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The Effect of Whole-Body Vertical Rhythm Training on Fatigue, Physical Activity, and Quality of Life to the Middle-Aged and Elderly with Hemodialysis Patients

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***Abstract*—**The study aims to investigate the effect of full-body vertical rhythmic training on fatigue, physical activity, and quality of life among middle-aged and elderly hemodialysis patients. The study adopted a quasi-experimental research method and recruited 43 long-term hemodialysis patients from a medical center in northern Taiwan, with 23 and 20 participants in the experimental and control groups, respectively. The experimental group received full-body vertical rhythmic training as an intervention, while the control group received standard hemodialysis care without any intervention. Both groups completed the measurements by using "Fatigue Scale", "Physical Activity Scale" and "Chinese version of the Kidney Disease Quality of Life Questionnaire" before and after the study. The experimental group underwent a 10-minute full-body vertical rhythmic training three times per week, which lasted for eight weeks before receiving regular hemodialysis treatment. The data were analyzed by SPSS 25 software, including descriptive statistics such as frequency distribution, percentages, means, and standard deviations, as well as inferential statistics, including chi-square, independent samples t-test, and paired samples t-test. The study results are summarized as follows: 1. There were no significant differences in demographic variables, fatigue, physical activity, and quality of life between the experimental and control groups in the pre-test. 2. After the intervention of the “full-body vertical rhythmic training,” the experimental group showed significantly better results in the category of "feeling tired and fatigued in the lower back", "physical functioning role limitation", "bodily pain", "social functioning", "mental health", and "impact of kidney disease on life quality." 3. The paired samples t-test results revealed that the control group experienced significant differences between the pre-test and post-test in the categories of feeling tired and fatigued in the lower back, bodily pain, social functioning mental health, and impact of kidney disease on life quality, with scores indicating a decline in life quality. Conversely, the experimental group only showed a significant worsening in bodily pain and the impact of kidney disease on life quality, with lower change values compared to the control group. Additionally, there was an improvement in the condition of "feeling tired and fatigued in the lower back" for the experimental group. The intervention of the “full-body vertical rhythmic training” had a certain positive effect on the quality of life of the experimental group. While it may not entirely enhance patients' quality of life, it can mitigate the negative impact of kidney disease on certain aspects of the body. The study provides clinical practice, nursing education, and research recommendations based on the results and discusses the limitations of the research.

***Keywords*—**Hemodialysis, full-body vertical rhythmic training, fatigue, physical activity, quality of life.

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I. Introduction

A. Research Background, Motivation, and Significance

TAIWAN has gained recognition for its comprehensive healthcare system, particularly in the field of dialysis treatment. Known as the "Kingdom of Dialysis," Taiwan has achieved notable advancements in medical technology and healthcare access, significantly improving the quality of dialysis care. This progress has been supported by a robust domestic health insurance system, which has contributed to an increase in the number of dialysis patients and their life expectancy.

According to the 2020 data from the United States Renal Data System (USRDS) [17], Taiwan leads the world in both the incidence and prevalence rates of dialysis patients. The Taiwan Renal Disease Annual Report indicates a continuous rise in the number of dialysis patients, reaching 94,000 in 2021. Despite these advancements, dialysis patients face numerous physiological, psychological, social, and economic challenges throughout their treatment [1].

When addressing the treatment goals for long-term chronic patients, the focus should be on the meaning of extended life. Reference [2] suggested that for end-stage kidney disease patients, the primary goals are not only to treat the disease and prolong life but also to enhance functional status and well-being, thereby improving overall quality of life.

Patients with end-stage kidney disease experience muscle protein breakdown due to the accumulation of uremic toxins, leading to muscle fiber degeneration, myopathy, muscle wasting, muscle atrophy, and decreased physical fitness [3]. Compared to other renal replacement therapies, hemodialysis patients generally show lower levels of physical functioning and reduced quality of life [4]. Physical activity is a predictor of survival and a key indicator of individual quality of life, care needs, and healthcare costs [5]. Therefore, improving physical activity in hemodialysis patients is crucial for enhancing their overall quality of life. Studies have shown that exercise and muscle strength training interventions can prevent muscle tissue pathology and loss of muscle function [6]. These interventions can also improve muscle strength and density, thereby benefiting the health and physical functioning of end-stage kidney disease patients [3].

