Original Article

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Effectiveness of Resistance Exercise Therapy on Patients' Physiological Status During Hemodialysis: A Randomized Controlled Trial

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ABSTRACT

Background: Management disorder of vital signs remains a critical issue worldwide, particularly regarding hypertension in chronic renal disease (CRD), both of which are associated with a higher risk of cardiovascular (CV) and renal events. Physical inactivity resulting in poor exercise capacity is a common consequence of chronic kidney disease and is associated with increased mortality in the general population. Nursing management for patients undergoing hemodialysis requires an experienced nurse who understands the types of complications.

Objective: The present study aimed to evaluate the effectiveness of resistance exercise therapy on patients' physiological status by utilizing a checklist of physiological parameters and comparing it with a control group.

Patients and Methods: The study was designed as a randomized controlled trial (RCT), using a double-blind technique, and it was conducted on patients divided into two groups (study and control groups). A total of 63 patients were included as follows: 32 patients for the study group and 31 patients in the control group. The patients were diagnosed with chronic kidney disease and were undergoing hemodialysis. The patients were randomly assigned to receive exercise therapy under the supervision of trained therapists during the second hour of the three routine hemodialysis treatments per week and under the supervision of the researcher. The study took place in Al-Najaf Al-Ashraf City/Al-Sadder Medical City and Al-Hakeem Hemodialysis Center.

Results: The study results indicated an improvement in the physiological status of the study group compared to the control group.

Conclusions: Exercise therapy effectively improves the physiological status of patients with chronic kidney disease undergoing hemodialysis.

Keywords: Effectiveness, Hemodialysis, Exercise Therapy, Physiological Status

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INTRODUCTION

Presently, chronic kidney diseases (CKDs) are a global public health problem, and the increasing prevalence of CKDs has attracted the attention of health researchers. In particular, the estimated prevalence ranges from 8% to 16% worldwide, and it is high in both developed and developing countries.[1] This disease is described as renal tissue damage and gradual loss of glomerular filtration (GFR) for more than three months at a rate of less than 60 mL/min/1.73 m^2. While hemodialysis treatment increases the patient's life expectancy, it also negatively impacts the patient on the physical, emotional, social, and spiritual levels most of the time since it can lead to impairment of mobility, reduced recreation, decreased autonomy, and other factors.[2]

Routine monitoring and evaluation of vital signs can provide critical information about the underlying physiological state of patients diagnosed with end-stage kidney disease (ESKD) undergoing hemodialysis therapy.[3] One of the elements that can lead to CKD development is hypertension (HTN). More than 90% of patients with advanced CKD have hypertension depending on the stage of CKD and its cause.[4] The key factor in blood pressure (BP) management in this cohort is fluid status. The "National Kidney Foundation" has suggested that blood pressure goals should be < 140/90 mmHg pre-dialysis and < 130/80 mmHg post-hemodialysis, respectively. A greater BP level is associated with higher risks of cardiovascular and mortality outcomes in patients on hemodialysis.[5]

Dyspnea and fatigue are the main symptoms of CKD, and both affect the quality of life of patients suffering from chronic renal insufficiency (CRF) and limit their exercise capacity. Several central or peripheral pathophysiological mechanisms, such as low cardiac output, hypertension, increased capillary pressure in the pulmonary artery during exercise, and peripheral myopathy, contribute to exercise intolerance in patients with CRF.[6]

As mentioned earlier, the prevalence of CKDs has increased worldwide, and it is expected to become the fifth most common cause of death in the world by 2040.[7,8] In high-income countries, hemodialysis and transplantation costs account for 2–3% of the annual healthcare budget; on the other hand, less than 0.03% of the total population of

these countries is spent in low- and middle-income countries, and most people with kidney failure do not have sufficient access to life-saving dialysis and kidney transplantation.[9]

In today's world, physical activity is essential. Exercise maintains the body's strength and health.[10] Continuous training exercises are described to improve the functional capability, quality of life, and clinical outcomes of CRF patients. Physical activity is an essential element for the prevention of chronic diseases as it decreases the risk of complex chronic diseases. Furthermore, among the general population, especially in patients with ischemic heart disease, it contributes to blood pressure and glucose control and improves the health-related quality of life (QOL).[11]

The experimental work presented in the current study provides one of the first investigations into the impact of resistance exercise therapy on patients' physiological status during hemodialysis. Therefore, this study contributes to the research and provides a deeper understanding of the improved physiological status of patients with chronic kidney disease by clarifying the methods and exercise used in the intervention program. This study focuses on an essential topic in nursing studies to fill the gap in nursing research. Therefore, it sought to answer the following research question: Does resistance training therapy improve the patients' physiological status undergoing hemodialysis?

