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Original Article

Beneficial Psychological and Muscular Effects of Resistance Exercise in Patients with Chronic Heart Failure: A Randomized Controlled Trial

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ABSTRACT

Background: Patients with chronic heart failure (CHF) are characterized by debilitating muscle weakness, the inability to move, and resultant psychological disadvantages. The current study investigated the acute effects of resistance exercise (RE) and their impact on psychological health and peak muscle contraction (PMC) in patients with CHF.

Methods: This randomized controlled trial was performed between October 2019 and December 2020. Fifty-seven patients with CHF (NYHA Class II, III) underwent initial assessments of the 6-minute walking test (6MWT), psychological response to exercise, and PMC. They were randomly divided into three groups, namely R1, R2, and the control group. The intervention consisted of a short aerobic exercise comprising 15 minutes of walking at an intensity of 50%-reserved heart rate for all three groups and an additional RE with the intensity of 50%-1RM and 75%-1RM for groups R1 and R2, respectively.

Results: No significant difference among the groups were observed in 6MWT, peak muscle contraction, and psychological response to exercise after the intervention ($P \geq 0.05$). PMC and psychological response to exercise improved significantly in all groups; however, only group R2 showed a significant increase in 6MWT after the intervention. Positive well-being (PWB) had a positive correlation with peak muscle contraction of the left knee extensors and dorsiflexors, and psychological dystress (PD) and FAT were negatively correlated to walking distance and PMC of the left knee extensors and dorsiflexors.

Conclusions: Performing just one session of exercise had significant beneficial impacts on PMC and psychological response in patients with CHF, regardless of exercise type or RE intensity. However, walking distance (6MWT) increased significantly in the R2 group (75% of 1-RM), indicating that performing higher resistance exercise is safe and leads to functional advantages in CHF patients. There was a positive relationship between PWB and 1RM and a negative relationship between both psychological distress (PD) and fatigue and 1RM.

Introduction

Chronic heart failure (CHF) is a chief cause of morbidity and mortality in the world [1]. The overall prevalence

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of CHF is 1-2%, which can increase to 10% in people over the age of 70 years [2]. Heart failure, categorized by inadequate cardiac function, is associated with fatigue and exercise intolerance attributed to fiber type alteration and atrophy in skeletal muscles [3] accompanied by a decrease in quality of life [4]. Muscle weakness impairs the patient's functional capacity and manifests in their walking ability, as evidenced by reduced muscle power and the 6-minute walking test (6MWT) [5].

Until the 1980s, exercise was forbidden for patients with CHF. Since then, however, numerous studies have suggested that exercise provides substantial physiological and psychological benefits for CHF patients [6]. Kubzansky et al. reported that psychological well-being, which includes positive thoughts and feelings such as purpose in life, optimism, and happiness, has its own independent associations with lower risk of cardiovascular diseases and may promote cardiovascular health, which includes physical activity [7].

Psychological health consists of both negative and positive emotional or affective states in terms of psychological distress and psychological well-being [8]. Multiple studies have investigated the positive effects of resistance exrcise (RE); however, the design of an appropriate RE program remains under debate [9], even though some studies have indicated psychological improvements after RE [10]. Affection is more sensitive to the acute effects of RE than other scales, such as anxiety or mood [11]. Regarding the Dual-Mode Theory, affective responses to aerobic exercise vary based on the exercise intensity and energy metabolism [12]. Moderate intensity is defined as any intensity that is below the ventilatory threshold, in which the affective responses are predominantly pleasant, while heavy intensity produces affective responses that are variable and strongly influenced by cognitive processes [13]. In severe intensity with anaerobic metabolism, negative affection has been found to be predominant [14]. There is no evidence for how RE intensity influences affective responses; therefore, examining the acute affective responses to RE is important to designing an appropriate RE program.

Better psychological well-being has been shown to be associated with higher exercise capacity in coronary and CHF patients [15]. Radzewitz et al., however, reported no significant changes in anxiety or depression after muscle strength training in CHF patients [16].

High intensity RE has also been reported to increase the possibility of cardiac complications [17]. Therefore, a safe intensity and criteria of RE, for both acute bouts and training, should be considered to prevent the risks of cardiovascular complications during or after RE in CHF [17]. Exercise intensity is one of the important parameters of an exercise program; nevertheless, there is insufficient scientific evidence to prescribe a safe and effective intensity of RE for CHF patients. Moreover, a wide spectrum of RE intensity levels has been recommended by previous studies [18], and guidelines suggest a range of 30-80% one-repetition maximum (1-RM) [19]. Therefore, the current study aimed to investigate and compare the acute effects of RE with two different low (50%1-RM) and high (75%1-RM) intensities on PMC, 6MWT, and psychological response to exercise in CHF patients.