B. Research Purpose and Questions

1) Given the background and significance outlined, this study aims to achieve the following objectives:
a) To understand the background information, fatigue levels, physical activity, and current quality of life of middle-aged and elderly hemodialysis patients.
b) To examine the differences in fatigue levels and quality of life before, during, and after the intervention of a vertical rhythmic exercise program for both experimental and control groups.
2) Based on these objectives, the study poses several key research questions:
a) What are the demographic characteristics, fatigue levels, physical activity, and current quality of life of middle-aged and elderly hemodialysis patients?
b) What differences exist in the improvement of fatigue levels, physical activity, and quality of life among middle-aged and elderly hemodialysis patients after an eight-week vertical rhythmic exercise program?

II. Literature Review

A. Chronic Kidney Disease and Staging

1) Definition of Chronic Kidney Disease and Physical Symptoms

Chronic Kidney Disease (CKD) is an irreversible condition characterized by impaired renal function, preventing effective removal of toxins and excess fluid [7], [8]. Individuals with CKD may require lifelong dialysis or kidney transplantation. As CKD progresses to end-stage renal disease (ESRD), renal function declines to only 15 mL/min/1.73 m^3, leading to inefficient clearance of metabolic waste and maintenance of fluid and acid-base balance, potentially causing uremia.

The Kidney Disease Outcome Quality Initiative (KDOQI) guidelines [9] define CKD by structural or functional kidney abnormalities lasting at least three months. CKD staging, based on the glomerular filtration rate (GFR), is divided into stages G1-G5.

TABLE I
STAGES OF CKD

Staging of the disease	Type	GFR (ml/min/1.73 m^3)
G1	Normal renal function with renal parenchymal damage and proteinuria	≧90
G2	Mild chronic kidney impairment	60-89
G3	Moderate chronic kidney impairment	30-59
G3a	Mild to moderate reduction	45-59
G3b	Moderate to severe reduction	30-44
G4	Severe renal failure	15-29
G5	End-stage kidney disease	＜15
G5	End-stage kidney disease	＜15

B. Fatigue Symptoms and Measurement in Hemodialysis Patients

Hemodialysis patients commonly experience fatigue due to physiological and psychological factors:
1) Physiological Aspects:
a) Accumulation of Metabolic Waste and Chronic Inflammatory Response:
(1) Buildup of metabolic waste products may contribute to fatigue.
(2) Increased inflammatory markers, like CRP, can directly activate the central nervous system, leading to fatigue.
b) Anemia: Anemia in hemodialysis patients, primarily due to reduced erythropoietin secretion, may not directly correlate with fatigue.
c) Decrease and Alteration of Body Energy: Abnormalities in protein synthesis and muscle reabsorption could lead to muscle fiber atrophy and affect immune function.
d) Insufficient Physical Activity: Prolonged bed rest and lack of recreational activities are associated with fatigue.
e) Sleep Status: Reduced sleep and sleep disorders are common among fatigued dialysis patients.
f) Gender: Fatigue tends to be more prevalent in females among dialysis patients.
g) Dialysis-Related Factors: Discomfort symptoms after hemodialysis, such as headaches and muscle cramps, can contribute to fatigue.
2) Psychological Aspects:
a) Mental State: Depression and anxiety are common among dialysis patients and are positively correlated with fatigue severity.
b) Social Support: Adequate social support can reduce psychological and physiological stress, thereby alleviating fatigue.

Addressing these factors is crucial for improving the quality of life and care for hemodialysis patients. Proactive assessment of psychological well-being and the provision of appropriate support and counseling can help alleviate depressive emotions and enhance the quality of care.

C. Exploration of Physical Activity in Hemodialysis Patients

1) Data Processing for IPAQ: The IPAQ collects physical activity data in MET-minutes/week using continuous indicators. Scores are calculated by multiplying the MET score of an activity by the minutes spent on it. The IPAQ short format includes walking (W), moderate-intensity activities (M), high-intensity activities (V), and an overall score, all in MET-minutes/week.
2) MET Values and Calculation Formula:
a) Derived from IPAQ reliability studies.
b) Scores calculated for walking, moderate, and high-intensity activities.
3) Dynamic Activity Level Conversion:
a) Daily activity level calculated based on frequency, intensity, and duration.
b) METs used to calculate daily energy expenditure.
c) Results categorized into activity groups based on weekly METs.
4) Effects of Exercise on Hemodialysis Patients:
a) Exercise improves fitness, mental health, and quality of life.
b) Cardiovascular training increases endurance and reduces mortality.
c) Aerobic exercise enhances muscle strength and reduces

fatigue.

d) Physical activity correlates with social support and quality of life.