Ultimately, the study aimed to evaluate the effectiveness of resistance exercise therapy on patients' physiological status (blood pressure, heart rate, respiratory rate, and oxygen saturation) and body mass index (BMI) by comparing the physiological status of the study and control group. In this sense, the study hypothesis was as follows: Patients who receive resistance exercise therapy demonstrate a better physiological status than the control group.

PATIENTS AND METHODS

Study Design: The study was designed as a randomized controlled trial conducted on patients divided into two groups: study and control group.

Study Setting: The study took place in the city of Al-Najaf Al-Ashraf at Al-Najaf Health Directorate, Al-Hakeem General Hospital, and Al-Sadder Medical City/Hemodialysis Center. The study was

carried out for eight weeks from December 21, 2020, to February 18, 2021.

Participants Selection: Following the "American Society of Nephrology" (ASN), "National Kidney Foundation" (NKF), and the Clinical Practice Guidelines for the Diagnosis of Chronic Kidney Disease[12], 68 eligible volunteer patients were recruited to participate in the current study. In particular,34 patients were selected randomly from each of the following centers that they were admitted to during the study period: Al-Sadder Medical City and Al-Hakeem General Hospital/Hemodialysis Center. . The patients were diagnosed with chronic kidney disease and were undergoing hemodialysis, thus meeting the eligibility criteria. According to medical consultations, one patient with a history of cardiac disease was excluded from the sample as defined by the sample criteria. Additionally, two patients refused to participate in the study. Moreover, two other patients were excluded because they could not regularly participate for eight weeks. The total number of participants who were withdrawn and excluded from the study before randomization and group assignment is five patients. Thus, the remaining 63 eligible patients participated in this study.

Sampling Technique: Using a non-probability technique (purposive sample), 63 selected patients were included in the current study. All patients had chronic kidney disease and were referred to the clinics for hemodialysis. They were taking for medical history and completed clinical examinations.

Sample Size: Based on statistical power, in randomized controlled trials, statistical power is usually set to a number equal to or greater than 0.80, with many experts in clinical trials now claiming a power set of 0.90.[13] The sample size was (55) participants. But the researcher increased the sample size to (63) to recruit this number of patients.

Assignment of Groups: The sample of 63 patients was randomly divided into two groups. The study group consisted of 32 patients who participated in the exercise training program. The control group included the remaining 31 patients who did not partake in the exercise training program.

Implementation of Randomization: After the initial evaluation, patients were randomly assigned using a computer-generated list of random numbers (Excel spreadsheet). Random assignment is done to prevent selection bias, and control prevents

accidental confounding. Block randomization lists random computer numbers prepared by investigators who are not involved in the clinical trials. It eliminates the source of bias in intervention assignments. Thus, the first week of the study was randomly assigned to the intervention in a simple randomized fashion. Afterward, all eligible patients were assigned to the experimental and control groups every two weeks. Therefore, the outcome data and post-study analysis; The total study sample (50).

Blinding: The current study used a double-blinded technique in which the data analyst does not know the allocation of study groups. In addition to the investigators and participants of the outcomes are also unaware of the study and control groups.

Study Group: A total of 32 patients participated in an exercise training program led by the researcher to provide the patients with information and improve physiological status with medical care and treatment. After the eighth-week evaluation (post-test), two patients did not complete the program (one patient died, and one patient was transferred to another hospital). In the study group, exercise training was provided for eight weeks under the supervision of a therapist (physiotherapist) during the first hour of the three routine hemodialysis treatments per week and under a self-training during hemodialysis. All exercises were performed using seated and/or supine positions. The warm-up and cool-down stages of the exercise sessions are common to the group. It consisted of 5–10 minutes of stretching exercises for the hip's triceps sural, hamstrings, and external rotator muscles.

Control Group: A total of 31 patients received regular medical care and treatment only. After the eighth-week follow-up, six participants withdrew from the study. Twenty-four participants completed the follow-up, and after evaluation (post-test), another five participants withdrew. Overall, the patients were instructed to maintain their regular medical care and usual physical activity throughout the study period; however, they didn't engage in the exercise training program. The patients in the control group were exposed to the usual activities of the center only.

Study Procedures: All study participants underwent the same exercise and battery of tests. At first, the patients were provided with a full explanation of the test procedures and study goals. Afterward, they agreed to

participate and signed written informed consent. This study was conducted from December 21, 2020, to February 18, 2021, according to the principles of the Belmont report (Ethical Principles and Guidelines for the Protection of Human Subjects of Research), and it was approved by the institutional ethics committee of the Nursing Faculty, University of Kufa. The interventions were compared to the control group, such as usual care or no exercise, consisting of medical care.