Methods

Study Design

This single-blind, randomized-controlled clinical trial was performed at the Heart Failure Clinic of Tehran Heart Center Hospital between October 2019 and December 2020. Every subject who agreed to participate in the study provided written informed consent, and all procedures were conducted according to the Declaration of Helsinki. The study protocol was approved by the Ethics Committee of Tarbiat Modares University, and the trial was registered in the Iranian registry of clinical trials (IRCT20190605043821N1).

Subjects

Fifty-seven CHF patients with reduced ejection fraction participated in the current study. The inclusion criteria consisted of an established clinical diagnosis of CHF, New York Heart Association (NYHA) classification II-III, optimal medical management for at least 3 months according to the American Heart Association (AHA), ejection fraction <40%, age between 45-75years, body mass index (BMI) between 25-32 kg/m^2, hemoglobin >12 mg/dl for women and >13 for men [20], stable hemodynamic condition, resting blood pressure (BP) between 100/70 and 140/90 mmHg, grade 3-4 of muscle strength for upper and lower extremities, respectively, and the ability to communicate.

Excluded from the study were high-risk patients such as those with unstable angina and complex ventricular arrhythmia, a recent myocardial infarction, a pacemaker, a history of cardiac intervention during the 6 months prior to the study, as well as those with any orthopedic, neurologic, or other impairment for which exercise is contraindicated or which prevents the patient from performing assessments, cognition impairment, participation in any exercise program during the study, or an unwillingness to cooperate for personal reasons.

Sample Size

The sample size was calculated by G-power software [21] and was based on the mean difference (533.9) and standard deviation (572.3) of LF (effect size=0.9) obtained from the Andrade [22] study in 2020 and the main effect (2.95) of positive and negative affects from the Bibeau [23] study in 2010 using an alpha level of 0.05 and power of 95%. A total of 19 cases in each group were considered.

Experimental Protocol

Demographic information and disease history, including age, BMI, duration of CHF, medications, comorbidities, and left ventricular ejection fraction, were collected. The fatigue severity scale [24], modified medical research council dyspnea scale (MRC) [25], subjective exercise experience scale (SEES) [8], and Minnesota living with heart failure questionnaire (MLHF) [26] were completed to measure fatigue, psychologic response to exercise, dyspnea, and quality of life, respectively.

The SEES is a 12-item questionnaire for assessing global psychological responses to exercise with three constructs, namely positive well-being (PWB), psychological distress (PD), and fatigue (FAT). Each item on this tool is scored on a Likert scale from 1 to 7. The validity and reliability of the Persian version of SEES were evaluated at the beginning of the study.

Patients were asked to avoid caffeinated and alcoholic drinks or any stimulants the night before and the day of data collection, not to perform moderate to heavy activities on the day before data collection, and to avoid heavy meals two hours before testing. Experiments were performed in a hospital room climate-controlled at 22-24 °C and 50-60% humidity. Data was collected between 8:00-12:00 AM to avoid circadian disparities.

Muscle Strength Measurement

Muscle strength was measured for ankle dorsi- and plantar flexors; knee flexors and extensors; hip flexors, extensors, and abductors; wrist flexors and extensors; elbow flexors and extensors; and shoulder abductors using digital dynamometry (hand-held dynamometer, model 01165SC, Lafayette Instrument Company, Lafayette, IN 47903, USA) [27] according to the Kendal protocol [28]. The average of three consequent contractions with 30 seconds rest between the contractions was recorded as the peak muscle contraction (PMC). Patients were verbally encouraged to produce the maximum contraction and asked to inhale during the concentric phase and exhale during the eccentric phase of contractions to avoid the Valsalva maneuver [18].