5) Challenges and Recommendations:

a) Patients face physiological discomfort and safety concerns.

b) Education on safe exercise practices is crucial.

c) Nurses play a vital role in promoting exercise.

6) Future Directions:

a) Implement vertical rhythmic exercise during dialysis.

b) Develop evidence-based interventions to improve patients' quality of life.

D. Exercise Training and Related Research in Hemodialysis Patients

During whole-body vertical vibration exercise, careful control of direction time, intensity, and rate of motion are crucial [10]. The intensity, determined by frequency and amplitude, should range between 20-70 Hz to avoid harm [11].

Exercise prescription involves a meticulously designed regimen aimed at enhancing physical fitness and health. The latest ACSM guidelines outline four types of fitness exercises with recommendations for intensity, duration, frequency, and progression [12].

For hemodialysis patients, non-weight-bearing activities are preferable due to skeletal issues, but exercise may affect hemodynamics. Close monitoring of blood pressure, heart rate, and hemodynamics during exercise is advised to ensure safety [13], [14].

E. Quality of Life for Hemodialysis Patients

In summary, the quality of life is crucial for assessing treatment effectiveness in dialysis patients. Studies indicate that these patients often experience lower quality of life due to symptoms associated with their condition [15]. Maintaining good physical health is essential for enhancing overall well-being, and structured exercise interventions can help alleviate fatigue, increase physical activity levels, and improve quality of life. Assessment tools for quality of life can be categorized into general and health-related scales, which play vital roles in managing diseases and guiding treatment decisions. Nursing research utilizes various scales such as the World Health Organization Quality of Life Questionnaire Taiwan Brief Version and the Kidney Disease Quality of Life Short Form to evaluate different dimensions of quality of life in dialysis patients.

III. Research Methodology

A. Research Design

1) Research Hypotheses

a) There is no significant difference in the basic background information between the experimental group and the control group.

b) There is no significant difference in fatigue perception, physical activity, and quality of life between the experimental group and the control group at the pre-test.

c) After the intervention with the vertical rhythmic exercise program, the experimental group will experience a significant reduction in fatigue perception and a significant increase in physical activity and quality of life compared to the control group.

d) Within the experimental group, there will be a significant reduction in fatigue perception and a significant increase in physical activity and quality of life between the pre-test and post-test after the intervention with the vertical rhythmic exercise program.

e) Within the control group, there will be no significant changes in fatigue perception, physical activity, and quality of life between the pre-test and post-test after the intervention with the vertical rhythmic exercise program, and there is even a possibility of deterioration in these measures.

B. Research Framework

This study's research framework, as depicted in Fig. 1 is based on theories and findings from a literature review. The independent variables include demographic information of elderly hemodialysis patients at a medical center in northern Taiwan (gender, age, education level, occupational status, living conditions, exercise habits, medication use, sleep duration, body mass index, recent hospitalization) and medical-related data (dialysis duration, biochemical blood parameters such as hematocrit, albumin, clearance rate), as well as participation in the exercise program. The dependent variables are fatigue (measured by a fatigue scale), physical activity (assessed through a physical activity scale), and quality of life (evaluated using a quality-of-life scale). The intervention involves hemodialysis interval vertical rhythmic exercise training.

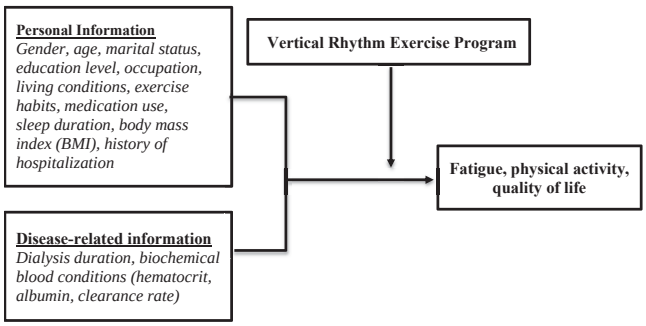

Fig. 1 Research Framework Diagram

C. Study Participants, Locations, and Protocol

1) Study Participants

The data collection period for the control group extended from October 30, 2022, to February 28, 2023, encompassing three structured questionnaire surveys. Out of a total of 25 individuals approached, three declined participations. Additionally, two participants discontinued their involvement due to reasons such as refusal to partake in the second interview, experiencing sleep disturbances during dialysis, and hospitalization. Consequently, the effective participation count in the control group amounted to 20 individuals. Further

specifics are outlined in Table II.

