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ORIGINAL ARTICLE

Effects of Cycle Ergometer Training on Heart Rate Recovery and Mind Fullness in NYHA class I, II Heart Failure Patients

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ABSTRACT

Aim: To determine effect of Cycle ergometer on heart rate recovery and mindfulness in NYHA Class I and II heart failure pts.
Study design: The study was a randomized controlled trial.
Place and duration: Total study duration was 6 months, carried out at Rawal general and dental hospital Islamabad.
Methodology: 38 patients were divided into the Control and experimental group. The control group received only conventional Therapy at home and the hospital on the third and 6th weeks for a supervised conventional therapy session. The experimental group received conventional therapy and cycle ergometer training thrice weekly for six weeks. Baseline demographic data, Vitals, HRR1, HRR2, and MAAS scores were gathered from both groups and compared after six weeks.
Results: The mean age of the control group was (46.37±4.43) and of the experimental group (was 50.47±9.22). The MAAS score was significant with a p-value (< 0.05). HRR1 and HRR2 were also significant, with a p-value (<0.05).
Conclusion: This study showed that cycle ergometer exercise training significantly improved heart rate recovery in NYHA Class I and II heart failure patients and improved mindfulness.
Keywords: Heart failure, Heart Rate Recovery 1(HRR1), Heart Rate Recovery 2 (HRR2), Mindful Attention Aware Scale

INTRODUCTION

Heart failure causes heart structure and functional abnormalities, showing symptoms like ankle swelling, breathlessness, fatigue, signs of pulmonary crackles, elevated jugular venous pressure, and peripheral edema. These symptoms increase intracardiac pressure and reduce cardiac output during rest or stress. Exercise intolerance is one of the major symptoms of Chronic heart failure (CHF), which can be attributed to several factors, including reduced cardiac output, cardiac cachexia, and neurohormonal axis changes[1,2].

Heart Failure is caused by hypertension, diabetes, and ischemic heart disease, which further causes myocardium injury. Some less common reasons of heart failure are myocarditis, valvular diseases, cardiomyopathies, systemic toxic infections, and cardio-toxic drugs[3]. Its prevalence increases with coronary artery disease and age. Heart Failure is the cause of mortality and morbidity. Although there are no such facilities that can predict heart failure and improve its prognosis[4].

Effective medical management of heart failure consists of evidence-based drugs like (β blockers and inhibitors of the renin-angiotensin-aldosterone system) it is an important therapy; however, a multidisciplinary team is needed to manage every disease[5]. Medical management therapy is always needed for heart failure, which consists of vasodilators, diuretics, and inotropic support therapy. One of the advanced therapies, Ultrafiltration, is an interesting treatment for patients resistant to diuretics; thus, they can prevent renal failure, arrhythmias, and hypertension[6]. Surgical intervention is for advanced and end-stage heart failure. A heart transplant is a standard gold therapy. Hence, heart structure surgeries (Mitral valve repair, CABG, and Cardiomyoplasty) can improve heart function and minimize heart failure progression[7].

A cycle Ergometer is an exercise device that measures the human body's exercise work. It is typically an immobile device with resistive pedals and also comes with various upper limb cycling. Hence this device is used in place of a treadmill in many studies to generate outcome data for the benefit of the human being[8]. Use a cycle ergometer in critical patients for effects like reducing oxidative stress and pro-inflammatory substances. Passive cycle ergometer use produces a little effect in reducing oxidation stress and does not cause any change in the immune system[9]. 1 minute of bicycle training improves peak oxygen uptake and is more sensitive than 3 minutes of exercise training[10].

During the clinical phase of management of pulmonary symptoms and mobilization, exercise-based cardiac rehab includes strength training (inspiratory and peripheral muscle training), aerobic exercises, and relaxation therapy (guiding the patient to breathe calmly and slowly to suppress the stress on the heart) during outpatient cardiac rehab[11]. Exercise training improves overall exercise capacity, improves abnormal structures that have functioned abnormally during heart failure, and reduces any other clinical conditions related to heart failure[12].

Aerobic exercise can reduce cardiovascular-related mortality. However, improvement in aerobic conditioning is also noted. Heart rate variability is modulated through parasympathetic and sympathetic branches. Exercise training inhibits parasympathetic activity. Exercise training has been studied to evaluate heart rate variability in different conditions[13]. Moderate-intensity aerobic exercise had a greater decrease in CHF patients with depression than those without training sessions. Aerobic exercise improved mental health and was a significant impact of aerobics on decreasing depression[14]. Cardiac rehabilitation training through aerobic exercise programs improves anxiety levels to motivate the patients and improve their quality of life[15].