Study Instrument: A study instrument is adopted by the researcher based on the kinds of academic literature to investigate the study phenomenon. Experts in a different field evaluated the questionnaire contents. The instrument construction was as follows: Part I involved the socio-demographic characteristics of the patients undergoing hemodialysis, and it comprised five items including gender, age, level of education, occupation, and monthly income. Part II dealt with the clinical characteristics of the patients undergoing hemodialysis, and it included their medical history. Part III included the checklist for the physiological parameters of the patients undergoing hemodialysis (heart rate, respiratory rate, systolic blood pressure, diastolic blood pressure, and O_2 saturation). The researcher checked physiological parameters for both the study and control groups and measured them at the hemodialysis centers. Each patient needed 5–10 minutes to answer the questions and checklists. The instrument reliability is 0.90, which was found to be good to evaluate the vital signs.

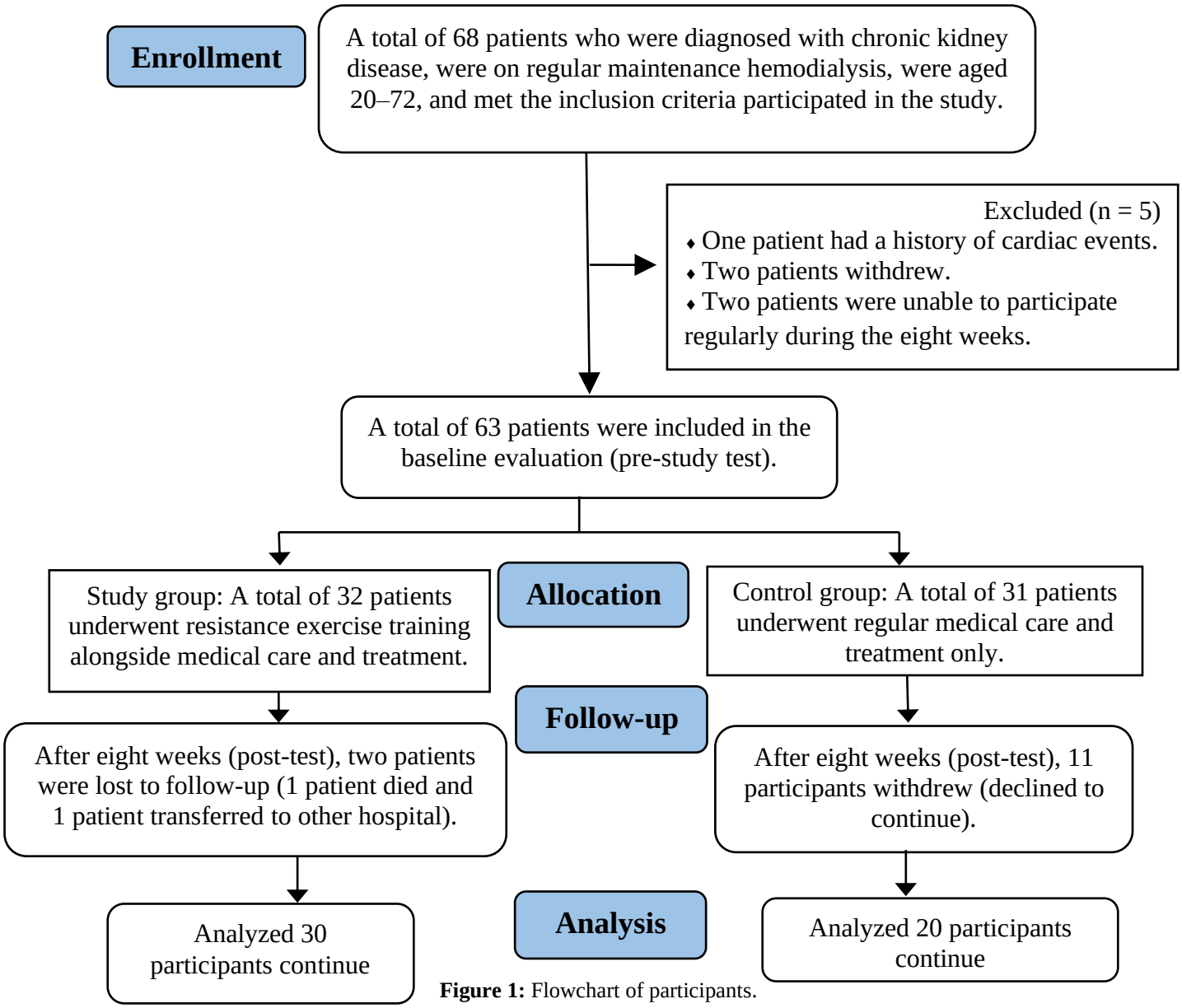

Figure 1: Flowchart of participants.

