14	15	0.486
	901-1500	18	11	7	
	1501-3000	25	17	8	
	3001-5000	25	12	13	
	≥5001	17	8	9	
Means of paying medical expenses *#	Own expense	6	3	3	0.127
	Medical insurance	53	31	22	
	Free medical service	4	3	1	
	Rural cooperative medical service	51	23	28	
Complications**#	Yes	95	51	44	0.275
Pain (whole body)**#	Yes	46	24	22	0.841
Pruritus**#	Yes	96	53	43	0.907
Appetite**#	Poor	48	24	24	0.592
	General	45	23	22	
	Normal	21	13	8	
Dialysis frequency (times/week)*#	1 time/week	4	0	4	0.068
	2 times/week	55	33	22	
	3 times/week	26	14	12	
	4 times/week	5	2	3	
	5 times/two weeks	24	13	11	

*Fisher's exact test; **Pearson chi-square test; #P>0.05

As presented in **Table 2**, the overall fatigue scores were comparable between the two groups, with 5.82 in the intervention group (IG) and 5.89 in the control group (CG). In both groups, mental fatigue was more pronounced than physical fatigue, with scores of 6.27 versus 5.21 in the IG and 6.35 versus 5.31 in the CG, respectively. Self-management behavior levels were similar between groups, measuring 61.13 in the IG and 60.56 in the CG, while vitality scores were 13.07 and 13.49, respectively. Furthermore, clinical parameters—including serum calcium (2.10 vs. 2.10 mmol/L), hemoglobin (100.83 vs. 102.90 g/L), and albumin (ALB; 39.13 vs. 39.25 g/L)—were below the normal reference ranges for patients undergoing hemodialysis with fatigue.

Table 2. Comparison of pre-intervention baseline characteristics between groups (continuous data, n=114)

Indicators	Experimental group Mean (SD)	Control group Mean (SD)	P
ALB (g/L) &	39.13 (3.75)	39.25 (4.95)	0.712
Hb (g/L) &	103.21 (22.09)	102.9 (21.93)	0.458
Fe (μmol/L) &	10.12 (4.68)	10.04 (5.37)	0.712
TSAT &	29.17 (9.93)	29.62 (11.36)	0.838
P (mmol/L) &	2.05 (0.50)	2.10 (0.58)	0.055
Ca (mmol/L) &	2.10 (0.25)	2.10 (0.25)	0.221
Overall fatigue [a] &	5.82 (1.57)	5.89 (1.90)	0.854
Mental fatigue &	6.27 (1.93)	6.35 (1.98)	0.882
Muscular fatigue &	5.21 (1.62)	5.31 (2.15)	0.767
PQSI [d] &	12.22 (4.13)	11.93 (3.64)	0.790
Overall perceived social support [b] &	52.25 (13.42)	53.69 (13.37)	0.724
Extrafamilial support &	28.94 (12.18)	31.21 (12.03)	0.521
The vitality of SF-36 [c] &	13.07 (4.43)	13.49 (3.90)	0.715
Overall self-management behaviour [f] &	61.13 (10.98)	60.56 (10.22)	0.457
Compliance with recommendations for liquid intake &	12.47 (4.21)	12.57 (4.55)	0.928
Depression [e] &	9.61 (6.29)	10.90 (4.85)	0.388
	Experimental group Median, P25–P75	Control group Median, P25–P75	P
Urea (mmol/L) #	8.45 5.97 (20.84)	10.00 6.87 (20.09)	0.235
CRP (mg/L) #	2.76 0.54 (13.06)	5.13 0.44 (10.25)	0.876
PTH (pg/mL) #	392.09 149.34 (652.53)	288.29 168.89 (492.98)	0.531
SF (μg/L) #	221.56 54.62 (686.87)	212.67 68.89 (483.07)	0.918
Anxiety [h] #	3.00 1.76 (5.00)	2.50 0.24 (4.74)	0.341
Intrafamilial support [g] #	23.00 20.00 (27.00)	23.00 21.00 (23.00)	0.568
Self-monitoring disease #	5.00 4.57 (6.11)	5.00 5.14 (7.57)	0.563
Protecting internal fistula #	3.50 1.00 (4.00)	4.50 2.15 (4.00)	0.276
Compliance with recommendations for iron intake #	4.00 3.00 (5.50)	3.00 3.00 (5.00)	0.064
Compliance with recommendations for sodium and protein intake #	14.50 10.74 (17.00)	16.00 11.50 (16.00)	0.512
Developing good habits #	5.00 5.00 (5.39)	5.00 —	0.227
Compliance with medication regimen #	4.00 4.00 (4.00)	4.00 4.00 (4.00)	1.000
Maintaining personal health #	5.00 4.00 (5.25)	4.50 3.55 (4.50)	0.476
Seeking knowledge #	5.00 2.00 (7.00)	5.00 3.00 (7.50)	0.398
Developing interests and hobbies #	1.00 1.00 (1.00)	1.00 1.00 (1.00)	0.283