TABLE II
REASONS FOR ATTRITION IN STUDY CASES

Projects	Experimental group	Control group
case selection	28	25
Number of cases refusing to participate	5	5
The actual number of cases enrolled	23	20
Reasons for participant dropout	5	5
Not fond of exercising and reluctant to move	1	0
The need to arrive early before each appointment is quite troublesome	1	0
Impacts on resting during dialysis	1	1
Inpatient surgery	1	1
The family members express concerns about safety	1	0
actual number of completed enrollments	23	20

2) Study and Exercise Venue

The research was conducted within the waiting areas situated on the 3rd, 5th, and 6th floors of a medical center in the northern region. Following the screening of eligible participants, the intervention involving whole-body vibration training and data collection was administered after their outpatient clinic visits.

D. Study Process

1) Preparation Phase - Unit Agreement:

- Literature Review: Conduct thorough literature review to establish research questions and framework.
- Define Research Scope: Set research scope based on objectives, questions, and hypotheses; prepare questionnaire and submit application to Institutional Review Board (IRB) for approval.

2) Pilot Phase

- Ethical Approval: Obtain IRB approval for research plan.
- Confirm Research Framework: Establish research framework and obtain consent for research tools.
- Pilot Questionnaire Administration: Test questionnaire, analyze data for validity and reliability.

3) Formal Implementation Phase:

- Questionnaire Administration: Recruit participants, explain study procedures, obtain consent, and assign to experimental or control group.
- Experimental Group: Undergo whole-body vibration training intervention and data collection.

4) Data Processing and Results Writing:

a) Data Analysis: Enter data into SPSS for hypothesis testing.
b) Formulate Conclusions and Recommendations: Write research report, draw conclusions, and provide recommendations.
c) Completing Research Paper: Submit draft for review, make revisions, and finalize paper for publication.

E. Research Tools and Reliability/Validity

The research tools utilized in this study include a self-administered structured questionnaire and a whole-body vibration training test. The questionnaire encompasses sections on "Personal Background Information," "Fatigue Scale," "Physical Activity Scale," and the "Chinese Version of Kidney Disease Quality of Life Scale (KDQOL-SFTM)."

F. Research Ethics

This study has undergone review by the Institutional Review Board (IRB) of a medical college in northern Taiwan, with the approval notification number 20220306D. Following approval by the committee, recruitment of participants and data collection commenced. Upon being fully informed about the relevant research information, individuals participating in the study made voluntary decisions on whether to participate and signed informed consent forms.

G. Data Analysis Methods

1) Descriptive Statistics

Utilizing methods like frequency distribution, mean, and standard deviation, we can analyze the impact of exercise programs on demographic variables, fatigue, physical activity levels, and quality of life among middle-aged and elderly dialysis patients. This provides insights into overall trends and distribution across different dimensions.

2) Inferential Statistics

By employing chi-square tests or one-way ANOVA, we can identify significant differences in demographic variables between experimental and control groups.

By using independent samples t-tests, we can compare groups at pre-test, mid-test, and post-test.

By employing paired samples t-tests, we can compare changes within the experimental group across different time points, and similar analyses will be conducted for the control group.

IV. RESEARCH RESULTS

A. Descriptive Statistical Analysis of Effective Samples of Hemodialysis Patients

The basic background attributes of the research cases are divided into two parts, including: 1) Current status of basic attributes of hemodialysis patients, such as gender, age, marital status, education level, religious beliefs, occupation, living conditions, exercise habits, smoking, alcohol consumption, sleep status, use of sleeping pills, and hospitalization in the past month; 2) Disease-related characteristics, such as months of dialysis, hematocrit value (%), albumin level, and clearance rate.