Data Collection: Face-to-face interviews were utilized for the sociodemographic and clinical data collection. The data collection started on December 21, 2020 and ended on February 18, 2021. Regarding the assessment of physiological status, the researcher employed the guided observation technique to assess the physiological status of patients before and after the application of the program. The physiological status was

evaluated through the ask patient collected by using the resistance exercises training while the patients were closely monitored. Regarding the physiological status assessment for the study group, the researcher used pre-test and post-test assessment periods (after eight weeks after the program's application) by following established guidelines. The researcher used pre-test and post-test evaluations for the control group without implementing the exercise training program.

Statistical Analyses: The Shapiro–Wilk test examined all continuous variables for statistically normal distribution and displayed the normal distribution.

The following statistical data analysis techniques were used to analyze these data: Microsoft Excel (2016) and Statistical Package for the Social Sciences (SPSS), version 26. The analysis included two types of statistics. **Descriptive Data Analysis:** This was presented as tables, percentages, frequencies, and graphic presentation by using bar charts (statistical figures), and the participants' statistical mean and standard deviation were calculated. **Inferential Data Analysis:** Statistical tests were conducted according to the distribution and type of variables. These tests were used to accept or reject the null hypothesis. Chi-squared tests were used to compare baseline characteristics for the categorical variables, and the homogeneity test was used to confirm the presence of a significant difference between the control and intervention groups and the association between the sociodemographic variable and outcome variable. T-tests to an independent group for continuous variables. The mean baseline changes were compared using two-sample t-tests. The researcher relied on the confidence interval (0.95) to determine whether the program's effectiveness was statistically significant (P-value of 0.05).

RESULTS

Table 1: Summary statistics of the study and control groups' socio-demographic data.

Variables	Rating and Intervals	Study group		Control group		Chi-Square, P-value
		Freq	%	Freq	%	
Age (Years)	20–29	2	6.3	2	6.5	χ^2 = 1.66 P = 0.79
	30–39	2	6.3	5	16.1	
	40–49	9	28.1	9	29.0	
	50–59	11	34.4	9	29.0	
	60+	8	25.0	6	19.4	
	$\bar{x}$ ± S.D.	51.93 ± 11.70		48.83 ± 11.31		
Gender	Male	22	68.8	21	67.7	χ^2 = 0.03 P = 0.84
	Female	10	31.3	10	32.3	
Educational Level	Doesn't read and write	4	12.5	5	16.1	χ^2 = 2.36 P = 0.79
	Reads and writes	11	34.4	11	35.5	
	Primary school graduated	9	28.1	8	25.8	
	Intermediate school graduated	4	12.5	1	3.2	
	Secondary school graduated	2	6.3	3	9.7	
	Institutes, college, or postgraduate	2	6.3	3	9.7	
Occupation Status	Government employee	4	12.5	5	16.1	χ^2 = 0.55 P = 0.99
	Own worker or self-employed	2	6.3	3	9.7	
	Retired	2	6.3	1	3.2	
	Housewife	9	28.1	9	29.0	
	Jobless	11	34.4	9	29.0	
	With disability	4	12.5	4	12.9	
Monthly Income	Insufficient (Low)	21	65.6	17	54.8	χ^2 = 0.48 P = 0.78
	Sufficient to some extent (Moderate)	10	31.3	13	41.9	
	Sufficient (High)	1	3.1	1	3.2	
Total		32	100.0	31	100.0	

$\bar{x}$: "Mean"; S.D: "Standard deviation"; χ^2: "Chi-Square";

Patients' Sociodemographic Data: Table 1 shows the statistical distribution of the study sample according to their sociodemographic data. Regarding the study group, the results indicate that the majority of the participants in the study group were aged 50–59 years old, were male, can read and write, were unemployed, and had insufficient income. For the control group, the results indicate that the majority of the control group were aged 40–59 years old, were male, can read and write, ranged in occupation status between housewife and jobless, and had insufficient income.

Table 2: Statistics distribution of the study and control groups according to clinical characteristics.