Functional Capacity (6-minute Walking Test)

To conduct the 6-minute walking test (6MWT) as the functional test of choice in CHF, patients were requested to wear comfortable walking shoes and clothes and allowed to have a light meal at least one hour before the test. After patients rested 30 minutes on a chair and while in a sitting position, patients' heart rate (HR) and blood pressure (BP) were measured by a digital sphygmomanometer (Omron M3, HEALTHCARE CO., Ltd, Kyoto, JAPAN) according to AHA protocol. The patients were asked to walk at a self-selected walking pace for 6 minutes as much distance as possible in a 30-meter corridor. They were informed they could rest if they needed to, but to continue as soon as possible [29]. BP, HR, and the rate of perceived exertion (RPE) (modified Borg scale 1-10) [30] were recorded immediately after the test, and the distance covered was recorded in meters. A wireless ECG monitor system (QardioCore, Model C100-1AW, Qardio, California, USA) was used to monitor patients during the test. QardioCore is a belt with three sensors for ECG recording with a sampling rate of 600 samples/second.

Rm Test

For the 1-RM test, the patient was asked to perform elbow flexion with maximum strength in a full range of motion, and then 1RM was calculated using the following formula (1RM $=W_0+w_1$). W_0 is a load that can be lifted for at least 7-8 repetitions, and w_1 is calculated by w1= W_0*0.025*r (r=number of repetition by that load) [31].

Group Assignment

Participants in this study were randomly allocated to three groups using sealed envelopes. Each patient was asked to pick an envelope from a box containing 57 envelopes (19 envelopes for each group [restricted randomization without replacement by physiotherapist]). The study groups included R1 (n=19), R2 (n=19), and control (n=19). The intensity of RE was 50% and 75% of 1-RM for groups R1 and R2, respectively, based on the results of the 1-RM test. Participants were blinded to their group assignment.

Intervention

Resting HR and BP were measured before an individualized face-to-face exercise session in all three groups. Patients were asked to perform 5 minutes of warm-up comprising gentle aerobic and stretching exercises. Then, they were asked to walk for 15 minutes at an intensity of 50% of HR reserve obtained from the Karvonen formula [32]. The experimental groups (R1 and R2) performed an additional 32 minutes of RE, comprising two sets of 6-8 repetitions of 11 exercises using free weights with an intensity of 50% or 75% of 1-RM. Five minutes of cool down as well as warm-up with gentle aerobic and stretching exercises were performed in all three groups [33].

The RE program for the R1 and R2 groups consisted of exercise with free weights for ankle dorsi- and plantar flexors; knee flexors and extensors; hip flexors, extensors, and abductors; wrist flexors and extensors; elbow flexors and extensors; and shoulder abductors. Patients were instructed to perform each movement for 5 seconds. One minute of rest was considered between each set and exercises. During exercise sessions, patients' ECG was monitored using the QardioCore system. If there was any complication such as chest pain during the exercise session, the exercise was terminated and only continued if possible according to the cardiologist's decision. HR, BP, and Borg scale were measured at the beginning and the end of the exercise sessions. All assessments, i.e. SEES, muscle strength, and 6MWT, were repeated immediately after the intervention. All assessments and intervention processes were performed by a trained physiotherapist under the supervision of a cardiologist (heart failure and transplant specialist).

Statistical Analysis

Data was analyzed using IBM SPSS statistics 24 software. The Shapiro-Wilk test was used to evaluate the normal distribution of the data. Continuous variables are presented as mean values±standard deviation, while categorical variables are presented as frequency (percentage). For data with normal distribution, paired t-test was used for within-group comparisons and analysis of variance, and the post hoc Tucky-test was used for between-group comparisons. The Pearson and Spearman correlation test was used to measure the degree of relationship between variables. In the case of abnormal distribution of data, the Wilcoxon signed-rank test was used for within-group comparisons, and the Kruskal-Wallis H test was used for between-group comparisons. The level of significance was set at $P<0.05$ for all statistical tests. The results were analyzed by an assessor blinded to the group allocation.

Results

Fifty-seven patients were randomized to three groups, and all of them were included in the analysis. Participants completed the study without any adverse events. The flow diagram of the study is given in Figure 1. The baseline characteristics of the patients are presented in Table 1. There was no significant difference between the groups at baseline for demographic and clinical characteristics, PMC, 6MWT, or SEES ($P\geq0.05$).

Functional Capacity

The results revealed no significant difference between groups for functional capacity including PMC and 6MWT after intervention ($P\geq0.05$) (Table 2). The results of 6MWT showed that the walking distance increased in all three groups but significantly only for group R2, in which the intensity of RE was 75% of 1-RM. The Borg scale increased significantly in all three groups. Peak muscle contraction also increased in all groups after the intervention for most of the muscle groups (Table 2). There was no significant difference between groups except for left elbow and wrist flexors and left hip abductor, which were higher in R2 (Table 2).