The analysis covers three main areas: 1) Overview of fatigue in hemodialysis patients; 2) Overview of physical activity in hemodialysis patients; 3) Overview of the quality of life in hemodialysis patients. The data organization is presented in Tables III-IV, and the details are explained separately.

B. Integrated Table of Independent Sample t-Tests for Each Subscale in the Experimental and Control Groups

Descriptive statistics are used to analyze fatigue, physical

activity, and quality-related conditions among Chinese hemodialysis patients. Independent sample t-tests are conducted on pre-test, mid-test, and post-test data for both experimental and control groups, aligning with the research objectives and questions of the study.

1) Fatigue

The Fatigue Severity Scale was used to measure fatigue levels at pre-test, mid-test, and post-test for both experimental and control groups. Scores ranged from 0 to 3, with lower scores indicating less frequent occurrence and lower fatigue levels.

a) Lack of Energy: Average scores ranged from 0.35 to 0.83, indicating rare or no occurrence of fatigue. Independent sample t-tests showed no significant differences between groups.
b) Unsteadiness on Feet: Average scores ranged from 0.43 to 1.13, suggesting varying degrees of unsteadiness. T-tests revealed no significant differences between experimental and control groups.

TABLE III
BASIC INFORMATION OF STUDY SUBJECTS AND CHI-SQUARE TEST RESULTS

Demographic variables	Overall	Experimental group n = 23	Control group n = 20	Chi-square P-value
Age (mean ± SD)		59.8 ± 9.7	62.2 ± 6.7	.053
Below 65 years old	25 (58.1%)	13 (56.5%)	12 (60.0%)	.818
Above 65 years old	18 (41.9%)	10 (43.5%)	8 (40.0%)	
Gender				.280
Male	22 (51.2%)	10 (43.5%)	12 (60%)	.219
Female	21 (48.8%)	13 (56.5%)	8 (40%)	
Marital status				.321
With spouse (married)	35 (81.4%)	18 (78.3%)	17 (85.0%)	.571
Without spouse divorced/widowed	8 (18.6%)	5 (21.7%)	3 (15.0%)	
Educational level				1.083
Junior high school /high school or below	20 (46.5%))	9 (39.1%)	11 (55.0%)	.298
College/University or above	23 (53.5%)	14 (60.9%)	9 (45.0%)	
Religious beliefs				.173
None	9 (21.4%)	6 (26.0%)	3 (15.8%)	.677
Have	33 (78.6%)	17 (73.9%)	16 (84.2%)	
Occupational status			.322	
Not retired	17(39.5%)	10(43.5%)	7(35.0%)	.571
Retired	26(60.5%)	13(56.5%)	13(65.0%)	
Source of income				.973
Self	29 (67.4%)	14 (60.9%)	15 (75.0%)	.324
Family and friends	14 (32.6%)	9 (39.1%)	5 (25.0%)	
Living situation				034
Living alone	6 (14.0%)	3 (13.0%)	3 (15.0%)	.853
Non-single living	37 (86.0%)	20 (87.0%)	17 (75.0%)	
Regular exercise habit			.114	
None	27 (67.5%)	14 (70%)	13 (65%)	.736
Have	13 (32.5)	6 (30%)	7 (35%)	
Smoking				1.439
None	4 (9.3%)	1 (4.3%)	3 (15.0%)	.230
Have	39 (90.7%)	22 (95.7%)	17 (85.0%)	
Drinking				.527
None	3 (7.0%)	1 (4.3%)	2 (10.0%)	.468
Have	40 (93.0%)	22 (95.7%)	18 (90.0%)	
Sleeping pills				2.161
None	25 (58.1%)	11 (47.8%)	14 (70%)	.142
Have	18(41.9%)	12 (52.2%)	6 (30%)	
Hospitalization in the past month			.005	
None	40 (95.2%)	21 (95.5%)	19 (95.0%)	.945
Have	2 (4.8%)	1 (4.5%)	1 (5.0%)	
BMI (Body Mass Index)			1.412	
Underweight	3 (8.6%	1 (5.3%)	2 (12.5%)	.494
Normal weight	25 (71.4%)	13 (68.4%)	12 (75.0%)	
Overweight	7 (20.0%)	5 (26.3%)	2 (12.5%)	

TABLE IV
SUMMARY OF BASIC DEMOGRAPHIC DATA ANALYSIS FOR THE RESEARCH SAMPLE (N = 43)