Clinical Characteristic	Rating and interval	Study group		Control group		C.S
		Freq	%	Freq	%	
Duration of Hemodialysis (Years)	1 or less	3	9.4	4	12.9	$\chi^2 = 1.31$ P = 0.72 NS
	2–3	13	40.6	10	32.3	
	4–5	10	31.3	13	41.9	
	6 or more	6	18.8	4	12.9	
Duration of Hemodialysis Sessions (Hours)	2.0	4	12.5	0	0.0	$\chi^2 = 5.40$ P = 0.24 NS
	2.5	0	0.0	1	3.2	
	3.0	15	46.9	15	48.4	
	3.5	3	9.4	3	9.7	
	4.0	10	31.3	12	38.7	
Number of Hemodialysis Sessions (Per Week)	2	14	43.8	15	48.4	$\chi^2 = 2.05$ P = 0.56 NS
	3	15	46.9	13	41.9	
	4	2	6.3	3	9.7	
	5	1	3.1	0	0.0	
Duration of Diagnosis With Renal Failure (Years)	1 or less	2	6.3	1	3.2	$\chi^2 = 1.02$ P = 0.60 NS
	2–4	16	50.0	14	45.2	
	5 or more	14	43.8	16	51.6	
Smoking Habits	Smoker	5	15.6	6	19.4	$\chi^2 = 0.57$ P = 0.74 NS
	Ex-smoker	14	43.8	12	38.7	
	Non-smoker	13	40.6	13	41.9	
Total		32	100.0	31	100.0	

C.S: comparison significance; χ^2: chi-square; P-value: probability value; NS: non-significant

Patients' Clinical Characteristics: Table 2 shows the study sample's statistical distribution according to their clinical features. Concerning the study group, the results of the study indicate that the majority of the patients were characterized as follows: duration of hemodialysis of 2–3 years, three hours of hemodialysis per session, hemodialysis sessions three times per week, duration of diagnosis with renal failure between 2 to 4 years, ex-smoker. Regarding the control group, the results indicate that the majority of the control group were characterized as follows: duration of hemodialysis of 4–5 years, three hours of hemodialysis per session, hemodialysis sessions two times per week, duration of diagnosis with renal failure five years and more, non-smoker.

Table 3: Summary statistics of patients' physiological parameters (vital signs) of the pre-test for both study and control groups.

Vital Signs		Study group		Control group		t-value, P-value
		Freq	%	Freq	%	
Systolic Blood Pressure (mmHg)	Normal <= 129	5	15.6	6	19.4	t = 0.13 P = 0.89 NS
	High-normal 130–139	7	21.9	4	12.9	
	Grade I hypertension 140–159	8	25.0	7	22.6	
	Grade II hypertension 160+	12	37.5	14	45.2	

Diastolic Blood Pressure (mmHg)	Normal < 85	10	31.3	4	12.9	t = 0.73 P = 0.46 NS
	High-normal 85–89	16	50.0	17	54.8	
	Grade I hypertension 90–99	4	12.5	8	25.8	
	Grade II hypertension 100+	2	6.3	2	6.5	
Heart Rate (beat/minute)	Normal	28	87.5	31	100.0	t = 0.44 P = 0.66 NS
	Tachycardia	4	12.5	0	0.0	
Respiratory Rate (breath/minute)	Normal	17	53.1	21	67.7	t = 0.61 P = 0.53 NS
	Tachypnea	15	46.9	10	32.3	
Oxygen Saturation (%)	Moderate Hypoxemia 85–89	6	18.8	4	12.9	t = 0.19 P = 0.84 NS
	Mild Hypoxemia 90–94	20	62.5	22	71.0	
	Normal 95+	6	18.8	5	16.1	
Total		32	100.0	31	100.0	

* The blood pressure categories are divided based on the last update of the 2020 International Society of Hypertension: Global Hypertension Practice Guidelines and the new guidelines for blood pressure levels in adults from the American Heart Association (Unger *et al.*, 2020).

** The categories of oxygen saturation levels (saturation of peripheral oxygen [SpO_2]) and pulse rate are divided according to pulse oximetry: the definitive guide for monitoring oxygen saturation of London Medical College (2021).

The results summarized in Table 3 refer to the assessment of physiological parameters (vital signs) of the sample. The study group findings demonstrate that most patients had a systolic blood pressure of Grade II hypertension, high–normal diastolic blood pressure, normal heart rate, normal respiratory rate, and mild hypoxemia. Meanwhile, the results of the control group indicate that the majority of patients had a systolic blood pressure of Grade II hypertension, high–normal diastolic blood pressure, normal heart rate, normal respiratory rate, and mild hypoxemia in oxygen saturation.

Table 4: Independent samples t-test of the physical parameters (vital signs) between study and control group at pre-test.