Psychological Response

A significant improvement in the PWB subscale and a significant decrease in the PD subscale of SEES were observed in all groups. The FAT subscale increased for

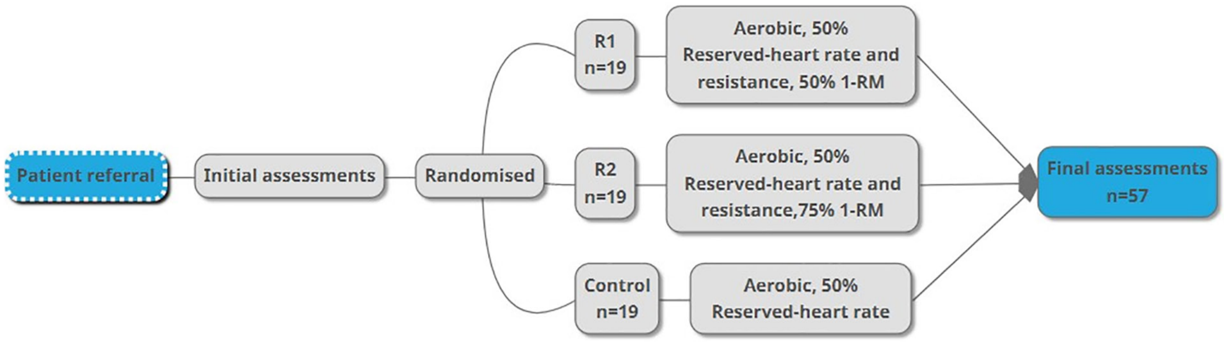

Figure 1: Flow diagram of study

Table 1: Baseline characteristics of the study population

Variables	Groups	R1 (n=19)	R2 (n-19)	Control (n=19)	P value
Age (year)		62.00±13.07	58.00±8.45	62.79±10.43	0.35
BMI(kg/m²)		25.59±3.90	28.04±5.26	27.87±5.46	0.24
Male		73.7	68.4	73.7	0.92
Female		26.3	31.6	26.3	
Education	Primary	52.6	57.9	57.9	0.40
	Secondary	15.8	10.5	10.5	
	Diploma	5.3	26.3	10.5	
	University	26.3	5.3	21.1	
Medications	B-blocker	84.2	68.4	78.9	0.50
	ACEI	89.5	89.5	78.9	0.56
	Diuretics	100	100	100	
	Vasodilators	10.5	31.6	26.3	0.27
	Digitalis	26.3	10.5	5.3	0.15
NYHA class	II	47.4	63.2	47.4	0.53
	III	52.6	36.8	52.6	
EF (%)		26.05±9.06	25.79±8.21	26.05±9.06	0.98
Heart failure duration (year)		28.72±20.57	26.22±16.63	28.22±19.61	0.99
Hemoglobin		14.10±1.61	13.67±1.58	13.58±1.80	0.59
1-RM (kg)	Elbow flexors	5.62±2.02	5.52±2.10	5.15±2.60	0.73
	Knee extensors	5.70±2.05	6.48±2.12	5.76±2.60	0.50
FSS (score)		45.11±9.32	40.84±11.62	47.37±9.48	0.30
MMRCDS (score)		3.21±0.71	2.84±0.96	3.32±1.25	0.30
MLHF (score)		56.00±23.31	47.42±17.48	53.74±24.65	0.47
6MWT (m)		298.95±108.26	366.84±126.01	293.89±172.51	0.20
BORG (score)		4.47±1.35	4.58±1.64	4.79±1.62	0.77
SEES (score)	PWB	17.37±5.28	17.05±6.13	16.26±4.43	0.46
	PD	7.89±1.04	9.47±6.81	10.21±5.86	0.83
	FAT	7.63±5.71	8.11±5.71	9.37±5.95	0.52

BMI: body mass index, NYHA: New York Heart Association, EF: ejection fraction, FSS: fatigue severity scale, MMRCDS: modified medical research council dyspnea scale, MLHF: Minnesota living with heart failure, 6MWT: 6-minute walking test, SEES: subjective exercise experience scale, PWB: positive well-being, PD: psychological distress, FAT: fatigue. Data is presented as mean±SD

Table 2: Changes in peak muscle contraction (PMC), 6-minute walking test (6MWT), and subjective exercise experience scale (SEES) questionnaire after the intervention