Demographic variables	Overall	Experimental group n = 23	Control group n = 20	t (p)
		Mean ± SD	Mean ± SD	
Age	62.05 ± 8.059	61.91 ± 9.214	62.20 ± 6.725	.115 (.909)
BMI (kg/m^3)	22.94± 3.743	23.31 ± 3.808	22.52 ± 3.719	.688 (.495)
Years on dialysis	9.77 ± 8.338	10.35 ± 8.616	9.10 ± 8.175	.485 (.630)
Sleep duration	6.37 ± 2.093	6.35 ± 2.124	6.40 ± 2.11	-.081 (.936)
Albumin (g/dl)	4.02 ± .527	3.98 ± .694	4.07 ± .229	-.595 (.555)
Hematocrit	33.75 ± 7.847	33.54 ±1031	34.00 ± 3.589	-.186 (.853)
Blood Urea Nitrogen (BUN) mg	68.60± 14.338	68.87± 17.342	67.15 ± 10.101	.616 (.541)
Pre-dialysis creatinine	10.28 ± 2.264	9.93 ± 2.509	10.70 ± 1.924	-1.116 (.271)
KTV (Clearance , Time, Volume)	1.42 ± .195	1.45 ± .187	1.38 ± .201	1.22 (.229)
Glutamic Oxaloacetic Transaminase (GOT)	18.16 ± 7.587	18.61 ± 7.590	17.65 ± 7.748	.409 (.685)
Glutamic Pyruvic Transaminase (GPT)	15.77± 10.179	16.04± 11.507	15.45 ± 8.691	.188 (.849)

c) Feeling of Back Pain: Average scores ranged from 0.40 to 1.09, indicating varying degrees of back pain. T-tests showed no significant differences between groups.
d) Becoming Forgetful and Sleepy: Average scores ranged from 0.65 to 1.30, suggesting varying degrees of forgetfulness and sleepiness. T-tests indicated no significant differences between experimental and control groups.

2) Physical Activity

The International Physical Activity Questionnaire - Short Form (IPAQ-SF) was used to assess physical activity levels over the past seven days, including work, housework, transportation, leisure activities, and exercise intensity. Scores were categorized into insufficient, sufficient, and high levels of physical activity based on metabolic equivalents (METs).

Chi-square tests showed no significant differences in physical activity levels between experimental and control groups at pre-test, mid-test, and post-test.

Independent sample t-tests on MET values revealed a significant difference only at pre-test, with the control group having a higher mean MET value. However, variability was high in the control group. No significant differences were found in mid-test and post-test MET values.

Paired sample t-tests within groups showed no significant differences in physical activity levels between pre-test and mid-test, mid-test and post-test, or pre-test and post-test assessments for both experimental and control groups.

3) Quality of Life

a) Physiological Function: Descriptive statistics and independent sample t-tests showed no significant differences in cumulative scores between experimental and control groups at pre-test, mid-test, and post-test.
b) Psychological Health: Similar findings were observed for sub-scales like "Vitality," "Social Function," "Role Limitations Due to Emotional Problems," and "Mental Health."
c) Renal Disease: Analysis of sub-scales including "Renal Disease" and "Impact of Renal Disease on Daily Life" also revealed no significant differences in cumulative scores between groups at pre-test, mid-test, and post-test.

C. Integrated Table of Independent Sample t-Tests for Each Subscale in the Experimental and Control Groups

1) Summary

The results of independent sample t-tests during the pre-test stage reveal that, except for "Physical Activity Capacity," where the control group outperformed the experimental group, there were no significant differences in other physiological health dimensions. However, in the "Physical Activity Limitation" subscale, the experimental group showed a significant advantage over the control group.

Most findings support Research Hypothesis 2, indicating no significant differences in fatigue, physical activity, and quality of life between the experimental and control groups at the pre-test stage. Regarding Research Hypothesis 3, which proposes that the experimental group, post-vertical rhythmic exercise intervention, would experience reduced fatigue and improved physical activity and quality of life compared to the control group, the results partially confirm this hypothesis. Specifically, the experimental group demonstrated reduced fatigue and improvements in physical activity and quality of life dimensions compared to the control group.