Pre-test		N	Mean	Std. Deviation	t-value	df	Sig.
Systolic Blood Pressure (mmHg)	Study	32	141.41	18.01	1.03	61	0.30 NS
	Control	31	146.29	19.36			
Diastolic Blood Pressure (mmHg)	Study	32	87.66	12.88	0.50	61	0.61 NS
	Control	31	89.19	10.96			
Heart Rate (beat\minute)	Study	32	83.06	13.57	1.63	61	0.10 NS
	Control	31	78.29	9.06			
Respiratory Rate (breath\minute)	Study	32	20.94	3.63	1.64	61	0.10 NS
	Control	31	19.55	3.02			
Oxygen Saturation (%)	Study	32	92.69	2.34	0.30	61	0.76 NS
	Control	31	92.48	2.96			
Body Mass Index (BMI) kg/m2	Study	32	20.44	0.75	0.38	61	0.70 NS
	Control	31	20.52	0.85			

N: "number"; df: "degree of freedom". Significant at P < 0.05.

Table 4 shows the comparison between the study and control groups. According to the statistical mean, the study results indicate a nonsignificant difference between the study and control groups in the pre-test, with a P-value less than 0.05.

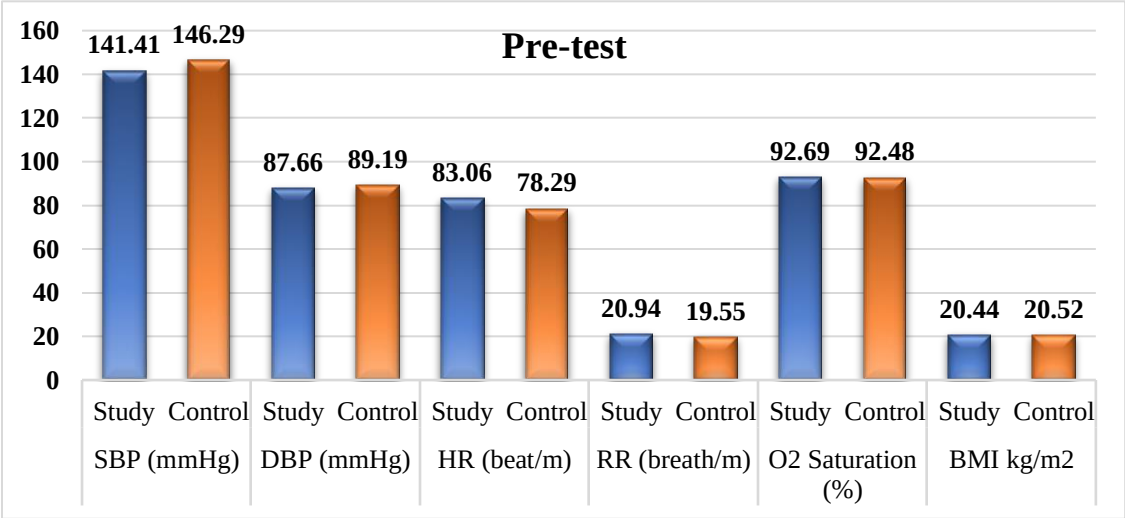

Figure 2: Physical parameters among study sample at pre-test.

Table 5: Independent samples t-test of the physical parameters (vital signs) between study and control group at the post-test period.

Post-test		N	Mean	Std. Deviation	T	df	Sig.
Systolic Blood Pressure (mmHg)	Study	30	131.67	9.58	4.26	48	0.0001 HS
	Control	20	149.25	19.35			
Diastolic Blood Pressure (mmHg)	Study	30	80.50	11.16	2.99	48	0.004 HS
	Control	20	89.75	9.93			
Heart rate (beat\minute)	Study	30	78.60	6.09	0.97	48	0.334 NS
	Control	20	80.45	7.21			
Respiratory Rate (breath\minute)	Study	30	18.77	2.26	3.50	48	0.001 HS
	Control	20	21.50	3.25			
Oxygen Saturation (%)	Study	30	95.23	1.73	6.11	48	0.0001 HS
	Control	20	91.45	2.64			
Body Mass Index (BMI) kg/m2	Study	30	20.50	0.73	0.45	48	0.654 NS
	Control	20	20.40	0.82			

N: "number", df: "degree of freedom", F (ANOVA value), NS: non-significant, High Significant at P<0.05

Effect of the Intervention Program on the Participants: Table 5 shows the comparison of the study group with the control group. According to the statistical mean, the study results indicate a highly statistically significant difference between the study and control groups at the post-test with a P-value less than 0.05; however, the body mass index showed a nonsignificant difference.