Physical and mental health is improved by good mindfulness. However, mindfulness increases in aerobic exercise training groups, while no change is observed in the relaxation group[16]. Mental well-being is an important health aspect, as already studied that heart failure patients are challenged by psychological aspects, which can be depression, anxiety, and post-traumatic stress conditions[17]. Physical training boosts mindfulness by enhancing the functioning of the anterior cingulate cortex, which has been linked to improving self-regulation and attention. Aerobic exercises can improve mood mindfulness[18].

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Aerobic exercises are very helpful in managing sleep disorders, for instance, insomnia, thus improving mood swings and enhancing the quality of life in youth[19]. Senior population over 40 also suffers from sleeping disorders, and mild to moderate intensity endurance exercises can help overcome such problems and cardiopulmonary function[20].

MATERIALS & METHODS

The study design was a Randomized controlled trial. This study was conductedat Rawal General and Dental Hospital Islamabad for 6 months duration from August 2020 to January 2021, with a sample size of 38 calculated from openepi. Patients were divided into two equal experimental and Control groups. Patients of age 40-60 years with NYHA class I and II 6-8 weeks post-discharge from the hospital, having ejection fraction of 35-50% and on one AV nodal blocker medication (Beta-blockers, C-C blockers) were included in this study and patients with any systemic disease/infection, Arrhythmias/Regular Pvc/Permanent pacemaker/ Tpm, Uncontrolled DM/HTN, and unable to perform 6 Minute walk test were excluded. The sampling technique carried out was purposive sampling.

Baseline demographic data was collected from the Experimental and control group. Patients of the experimental group were asked to perform 6MWT 400-700m distance at baseline. Heart rate recovery and all vitals were measured before and after every exercise session in the experimental and Control groups at baseline, after three weeks, and after six weeks. Also, both groups assessed mind fullness at baseline and after six weeks. The experimental group was followed 3x/week of cycle ergometer training for six weeks. The control group was followed at baseline, after three weeks, and then after six weeks for conventional Therapy.

Conventional Therapy includespatient education and counseling (proper daily sleep, elevated head in case of choking or congestive feeling in chest upper part), No heavy physical labor (weights, push or full, etc.), Eating heart-healthy diet (low fats, low salt), Quit smoking and maintain a healthy weight.

In-bed activities (Active ankle and hand pumping exercise* 15 Rep* BD AROMS of extremities* 15 Rep* BD, Deep breathing exercises* 15 Rep* BD, Ambulation (walk 10-15 minutes below fatigue and onset of symptoms level* BD) and experimental group conventional therapy and supervised hospital-based ergometer cycling for 20 minutes (Including warm up and cool down), 3x/week on alternate days for six weeks at 40–60% of VO2max. THR was calculated through the Karvonen formula. The resistance of the ergometer was kept at zero level. The session was discontinued if Fluctuation in HR or HR exceeded the targeted value, there was Drop in SpO_2, RPE>11 on Borg,and a patient was unwilling to continue the exercise training.

Data Collection Tools were HRR, Pulse oximetry MAAS Urdu version, and Echocardiography. After taking consent from the patient, data collection started and analyses through SPSS 21 version.

RESULTS

Table 1 shows 38 patients who participated in this study, divided into Control and experimental groups equally.7 males and 12 females were inthe control group, and 1 female and 18 males were in the experimental group.The control group patients consisted of 8 NYHA Class I and 11 NYHA Class II Patients. While in the Experimental group, there were 7 NYHA Class I and 12 NYHA Class II Patients.

Table 2 shows the mean age of the Control and experimental group was 46.37±4.43 and 50.47±9.22.The mean resting Heart rate of the Control and experimental group was 80.78±3.34 and 82.63±3.26.The mean systolic and diastolic BP of the Control and experimental group was 116.15±3.78, 89.94±4.50 and 120.21±4.70, 93.10±6.41 respectively. The mean Ejection fraction of the Control and experimental groups was 46.63±2.06 and 44.89±2.02, respectively.

Table 3 shows that the median score of MASS in the Control and experimental groups was 3.06 and 2.8 at baseline with a p-value of 0.001. After 6 months of intervention, median scores of 3.33 and 4.6 in the Control and experimental groups, respectively, with a p-value of 0.000. HRR1 median score in the Control and experimental groups was 110 and 115 at baseline with a p-value of 0.000. After 6 months of intervention,the median score was 105 and 88, with a p-value of 0.000, respectively. HRR2 median score in the Control and experimental group was 105 and 105 at baseline with a p-value of 0.595. After 6 months of intervention,the median score was 104 and 79, with a p-value of 0.000, respectively.

Table 4 showsthe control group MASS score, HRR1 and HRR2 showed significant differences at baseline and after six weeks of intervention with p-values (0.000), (0.001), and (0.001), respectively.