Variables \ Group		R1 (n=19)	P value	R2 (n-19)	P value	Control (n=19)	P value	P value (Between-groups)
Right shoulder abduction		0.16±0.36	0.07	0.07±0.40	0.47	-0.08±0.70	0.63	0.35
Left shoulder abduction		0.38±0.55	0.01	0.21±0.38	0.03	0.29±0.45	0.01	0.56
Right elbow extension		0.06±0.35	0.47	0.19±0.14	0.00	0.18±0.18	0.00	0.15
Left elbow extension		0.12±0.24	0.004	0.09±0.25	0.03	0.08±0.36	0.07	0.96
Right elbow flexion		0.09±0.25	0.03	0.16±0.51	0.02	-0.04±0.56	0.39	0.78
Left elbow flexion		0.27±0.30	0.001	0.08±0.23	0.04	0.04±0.51	0.19	0.04
Right wrist extension		0.06±0.22	0.22	0.01±0.28	0.87	0.14±0.30	0.00	0.32
Left wrist extension		0.09±0.22	0.09	0.06±0.37	0.51	0.11±0.45	0.05	0.90
Right wrist flexion		0.13±0.38	0.05	0.15±0.36	0.003	0.10±0.34	0.07	0.81
Left wrist flexion		0.15±0.31	0.05	0.32±0.17	0.00	0.25±0.31	0.001	0.02
Right hip abduction		0.23±0.47	0.004	0.38±0.55	0.001	0.19±0.41	0.05	0.43
Left hip abduction		0.07±0.37	0.06	0.57±1.03	0.007	0.01±0.48	0.23	0.01
Right hip extension		0.07±0.33	0.37	0.24±0.34	0.01	0.11±0.45	0.29	0.38
Left hip extension		0.14±0.23	0.01	0.25±0.36	0.003	0.23±0.34	0.003	0.79
Right hip flexion		0.04±0.26	0.37	0.18±0.61	0.17	0.03±0.53	0.15	0.53
Left hip flexion		0.16±0.37	0.04	0.13±0.58	0.11	0.01±0.34	0.23	0.82
Right knee extension		-0.02±0.55	0.13	0.10±0.59	0.06	0.01±0.31	0.36	0.43
Left knee extension		0.27±0.45	0.02	0.09±0.50	0.45	0.14±0.42	0.16	0.47
Right knee flexion		0.01±0.37	0.42	0.06±0.44	0.43	0.22±0.55	0.05	0.67
Left knee flexion		0.9±0.38	0.05	0.09±0.37	0.06	0.12±0.27	0.09	0.99
Right dorsiflexion		0.22±0.66	0.01	0.31±0.48	0.01	0.20±0.25	0.003	0.42
Left dorsiflexion		0.15±0.54	0.05	0.29±0.47	0.003	0.04±0.51	0.13	0.70
Right plantar flexion		0.01±0.58	0.25	0.04±0.56	0.21	-0.06±0.85	0.36	0.97
Left plantar flexion		0.22±0.42	0.02	0.34±0.78	0.01	0.15±0.42	0.03	0.69
6MWT(m)		16.84±61.84	0.25	29.58±33.97	0.001	10.11±30.74	0.17	0.57
BORG (score)		1.26±0.73	0.00	1.37±0.68	0.00	0.84±0.69	0.00	0.07
SEES (score)	PWB	4.26±2.60	0.00	4.32±2.79	0.00	4.74±1.63	0.00	0.46
	PD	-1.74±1.69	0.001	-2.42±3.44	0.001	-2.37±2.83	0.003	0.83
	FAT	0.16±2.09	0.80	-0.84±2.89	0.39	0.16±2.50	0.31	0.63

R1: 50% 1-RM, R2: 75% 1-RM, PMC: peak muscle contraction, 6MWT: 6-minute walking test, SEES: subjective exercise experience scale, PWB: positive well-being, PD: psychological distress, FAT: fatigue. Data is presented as mean±SD.