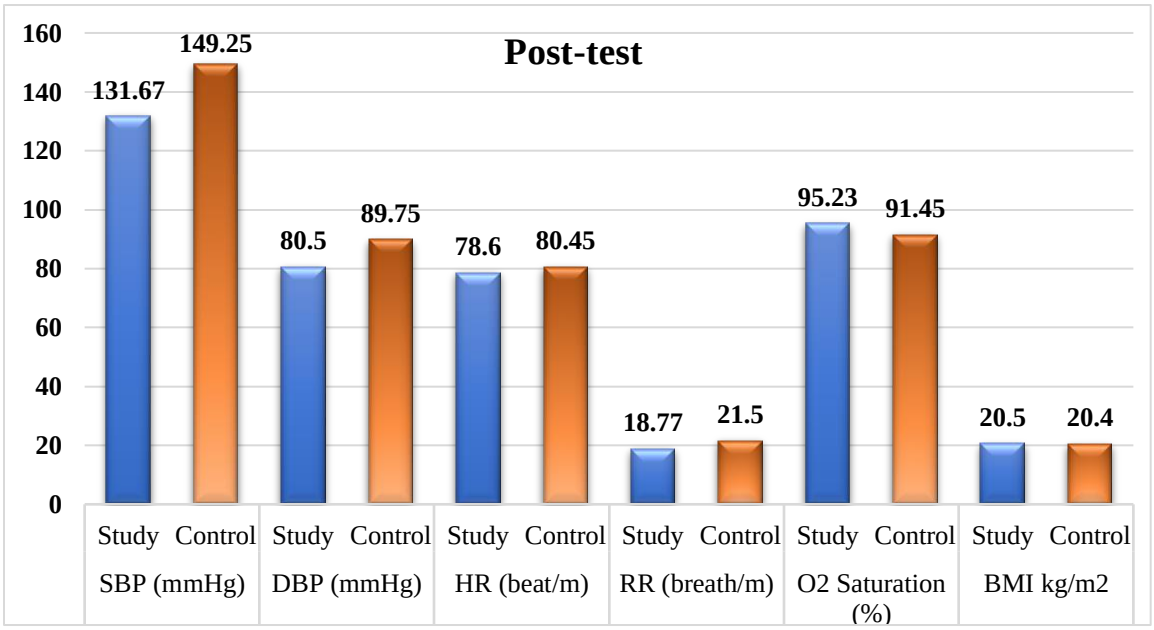

Figure 3: Physical parameters among study sample at pos-test.

Table 6: Applying one-way analysis of variance test (ANOVA) on the physiological status throughout pre-test and post-test periods in the control group.

Vital signs	Periods of test	N	Mean	Std. Deviation	df	Sig.
Systolic Blood Pressure (mmHg)	Pre-test	31	146.29	19.36	49	0.59 NS
	Post-test	20	149.25	19.35		
Diastolic Blood Pressure (mmHg)	Pre-test	31	89.19	10.96	49	0.85 NS
	Post-test	20	89.75	9.93		
Heart rate (beat\minute)	Pre-test	31	78.29	9.06	49	0.37 NS
	Post-test	20	80.45	7.21		
Respiratory Rate (breath\minute)	Pre-test	31	19.55	3.02	49	0.03 S
	Post-test	20	21.50	3.25		
Oxygen Saturation (%)	Pre-test	31	92.48	2.96	49	0.21 NS
	Post-test	20	91.45	2.64		
Body Mass Index (BMI) kg/m2	Pre-test	31	20.52	0.85	49	0.23 NS
	Post-test	20	20.20	1.00		
Total		51				

N "number', df: "degree of freedom", F (ANOVA value)

Table 6 demonstrates a nonsignificant difference in the control group between the mean throughout the two periods of measurement (pre-test and post-test). The levels of all of the physiological statuses were below the predicted levels at the pre-test and were still deteriorating even after the post-test (i.e., no improvement in patient physical parameters).

Table 7: Mean difference (ANOVA) between the physiological parameters of patients (vital signs) for the study group (post-test 2).

Vital signs	Periods of measurements	N	Mean	Std. Deviation	df	Sig.
Systolic Blood Pressure (mmHg)	Pre-test	32	141.41	18.01	60	0.01 S
	Post-test	30	131.67	9.58		
Diastolic Blood Pressure (mmHg)	Pre-test	32	87.66	12.88	60	0.02 S
	Post-test	30	80.50	11.16		
Heart Rate (beat\minute)	Pre-test	32	83.06	13.57	60	0.04 S
	Post-test	30	78.60	6.09		
Respiratory Rate (breath\minute)	Pre-test	32	20.94	3.63	60	0.02 S
	Post-test	30	18.77	2.26		
Oxygen Saturation (%)	Pre-test	32	92.69	2.34	60	0.001 HS
	Post-test	30	95.23	1.73		
Body Mass Index (BMI) kg/m2	Pre-test	32	20.44	0.75	60	0.55 NS
	Post-test	30	20.33	0.60		
Total		62				

*df: "degree of freedom". HS: high significance at P < 0.01

Table 7 shows a significant difference in the study group regarding the statistical mean of systolic blood pressure, diastolic blood pressure, heart rate, and respiratory rate. Additionally, a highly significant difference was detected in oxygen saturation throughout the periods of measurement (pre-test and post-test). Thus, the intervention program used in the present study effectively improved the patients' physiological parameters (vital signs). In comparison, there is a nonsignificant difference in the body mass index (BMI) throughout periods of measurement.