Abbreviations: Hb, hemoglobin; ALB, albumin; P, phosphorus; Ca, calcium; Fe, ferritin; SF, serum ferritin; TSAT, serum transferrin saturation; SF-36, 36-Item Short-Form Health Survey; PSQI, Pittsburgh Sleep Quality Index; CRP, C-reactive protein; PTH, parathyroid hormone.

a Total fatigue scores range from 0 to 10, with 0 indicating no symptoms, 1–3 mild, 4–6 moderate, and 7–10 severe symptoms.
b Total perceived social support scores range from 12 to 84, with higher values indicating stronger support.
c Total SF-36 scores range from 0 to 145, with higher scores reflecting better overall health.
d Total PSQI scores range from 0 to 21, where ≤ 7 indicates normal sleep and > 7 indicates a sleep disorder.
e Total HADS scores range from 0 to 21, with < 7 indicating no symptoms and ≥ 7 indicating suspected or confirmed symptoms.
f Behavioral self-management scores range from 25 to 100, with higher scores reflecting better self-management.
g Intrafamilial support scores range from 4 to 28, with higher scores indicating stronger perceived support.
h Total PSSS scores range from 0 to 21, where < 7 indicates no symptoms and ≥ 7 indicates suspected or confirmed symptoms.

& Normally distributed variables are reported as mean ± standard deviation (SD) and were compared using a two-tailed independent-sample t-test (P > 0.05).
Non-normally distributed variables are presented as median ± interquartile range (IQR, difference between 25th percentile [P25] and 75th percentile [P75]) and were compared using the Mann–Whitney U test (P > 0.05).

Impact of Nurse-Led NICIs within and between groups
Following the intervention, the intervention group (IG) demonstrated significant improvements across multiple outcomes, including overall fatigue and its physical and mental components, serum albumin, sleep quality, vitality, anxiety, depression, adherence to fluid and iron intake recommendations, self-management behaviors, personal health maintenance, complication rates, pain, and appetite (P=0.000). In contrast, the control group (CG) showed no statistically significant changes in these measures (P>0.05). When comparing post-intervention outcomes between groups, the IG exhibited significantly greater improvements than the CG in overall fatigue, physical fatigue, mental fatigue, self-management behaviors, depression, sleep quality, vitality, compliance with dietary recommendations (iron, fluid, protein, and sodium), transferrin saturation, and serum urea (P<0.05). Of particular note, the reduction in total fatigue was markedly larger in the IG compared to the CG (P=0.000), and appetite changes also differed significantly between groups following the intervention (P=0.025).

Table 3. Comparison of variables inter- and intra-group before and after six months of intervention (n=114)