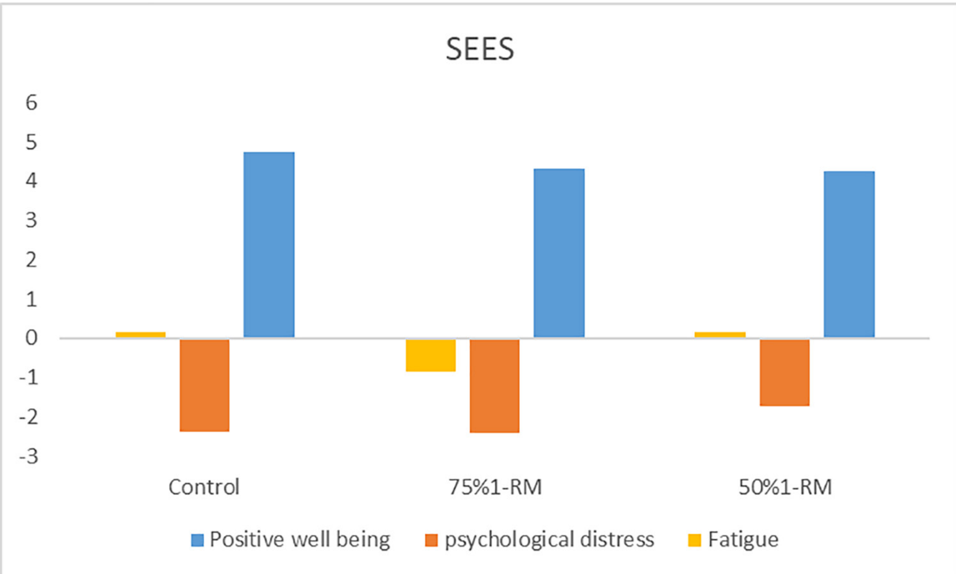

Figure 2: Between-group changes in SEES (subjective exercise experience scale) after the intervention (P>0.05)

group R1 and the control group but decreased for group R2, but the changes were not statistically significant for any of the three groups (Figure 2). Before the intervention, walking distance had a significant negative relationship with PD and FAT (Table 3). There was a significant positive relationship between PWB and PMC of the left knee extensors and dorsiflexors and a significant negative relationship between PD and FAT and PMC of the left knee extensors and dorsiflexors (Table 3).

The changes in PWB had a significant positive relationship with the changes in elbow flexion in R1 and elbow extension in R2 (Table 4). The changes of PD had a significant positive relationship with the changes in wrist and hip extension and knee flexion and a significant negative relationship with hip abduction and ankle dorsiflexion in R1. In R2, the changes in PD

Table 3: The relationships between peak muscle contraction (PMC), 6-minute walking test (6MWT) and subjective exercise experience scale (SEES) before the intervention

Variables	SEES (score)		
	PWB	PD	Fatigue
Distance in 6MWT (m)	0.23	-0.29*	-0.43**
Borg scale (score)	-0.53**	0.49**	0.44**
1RM-upper (kg)	0.42**	-0.46**	-0.48**
1RM-lower (kg)	0.49**	-0.34**	-0.46**
Right shoulder abduction (kg)	0.06	-0.12	-0.12
Left shoulder abduction (kg)	0.12	-0.25	-0.31*
Right elbow extension (kg)	0.08	0.04	-0.05
Left elbow extension (kg)	0.08	-0.11	-0.14
Right elbow flexion (kg)	0.12	-0.18	-0.11
Left elbow flexion (kg)	0.06	-0.19	-0.06
Right wrist extension (kg)	0.19	-0.30*	-0.18
Left wrist extension (kg)	0.11	-0.16	-0.23
Right wrist flexion (kg)	0.09	-0.18	-0.09
Left wrist flexion (kg)	0.10	-0.15	-0.17
Right hip abduction (kg)	0.21	-0.16	-0.26
Left hip abduction (kg)	0.15	-0.19	-0.15
Right hip extension (kg)	0.08	-0.08	-0.20
Left hip extension (kg)	0.17	-0.10	-0.23
Right hip flexion (kg)	0.09	-0.02	-0.07
Left hip flexion (kg)	0.25	-0.14	-0.07
Right knee extension (kg)	0.19	-0.14	-0.21
Left knee extension (kg)	0.28*	-0.26	-0.16
Right knee flexion (kg)	0.13	-.024	-0.42**
Left knee flexion (kg)	0.20	-0.37**	-0.38**
Right dorsiflexion (kg)	0.06	-0.08	-0.17
Left dorsiflexion (kg)	0.30*	-0.10	-0.24
Right plantar flexion (kg)	-0.01	-0.08	-0.02
Left plantar flexion (kg)	0.09	-0.13	-0.23

PMC: peak muscle contraction, 6MWT: 6-minute walking test, SEES: subjective exercise experience scale, PWB: positive well-being, PD: psychological distress, FAT: fatigue. Data is presented as mean±SD. **P<0.01, *P<0.05.

had a significant positive relationship with the changes in wrist extension and a significant negative relationship with knee extension. FAT had a significant positive relationship with shoulder abduction in R1 and with hip extension, knee extension, and ankle dorsiflexion in the control group (Table 4).