Table 5 shows theexperimental group MASS score, HRR1 and HRR2 showed significant differences at baseline and after six weeks of intervention with p-values (0.002), (0.000) and (0,000), respectively.

Table 1.Demographic data for Control and Experimental Group (Gender, NYHA Classification)

Variable Name		**Control Group (n=19) Frequency (%)**	**Experimental Group (n=19) Frequency (%)**
Gender	Male	7 (36.8)	18 (94.7)
	Female	12 (63.2)	1 (5.3)
NYHA	Class I	8 (42.1)	7 (36.8)
	Class II	11 (57.9)	12 (63.2)

Table 2. Demographic data of Control and Experimental Group

Variable Name	**Control (n= 19)**	**Experimental(n= 19)**
	Mean ± S.D	Mean ± S.D
Age	46.37±4.43	50.47±9.22
Resting HR	80.78±3.34	82.63±3.26
Systolic BP	116.15±3.78	120.21±4.70
Diastolic BP	89.94±4.50	93.10±6.41
Ejection fraction	46.63±2.06	44.89±2.02

Table 3. Man Whitney U Test in terms of Control and experimental group

Variable Name		**Control Group (n=19) Median (IQ)**	**Experimental Group (n=19) Median (IQ)**	**P Value**
MAAS Score	Baseline	3.06 (0.2)	2.8 (0.2)	0.001
	6th Week	3.33 (0.13)	4.6 (0.6)	0.000
HRR1	Baseline	110 (2)	115 (6)	0.000
	6th Week	105 (7)	88 (6)	0.000
HRR2	Baseline	108 (3)	105 (5)	0.595
	6th Week	104 (7)	79 (5)	0.000

Table 4. Within group analysis (Control group)

Variable Name		**Median (IQ)**	**Z value**	**P Value**
Control group				
MAAS Score	Baseline	3.06 (0.2)	-3.633	0.000
	6th Week	3.33 (0.13)		
HRR1	Baseline	110 (2)	-3.444	0.001
	6th Week	105 (7)		
HRR2	Baseline	108 (3)	-3.233	0.001
	6th Week	104 (7)		

Table 5. Within group analysis (Experimental group)

Variable Name		**Median (IQ)**	**Z value**	**P Value**
Experimental group				
MAAS Score	Baseline	2.8 (0.2)	-3.060	0.002
	6th Week	4.6 (0.6)		
HRR1	Baseline	115 (6)	-3.828	0.000
	6th Week	88 (6)		
HRR2	Baseline	105 (5)	-3.826	0.000
	6th Week	79 (5)		

DISCUSSION

The study's objective was to determine the effects of cycle ergometer training on heart rate recovery and mind fullness in NYHA Class I and II heart failure patients. Results showed that the Cycle ergometer has good effects on heart rate recovery HRR1 and HRR2, and their p-values lie in significant figures of (0.000) and (0.000), respectively.

In 2018 Ahmad Elshazly et al. conducted a study investigating exercise training effects on heart rate recovery in post-Anterior Myocardial Infarction patients. Fifty patients with a one-month history of MI were recruited for this study. These patients were also referred to Ain Shams University Hospital for cardiac rehabilitation between October 2016 and July 2017. Exercise training was provided in three sessions a week for 12 weeks. An exercise test was carried out at a symptom-free range to determine heart rate recovery HRR1 after one minute and HRR2 after 2 minutes of the exercise session finishes. Results showed that major improvements in HRR1 and HRR2 were noted after exercise-based cardiac rehabilitation. Also, resting heart rate, reserve, and metabolic equivalent improved significantly[21].

In 2018 Yasushi Tanaka and Yasushi Takarada reported that aerobic exercise training is fruitful in heart failure patients with vascular occlusion. Aerobic exercise increases the exercise capacity of heart failure patients with vascular occlusion by strengthening the musculature and modifying sprinting on a cycle ergometer. This is all gained through the increased nitric oxide level, which is why vasodilation improves circulation in heart failure patients. Hence low, intense aerobic cycling enhances the exercise capacity of patients[22].

Patricia Forestieri et al. In 2016, cycle ergometer exercise training showed good effects and improved heart failure symptoms in end-stage cardiac failure patients waiting for heart transplantation. Weakness of inspiratory muscles resulting from cardiac deterioration further worsens patients' exercise capacity. So using a cycle ergometer in heart failure patients is useful in coping with inspiratory insufficiency and muscular weakness in prolonged bedridden patients awaiting heart transplantation[23].