Indicators	Experimental group (n=60)[e] Median, P25–P75	Control group (n=54)[f] Median, P25–P75	P
TSAT	8.05, 2.27 (14.89)	2.04, 0.77 (2.86)	0.000
RPFS [ae]	2.26, 1.45 (3.44)	0.48, 0.25 (1.03)	0.000
Mental fatigue [e]	1.41, 0.61 (2.89)	0.54, 0.20 (1.08)	0.000
Muscular fatigue [e]	2.13, 1.24 (3.00)	0.75, 0.22 (1.16)	0.000
PTH (pg/mL)	22.64, –27.35 (63.96)	8.38, –26.36 (67.46)	0.653
CRP (mg/L)	1.83, –2.21 (8.29)	1.30, –3.40 (4.35)	0.211
ALB (g/L)[e]	6.15, 1.11 (8.32)	4.40, 1.70 (8.56)	0.643
Hb (g/L)	7.98, –1.99 (27.96)	5.48, 1.73 (22.97)	0.734
Fe (μmol/L)	3.17, –2.17 (7.62)	0.74, –1.76 (4.64)	0.184
Ca (mmol/L)	0.17, –0.05 (0.45)	0.09, –0.10 (0.28)	0.135
P (mmol/L)	0.31, –0.43 (0.99)	–0.04, –0.32 (0.27)	0.183
SF (μg/L)	25.34, –12.36 (52.64)	10.63, –13.01 (29.12)	0.289
Urea (mmol/L)	3.36, –0.06 (11.74)	1.61, –3.44 (5.93)	0.016
PQSI [ce]	5.00, 0.85 (7.00)	2.00, 0.00 (2.00)	0.008
Anxiety [e]	2.00, –1.00 (3.00)	1.00, 0.00 (1.00)	0.616
Vitality on the SF-36 [e]	5.01, 1.02 (8.95)	1.00, 1.00 (4.20)	0.035
Depression [e]	2.50, 0.00 (6.25)	0.00, 0.00 (0.00)	0.000
PSSS [b]	6.06, 2.78 (6.04)	5.06, –16.08 (21.05)	0.881
Extrafamilial support	2.12, –16.13 (16.24)	2.16, 0.09 (2.06)	0.973
Intrafamilial support	4.11, 2.05 (4.08)	2.12, 0.07 (6.08)	0.343
Overall behavioural self-management [d]	17.50, 5.00 (18.25)	5.50, 1.00 (10.00)	0.000
Compliance with recommendations for liquid intake [e]	4.00, 1.00 (7.00)	1.00, 0.00 (3.20)	0.000
Compliance with recommendations for sodium and protein intake [e]	3.00, 1.00 (5.00)	1.00, 0.00 (3.00)	0.000
Compliance with recommendations for iron intake [e]	2.00, 0.00 (3.00)	0.00, 0.00 (0.00)	0.000
Self-monitoring of disease [e]	1.00, 0.00 (2.00)	1.00, 0.00 (1.00)	0.164
Protecting the internal fistula	0.00, 0.00 (2.00)	0.00, 0.00 (1.00)	0.409
Maintaining personal health [e]	1.00, 0.00 (1.00)	0.00, 0.00 (1.00)	0.076
Developing interests and hobbies	0.00, 0.00 (1.00)	0.00, 0.00 (0.00)	0.424
Developing good habits	0.00, 0.00 (1.00)	0.00, 0.00 (1.00)	0.337
Seeking knowledge	0.00, –1.00 (2.00)	0.00, 0.00 (1.00)	0.877
Compliance with medication regimen	0.00, 0.00 (0.00)	0.00, 0.00 (0.00)	1.000
	Experimental group (n=60)	Control group (n=54)	P

	Yes, n (%)	No, n (%)	Yes, n (%)	No, n (%)	
Complications*#	55 (57.3)	5 (27.8)	41 (42.7)	13 (72.2)	0.073
Pruritus*	50 (53.2)	10 (50.0)	44 (46.8)	10 (50.0)	0.909
Pain (whole body)*@	18 (46.2)	42 (56.0)	21 (53.8)	33 (44.0)	0.363

	Experimental group (n=60)		**Control group (n=54)**		**P**
	Normal n (%)	General n (%)	Normal n (%)	General n (%)	
Appetite*&	10 (62.5)	40 (59.7)	6 (37.5)	27 (40.3)	0.029

Abbreviations: CRP, C-reactive protein; PTH, parathyroid hormone; Hb, hemoglobin; ALB, albumin; P, phosphorus; Ca, calcium; Fe, ferritin; SF, serum ferritin; TSAT, serum transferrin saturation; RPFS, Revised Piper Fatigue Scale; SF-36, 36-Item Short-Form Health Survey; PSSS, Perceived Social Support Scale; PSQI, Pittsburgh Sleep Quality Index.

Continuous within-group variables are presented as the median ± interquartile range of the differences between pre- and post-intervention measurements, while categorical variables are reported as frequencies after the intervention.

a Total fatigue scores range from 0 to 10, with 0 representing no symptoms; 1–3, mild symptoms; 4–6, moderate symptoms; and 7–10, severe symptoms.

b Total perceived social support scores range from 12 to 84, with higher scores indicating stronger perceived support.

c Total PSQI scores range from 0 to 21, where ≤ 7 indicates normal sleep, and >7 indicates a sleep disorder.

d Behavioral self-management scores range from 25 to 100, with higher values reflecting better self-management.

e Comparison of pre- and post-intervention values within the experimental group, P = 0.000.

f Comparison of pre- and post-intervention values within the control group, P > 0.05.