Discussion

The present study aimed to investigate the acute effects of RE with intensities of 50 (R1) and 75%-1RM (R2) on PMC, 6MWT, and psychological response to exercise in patients with CHF and to explore more beneficial intensity in the wide range of RE intensities recommended in the guidelines [19].

According to SEES questionnaire scores, the present study demonstrated improved psychological response (PWB increase and PD decrease) in response to a single bout of exercise in all three groups without any significant difference among them. The studies related to the acute psychological benefits of exercise revealed that different forms of a single bout of exercise trigger identically positive psychological benefits through physiological mechanisms as a central mediator of the psychological effect [34]. The placebo effect is another mechanism responsible for the psychological benefits of exercise which is related to expectancy and conditioning. Exercise performed at self-selected intensity, very short duration exercise, and exercise with various modalities all yield psychological benefits related to the placebo effect [35]. In cases of low volumes of exercise, the psychological models could be more appropriate in explaining the acute psychological benefits of exercise; however, the exercise protocol of the present study was not low for a single session in patients with CHF [35]. CHF is a progressive and debilitating disease that decreases the sufferer's quality of life and causes anxiety and depression. The improved PWB and decreased PD in the present study demonstrate the benefits for patients of CHF of performing RE in both intensities (50 and 75% 1RM) as well as aerobic exercise [36]. Adherence to an exercise program has been reported as depending on previously experienced pleasant feelings during exercise [37]. In other words, a person will engage in enjoyable behaviors and will avoid unpleasant ones [38]. Previous investigations have shown that different intensities of RE have different effects, such that moderate-intensity (60–80% 1RM) exercises had better positive affects [23, 38-40], and high-intensity (>80%1RM) exercises had negative affects [38]. Bellezza et al. [39] observed an increase in positive effects in response to performing nine different single-joint exercises. Moreover, exercising small muscle groups at the begining and large muscle groups at the end of an exercise session enhanced the positive affective responses from RE; the ending task is the most powerful affective stimulus [41].

Table 4: The relationships between the changes in peak muscle contraction (PMC), 6-minute walking test (6MWT), and subjective exercise experience scale (SEES) after the intervention in each group

Variables	R1 (n=19)			R2 (n=19)			Control (n=19)		
	SEES								
	PWB	PD	FAT	PWB	PD	FAT	PWB	PD	FAT
Distance in 6MWT(m)	-0.20	0.20	-0.27	-0.44	0.003	0.30	0.10	0.28	-0.43
Borg scale (score)	-0.34	-0.05	-0.02	-0.02	-.23	0.10	0.47	-0.38	-0.25
Right shoulder abduction (kg)	0.31	-0.44	-0.20	0.41	-0.24	0.12	-0.27	-0.12	0.05
Left shoulder abduction (kg)	0.24	-0.27	0.57*	0.18	0.04	-0.13	-0.50	0.34	0.05
Right elbow extension (kg)	-0.11	0.003	0.004	0.21	0.06	-0.10	-0.33	022	0.17
Left elbow extension (kg)	0.17	0.45	-0.32	0.53*	-0.07	0.17	-0.11	0.17	-0.02
Right elbow flexion (kg)	0.48*	0.03	0.08	0.12	-0.35	-0.33	-0.27	0.13	0.14
Left elbow flexion (kg)	0.25	-0.08	0.16	0.15	0.13	0.19	-0.51	0.33	0.15
Right wrist extension (kg)	-0.20	0.77**	-0.32	0.15	-0.01	0.36	-0.03	0.03	0.38
Left wrist extension (kg)	0.03	0.02	-0.43	0.14	0.49*	0.24	-0.29	0.39	-0.27
Right wrist flexion (kg)	-018	-0.40	0.39	0.36	0.03	0.06	-0.17	0.01	0.58
Left wrist flexion (kg)	-0.30	-0.10	-019	-0.23	-0.10	0.32	-0.37	0.24	0.17
Right hip abduction (kg)	0.06	-0.51*	0.15	-0.28	-0.09	-0.14	-0.18	0.26	-0.08
Left hip abduction (kg)	0.01	0.15	-0.14	-0.12	0.03	-0.14	-0.14	-0.28	0.10
Right hip extension (kg)	-0.28	0.34	-0.53*	0.38	0.15	0.17	-0.36	0.38	0.54*
Left hip extension (kg)	-0.42	0.55*	-0.51	0.13	0.01	0.07	0.05	0.22	0.13
Right hip flexion (kg)	-0.34	0.12	0.03	-0.07	-0.04	0.26	0.15	0.06	0.05
Left hip flexion (kg)	-0.26	0.27	-0.03	0.44	-0.06	0.07	-0.22	0.06	0.41
Right knee extension (kg)	-0.19	-0.14	-0.30	-0.25	-0.11	0.08	-0.24	0.21	0.53*
Left knee extension (kg)	0.08	-0.18	-0.40	0.07	-0.58**	-0.19	0.15	-0.04	0.13
Right knee flexion (kg)	-0.37	0.46*	-0.39	-0.18	0.23	0.31	-0.22	0.36	0.12
Left knee flexion (kg)	0.05	0.12	-0.15	-0.07	-0.18	0.29	0.10	-0.15	0.19
Right dorsiflexion (kg)	0.42	-0.62**	-0.14	0.02	0.35	0.38	0.14	0.20	-0.26
Left dorsiflexion (kg)	028	0.04	0.01	0.09	-0.02	0.01	-0.11	0.10	-0.16
Right plantar flexion (kg)	-0.09	0.06	-0.12	0.33	0.19	0.37	0.18	0.14	0.49*
Left plantar flexion (kg)	0.07	-0.06	0.04	0.28	0.38	0.33	0.19	-0.01	0.11