DISCUSSION

Physical inactivity, which leads to low performance in exercise, is the common result of chronic kidney diseases and is associated with an increase in the mortality rate of the general population.[16] Exercise is an integral part of the rehabilitation program and an essential method for the treatment of many medical disorders and chronic diseases. Furthermore, exercise can also have a positive effect on the improvement of disorders.[17,18] Rehabilitation and patient education should be provided because it is crucial to ensure that patients engage in as much self-management of their chronic kidney disease risks as possible.[19]

Patients' Vital Signs: The standard vital signs monitored in patients in a hospital usually include temperature, heart rate (HR), respiratory rate (RR), blood pressure (BP), and, when appropriate, peripheral oxygen saturation (SpO2). The routine monitoring

and evaluation of these vital signs can provide critical information about the underlying physiological state of patients diagnosed with ESKD undergoing hemodialysis treatment.[3] In this sense, the results of this study demonstrate that most of the patients have normal vital signs (heart rate, respiratory rate, and oxygen saturation) except for systolic blood pressure (Grade II hypertension) and diastolic blood pressure (high-normal).

Li *et al.*[5] (2020) have studied the blood pressure variability and outcomes in end-stage renal disease patients on dialysis, and they found that the majority of the patients presented with a history of increased systolic blood pressure and diastolic blood pressure. This is due to the reduced glomerular filtration rate; there is an increase in the regulation of the renin-angiotensin-aldosterone system (RAAS) that promotes salt and water retention. The other vital signs were normal, perhaps because the patients undergoing medical treatment with drugs and hemodialysis contributes to keeping them normal.

Effectiveness of the Intervention on Patients' Physiological Parameters: The two evaluations' results pre- and post-intervention demonstrate that the resistance exercise training method affected patients undergoing hemodialysis. The resistance exercise training program effectively reduced the blood pressure, heart rate, and respiratory rates in the study group of patients. Additionally, a highly significant difference was detected in oxygen saturation throughout the measurement periods (pre-test and post-test). Therefore, the intervention program used in the current study effectively improved patients' vital signs. At the same time, a nonsignificant difference was observed in the body mass index (BMI) throughout the periods of measurement.[20]

The available studies suggest that resistance training can reduce blood pressure. Thompson *et al.*[21] (2020) studied the effect of exercise on blood pressure in chronic kidney disease, and they suggested that exercise training is a strategy to lower blood pressure in an intradialytic patient with chronic kidney disease. Additionally, Abd Elhalim *et al.*[22] mentioned in their study results that the intradialytic resistance exercise training three times per week in patients on regular hemodialysis had a positive effect on the reduction of blood pressure.

Brasileiro *et al.*[2] (2017) indicated that the exercise effectively reduced heart rate in patients who suffer from chronic kidney disease, and the volunteers' evaluation of the intervention was positive. Tasoulis *et al.* (2010) studied the effects of interval exercise training on the respiratory drive in patients with chronic heart failure, and they reported that the exercise rehabilitation program involving resistance training improves the respiratory rate and ventilatory pattern at rest and during exercise in patients with chronic heart failure.[21] Furthermore, Woo *et al.* (2006) studied the influence of age, gender, and training on exercise efficiency, and they ascertained that exercise training increases oxygen saturation. Finally, regular exercise training constantly maintains the specifications of the vital signs' parameters among patients with chronic kidney disease.[23]

CONCLUSIONS

The study concluded that implementing a resistance exercise program for at least eight weeks is an effective way to improve the physiological status of patients with chronic kidney disease undergoing hemodialysis.

Recommendations: Longer follow-up is needed to determine whether these results will be interpreted into decreased death rates. Future research should seek to overcome these limitations. The researcher suggests the potential application of exercise therapy for patients with other similar conditions such as chronic heart failure.

Limitations: The current study faces some limitations, such as the dropout rate in the patients before the completion of the study. Additionally, the researcher was unable to contact the patients regularly. Other limitations included the patients' lack of awareness and comorbidity factors that may interfere with the study's findings.

Ethical Considerations: Ethical study approval was obtained by governmental legal agreement before conducting the study. Participants were clearly informed about the study's objectives and their rights to participate or withdraw from the study and were freely participating.

Conflicts of interest: The author declares no conflict of interest.

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