Research Hypothesis 3 posits that after the vertical rhythmic exercise intervention, the experimental group will experience reduced fatigue and improved physical activity and quality of life compared to the control group. This hypothesis is partially supported by the findings.

2) Explanation

The study's outcomes indicate that, consistent with the hypothesis, the experimental group, undergoing the vertical rhythmic exercise intervention, experienced reduced fatigue compared to the control group. Moreover, significant improvements in physical activity and quality of life dimensions were observed within the experimental group compared to the control group.

The term "partially" suggests that while certain aspects of the hypothesis were supported by the findings, there may be specific dimensions or elements within fatigue, physical activity, or quality of life where the differences did not reach statistical significance. This underscores the importance of a nuanced interpretation, considering specific aspects of the

measured variables.

D. Dependent Samples t-Test Analysis of Subscale Mean Scores

This section consolidates the results of independent samples t-tests for various subscales between the experimental and control groups. The aim is to compare the mean scores of different subscales at different time points for elderly hemodialysis patients in both groups. Specifically, the analysis examines scores related to fatigue, physical activity, and quality of life. In terms of fatigue, higher scores indicate a more severe sense of exhaustion, while higher scores for physical activity and quality of life suggest better physical activity levels and a higher quality of life.

In statistical terms, if the t-value obtained from the dependent samples t-test is negative, it suggests that the scores from the previous test are lower than those from the subsequent test. Specifically, for fatigue, a higher negative t-value indicates that the fatigue scores in the subsequent test are higher, reflecting a worsened condition. Conversely, for physical activity and quality of life, a higher negative t-value suggests that the scores in the subsequent test are higher, indicating an enhancement in both physical activity and quality of life.

According to the results of Research Hypothesis 4, despite observing significant improvements in certain aspects of fatigue after implementing the vertical oscillation exercise program in the experimental group, there was a concerning trend in secondary dimensions of other aspects of quality of life. Specifically, "body pain" and the "impact of kidney disease on life" showed deterioration, although these changes did not reach statistical significance. Consequently, Research Hypothesis 4 was deemed unsupported.

V. Conclusion and Recommendations

A. Research Conclusions and Discussions

Fatigue is a common and persistent symptom among long-term hemodialysis patients, significantly affecting their physiological and psychological functions [16]. Horigan found that fatigue severity is linked to negative emotions, impacting daily physical activities [17]. Severe fatigue can diminish the ability and motivation to engage in routine activities. This study confirms that vertical rhythmic exercise reduces fatigue in hemodialysis patients in the experimental group, who also show better quality of life outcomes compared to the control group in mid-term and post-intervention assessments.

The study's use of the international physical activity scale highlights several considerations:

- The two-month intervention may be too short to alter habitual physical activity behavior.
- The assessment did not include mild activities and sleep duration, despite participants often experiencing fatigue and physical discomfort, leading to increased mild activities and longer sleep.
- The COVID-19 pandemic reduced outdoor activity opportunities, affecting physical activity levels.
- Participants may believe illness limits physical activity, and family overprotection may further reduce their activity levels.

These factors should be considered when interpreting the study's assessment of physical activity effectiveness.

B. Research Recommendations

Strengthening rehabilitation knowledge and application in nursing education is crucial for preparing nurses to effectively manage and support patients in their recovery journeys. Based on the research findings, it is recommended that healthcare professionals enhance their knowledge of exercise training and related rehabilitation activities through ongoing education and nursing school curricula. The established exercise models should be incorporated into the reference content for continuing education of clinical nursing staff and promoted for application to enhance professional competence. Additionally, in nursing school training, experiential courses and skills training related to exercise can be provided to lay the foundation for future clinical practice.

C. Limitations of the Study

Due to limitations in time and personnel, there were certain areas that this study could not fully cover. To ensure consistency and accuracy in the assessment methods and procedures, only one researcher could assist with measurements during each exercise session. Given the proximity of assessments, there were multiple participants requiring evaluation during the same time period, which may have slightly delayed dialysis treatment sessions. Additionally, due to constraints on recruitment time, this study could not enroll a larger sample size or conduct repeated measurements over a longer duration. Future research is recommended to consider longer-term intervention programs to gain a better understanding of the effects of long-term interventions and to delve deeper into maximizing the benefits of exercise between dialysis sessions and when stable long-term effects can be maintained. The findings of this study can only infer the effects achieved within the eight-week timeframe.

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