6MWT: 6-minute walking test, SEES: subjective exercise experience scale, PWB: positive well-being, PD: psychological distress, FAT: fatigue. Data is presented as mean±SD.**P<0.01, *P<0.05.

It has been shown that the negative affective response of lower-body RE was greater than that of the upper-body RE [42]; therefore, it is better to use upper-body RE initially to maximize pleasant feelings. Arent et al. [40] observed a decrease in anxiety and negative effects and an increase in positive effects after moderate-intensity upper-body RE but saw a decrease in positive effects after low-intensity and a decrease in negative effects after high-intensity RE. Another study by O'Connor et al. [40] showed a decrease in anxiety after 90 minutes of moderate-intensity upper and lower-body exercises, while the high-intensity group in their study showed no changes. As O'Connor et al. used both upper- and lower-body exercises, it can be infered that full body exercises induced more fatigue than upper-body exercises alone. Of course, the exercise intensities in these two studies differed (Arent et al.: 100% 10RM, O'Connor et al: 80% 10RM). These results were all in accordance with the present study on heart failure patients in that 1RM of both the upper (r=0.42) and the lower body (r=0.49) had a significant positive correlation with PWB and a negative correlation with PD and FAT. Some lower body PMCs also had a positive influence on the exercise experience of these patients, as derived from SEES. Although the correlations were weak, this result could be attributed to the fact that just one session of exercise was performed. Therefore, as even one session was shown to have exerted positive effects in these high risk patients, it shouldn't be omitted from their routine daily program. Levine et al. indicated that clinicians are very good at treating diseases but often not as good at treating the person: "Less attention has been given to psychological health and how that can contribute to physical health and disease" [43].

Perceived exertion (Borg Scale) has been widely used as a subjective measure of aerobic and resistance exercise intensity because of the reasonable correlation with HR and VO2 [44]. Pritchett et al. indicated that perceived exertion was affected by total work rather than exercise intensity alone (% 1RM) [45]. The relationship between perceived exertion and total work is stronger than exercise intensity during exhaustive bouts of RE. Therefore, perceived exertion may be considered a safe, quick, subjective, and reliable method for monitoring resistance exercise and training programs.

According to the present study, regardless of the type of exercise (aerobic or resistance) and even with different RE intensities, CHF patients felt stronger and more positive after the intervention, as they were able to perform exercise rather than being confined to a sedentary and unpleasant lifestyle.

Possible limitations of this study were that no other aspects of the psychological state of patients, nor other parameters of exercise such as volume and type of RE were assessed.

Conclusion

The increase in 6MWT distance in the 75%-1RM group indicates that higher exercise intensities should also be considered in the cardiac rehabilitation and routine exercise programs of CHF patients. Positive psychological and subjective experience responses in all exercise groups suggest that even one session of exercise, regardless the type or intensity, could be beneficial for positive well-being in patients with CHF.

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