In 2012 Steven J. Keteyian et al. conducted a study to determine whether exercise training volumes positively affect heart failure's reduced symptoms. This study also explains whether clinical events of heart failure can be reduced through exercise training. They reported that, due to moderate exercise training sessions, heart failure patients benefit, and their clinical events are minimized. Also, through high-exercise training sessions, clinical events arise very quickly. Although this study concluded that heart failure patients could be managed through this technique, further studies are necessary to carry out and to determine the exact volume of exercise concerning clinical events to occur in the future[24].

In 2011 Michael A. Jolly et al. conducted a study on how exercise impacts heart rate recovery. 1070 patients included in the study who underwent cardiac rehabilitation phase II were followed regularly. They concluded that after cardiac rehabilitation phase II, the heart rate recovery of these patients improves, also concluded from this study that causes of mortality can be determined through this heart rate recovery. Those patients who have normalized their heart rate recovery after exercise and abnormal heart rate recovery at baseline show the same mortality rate[25].

In 2020 Tseng-Hau Tseng et al. carried out a randomized control trial study to find out how Aerobic exercise training can positively modify heart rate variability and bring relaxation in sleeping disturbed patients older and middle-aged. Forty individuals above 40 years of age were distributed in exercise and control groups. Exercise group members of the study show a significant improvement in their heart rate variability and sleep cycle after receiving stretching of 10 minutes and 40 minutes of exercise training three times a week for twelve weeks. Hence this study concludes that aerobic exercise training positively affects autonomic heart function and the quality of the sleep cycle[26]. The present study showed that cycle ergometer training exercises improved MAAS scores and a significant p-value of (0.000), indicating that their quality of life and mindfulness improved.

In 2022 Matei Daniela et al.reviewed how Autonomic nervous system stimulation fixes metabolic de-regulation, and cardiac rhythm and boosts immune functions. The results of this review study show that physical exercise has positive effects on the autonomic nervous system. Also,the autonomic nervous system has a positive role in regulating anti-inflammatory effects on the body. Hence, this study concludes that physical exercise is a good treatment tool for patients with immune dysfunction and cardiovascular and metabolic pathologies, and their conditions improve[27].

In 2017 M. J. Pearson et al carried out a systematic review of heart failure patients on how their autonomic parameter function changes due to exercise training. Different databases were searched on how exercise-based rehabilitation training can modify heart failure conditions. The result of this study indicates that heart rate recovery at 1 minute inthe exercise group was substantially improved with exercise training than the control group, and heart rate variability was also improved. Hence this study concludes that exercise-based rehabilitation training positively affects heart rate recovery and variability[28].

In 2019 Massimo Leggio et al. conducted a study to evaluate how physical exercise training can modify heart failure with preserved ejection fraction and improve their quality of life. Different research studies were followed, and data was gathered from home-based and hospital-administered physical exercises training like aerobic exercises, treadmills, and walking activities. Results of this study show that heart failure patients with preserved ejection fraction were improved in the ventilatory threshold, 6-minute walk test, and peak oxygen uptake. At the same time,Echocardiography and quality of life were also improved in specific studies, and quality of well-being was also improved. Hence, this study concludes that physical exercise training programs can improve heart failure conditions[29].

In 2019 Florent Besnier et al conducted a study investigatinghow high-intensity exercise training can improve heart rate variability, cardiac functions and cardiorespiratory fitness compared to moderate-intensity exercise training. For this purpose, 31 participants were randomly allocated to these two exercise groups. Participants were screened before and after exercise training in Echocardiography, cardiopulmonary exercise test, and electrocardiography. Results show that high-intensity interval exercise training improved heart rate variability, cardiorespiratory fitness and cardiac functions more than moderate-intensity interval exercise training. Hence this study concludes that high-intensity interval exercise training can enhance the autonomic system and improve heart failure patients[30].

CONCLUSION

This randomized control trial showed that cycle ergometer exercise training significantly improved heart rate recovery in NYHA Class I and II heart failure patients and improved mindfulness in these patients.The MASS score increased from 3.06 to 3.33 in the control group and 2.8 to 4.6 in the experimental group.HRR1 median score decreased in the Control and experimental group from 110 and 115 to 105 and 88. HRR2 median score decreased in the Control and experimental group from 105 and 105 to 104 and 79.

Authorship and contribution Declaration: Each author of this article fulfilled following Criteria of Authorship:

1. Conception and design of or acquisition of data or analysis and interpretation of data.
2. Drafting the manuscript or revising it critically for important intellectual content.
3. Final approval of the version for publication.
4. All authors agree to be responsible for all aspects of their research work

Recommendation: It is recommended that further studies should be carried out on a large sample with equal participation of both Genders in the experimental group

Conflicts of interest: Nil
Funding: No

Ethical approval: The ethical research committee approved data collection at Riphah international university and Rawal General and Dental Hospital Islamabad. The informed consent form was signed by all the patients included in the study.

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