• Post-intervention values; comparison between the two groups was conducted using Pearson's chi-square test.

Pre- and post-intervention comparison within the experimental group using McNemar's nonparametric test for related samples, P = 0.000.

@ Pre- and post-intervention comparison within the experimental group using McNemar's nonparametric test for related samples, P = 0.014.

& Pre- and post-intervention comparison within the experimental group using the McNemar-Bowker test of cross-tabulations, P = 0.000.

Results and Discussion

This randomized, controlled, parallel-group trial examined the efficacy of nurse-led multidisciplinary nonpharmacological integrated care interventions (NICIs) for alleviating fatigue in patients undergoing hemodialysis. The findings demonstrated that NICIs significantly reduced total fatigue, encompassing both muscular and mental components, and improved other clinical and behavioral outcomes, corroborating previous research [22]. These results align with studies reporting that combining acupoint massage with aerobic exercise provides greater relief from fatigue and more favorable modulation of serum phosphate levels in patients with carcinoma-related fatigue than aerobic exercise alone [32].

Fatigue remains a predominant stressor for hemodialysis patients, and a systematic review has highlighted that exercise interventions tend to outperform routine care in mitigating fatigue among adults on hemodialysis [33]. Nevertheless, patients often perceive intensive exercise as daunting, underscoring the need for low-intensity exercise regimens [13]. In line with AASM guidelines, indoor walking was selected for this study as a safe, low-cost, and accessible form of physical activity. The six-month walking program contributed to significant improvements in both muscular and mental fatigue, which is consistent with prior evidence linking mild-intensity walking to enhanced mental functioning [13]. Additionally, walking may improve cardiovascular efficiency and facilitate metabolite clearance through enhanced tissue perfusion, thereby improving dialysis efficacy and relieving fatigue [34].

Self-management plays a pivotal role in chronic disease care by supporting daily health-related tasks across medical, role, and emotional domains [35, 36]. Central to self-management is self-efficacy, which influences adherence to prescribed treatments and healthy behaviors [37]. Meta-analytic evidence suggests that self-management interventions yield moderate improvements in self-efficacy, which in turn enhance self-care behaviors [38]. Similarly, self-management of dietary and fluid restrictions in hemodialysis patients indirectly regulates interdialytic weight gain, resulting in fatigue reduction [39]. In the present study, the intervention enhanced self-management behaviors and contributed to reductions in overall fatigue while positively affecting other outcome measures. The self-management education implemented aimed not only to alleviate fatigue but also to reduce healthcare costs and improve longevity and quality of life [40].

Motivational interviewing (MI), which does not require formal psychological training, was incorporated to address ambivalence that may hinder behavior change, such as adherence to dietary guidance or walking regimens [41]. MI facilitates cognitive shifts that support behavior modification, including improved adherence to self-management protocols. Consequently, patients' perceived physical well-being increases, reflected by reductions in fatigue [42–44]. Moreover, the self-efficacy promoted through MI encourages patients to actively pursue lifestyle changes that support their health objectives, consistent with the findings of this study [45].

Several limitations should be acknowledged. First, the study did not include long-term follow-up to assess sustained effects. Second, participants in the intervention group may have received greater attention from staff than those in the control group. Third, the study was conducted at a single center with a relatively small sample size. Finally, quality control procedures for intervention delivery and outcome assessment were not implemented.

Conclusion

The findings indicate that nurse-led multidisciplinary NICIs are effective in improving multiple outcomes in hemodialysis patients, including fatigue, self-management behaviors, dietary and medication adherence, and other clinical indicators. The study underscores the importance of both dialysis nurses and multidisciplinary teams in chronic disease management. Nevertheless, further research through multicenter trials with long-term follow-up is needed to validate the effects of NICIs and to explore the biological mechanisms underlying fatigue in hemodialysis patients, as well as the role of specific intervention components in fatigue management.

Abbreviations

MI: motivational interviewing
RPFS: Revised Piper Fatigue Scale
Hb: haemoglobin
ALB: albumin
P: phosphorus
Ca: calcium
Fe: ferritin
SF: serum ferritin
TSAT: serum transferrin saturation
SF-36: 36-Item Short-Form Health Survey
PSQI: Pittsburgh Sleep Quality Index
PSSS: Perceived Social Support Scale
CRP: C-reactive protein
PTH: parathyroid hormone
SF: serum ferritin

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