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ORIGINAL ARTICLE

EFFECTS OF AEROBIC EXCERCISES ON VO_2 MAXIMUM AND HEART RATE AMONG ISCHEMIC HEART FAILURE PATIENTS

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ABSTRACT

Heart failure results from myocardial deficiencies, which prevent the heart from adequately supplying the body with oxygen. The severity is further divided into groups, with ischemic cardiomyopathy as a major contributor. The effectiveness of conventional treatments like beta-blockers and continuous positive airway pressure (CPAP) is still constrained as the prevalence of heart failure rises, especially in areas with high rates of ischemic heart disease. Recent research, however hints that individual may benefit from cardiovascular advantages and symptom reduction from aerobic activity. **Objective:** To determine how a structured aerobic exercise program affects the VO_2 maximum and heart rate in ischemic heart failure patients. **Methods:** Ninety individuals with ischemic heart failure, aged 35 to 70, participated in a randomized clinical trial. Over the course of four weeks, the participants were split into three groups and subjected to aerobic activity on treadmills and cycle ergometers. The 6-minute walk test (6MWT), peak VO_2 readings, and pre- and post-intervention heart rate analyses were all included in the evaluations. **Results**: Four weeks into the rehabilitation treatment, a substantial rise in peak VO_2 and heart rate was seen. Post-intervention distances on the 6-minute walk test also indicated improvement. Peak VO_2 improvements, however, did not differ significantly amongst the three groups. **Conclusion**: Study's findings highlight the benefits of aerobic exercise for those with ischemic heart failure, particularly in terms of improving peak VO_2 and heart rate recovery.

Keywords: Aerobic Training, Congestive Heart Failure, Rehabilitation, Heart Rate, VO_2 Max

INTRODUCTION

The New York Heart Association (NYHA) functional classification elaborate four functional classes for heart failure. Class I: Patients performed normal physical activity without any symptoms. Class II: Patients are wellbeing at rest and ordinary works provoke symptoms of dyspnea and fatigue. Class III: Limitations occur during exertion or any kind of activity with clinical symptoms of palpitations. Class IV: Patients are unable to do anything and symptoms of heart failure is present even at rest[1].

Common causes of cardiac failure were ischemic cardiomyopathy. It occurs due to inability of heart to pump blood effectively. Around 70 percent of the all-heart failure syndrome is occurred due to underlying cause of ischemic heart disease. Patients with the history of coronary artery disease will have reduced ejection fraction due to acute ischemic injury which led to myocardial infraction and formation of scar. In contrast to cardiac failure with preserved ejection fraction will have others defects of myocardial signaling pathway and inflammation

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Handgrip strength is an indication of total physical aptitude and an assessment of upper extremity functioning. It has been proven to be an important factor in predicting impairment in musculoskeletal disorders, bone mineral density, and the likelihood of osteoporosis falls and fractures[1]. The amount of static force that the hand can exert around a dynamometer can be used to determine hand grip strength. The most common units of force measu-re ment have been kilograms and pounds[2,3].

The amount of muscular strength and power that athletes can generate with their hands is referred to as handgrip strength. Some sports rely substantially on handgrips, such as rock climbing, tennis, volleyball, and baseball[4]. Tennis is a popular sport with an estimated 75 million players worldwide[5]. The power grip assignment is completed by subjects flexing their digits in palmar opposition around an object. Athletes that do handgrip motions may have different handgrip strength and hand size[6,7].

Among all muscle function tests, assessing hand grip strength has gained prominence as a simple, non-invasive indicator of upper extremity muscular strength that is excellent for clinical use[8,9]. Handgrip strength and wrist stability are essential to hold the racket firmly, move the racket in line with the ball, and create an effective stroke during these high-speed actions. This is especially important in sports requiring a lot of external rotation in the shoulder and forehand strokes, like tennis[10]. Despite the fact that cumulative strength training can lead to large increases in maximal strength and muscle mass, muscular strength loss is the most major physiologic change that happens with aging[9, 11] varied nations have varied hand sizes[12].

Handgrip strength (HGS) testing is commonly used in clinic and occupational settings to determine the clinical consequences of operations, regulate the rehabilitation process, and provide practical information regarding muscles, nerves, articular, and heart problems[13, 14]. Handgrip strength has been discovered as a biomarker for various systems, including the endocrine system[15, 16]. Grip strength may be seen as a measure of strength independent of resistance training[17,18]. Relationship between hand grip strength and height, weight, arm circum-ferences, and subcutaneous skin folds, men had higher anthropometric factors and hand grip strength values than females[19,20].The purpose of this research is to investigate the association between handgrip strength and hand dimensions.

MATERIALS AND METHODS

A random clinical trial involving 35-70 years' old individuals with ischemic heart failure whose ejection fraction was above thirty-five (35) per cent[11]. A total of 90 patients were analyzed which were divided into three groups. The study was done for six months ranging from December, 2020 to June, 2021. Approval for ethical clearance was obtained by Riphah international university and the Rawalpindi Institute of Cardiology; registration number NCT04937231, ethical approval letter number Riphah/RCRS/REC/00880.

Patients with disorders such as unstable angina, severe limb pain and some blood pressure and cardiac rehabilitation contraindications were excluded. The most commonly used instrument for assessment of functional capacity is 6-minute walk test that has proven to be reliable and valid in measuring heart failure patients[12]. The aerobic exercise intervention comprised of tread mill training for the first two weeks and then cycling ergometry for the next two weeks at intensities varying between 60 - 80 % of heart rate reserve. The data were collected through a sealed envelope method where a pre and post intervention examination was done which included a 6-minute walk test. During this test vitals were measured and data was collected for heart rate of patient before and after providing the intervention.

Statistical Analysis

Statistical analysis was conducted through IBM SPSS 21 and non-parametric tests were used for normality testing. Kruskal-wallis test was applied to assess between groups differences.

RESULTS

The total 90 number of participants were analyzed, they were divided into three experimental groups

Group A =30, Group B =30, Group C =30 as shown in Table 1. The Frequency of male in group A was 7 (23.3%) and female was 23 (76.7%). Among 90 participants 30 patients were included in all groups and female in group B was 12 (40.0%) and male was 18 (60.0%). whereas in Group C frequency of female was 12 (40.0%) while male was 18 (60.0%). The mean age of the patients involved in the study was 50 years.

For analyzing distance of 6 MWT between groups, kruskal-wallis test was applied between three groups, the pre value of mean ± Std. was 169.4 ± 38.74 and post value of mean+ Std. was 216.6 ± 41.84 in group A. Whereas, the pre and post-value of the mean ± Std. was 191.7 ± 39.61 and 235.2 ± 44.05, respectively, in group B. Meanwhile, in group C, the mean ± Std. was 185.3 ± 34.65 before and 231.4 ± 35.67 after the intervention. The p-value of these comparative analysis between the group was >0.05, which indicates non-significant difference in distance 6MWT between the group after 4 weeks of exercise.

Likewise, Table 2 presented analyzed peak VO_2 between groups, kruskal-wallis test was applied between three groups, the Pre value of mean+ Std. was 4.98±.0081 and post value of mean+ Std. was 4.99±.0097 ,while the group B pre and post value of mean+ Std. was 4.99±5.003 and 5.00±.011 whereas group C the value of mean+ Std. was 4.99±.0071 and 5.001±.0083 .The p-value of these comparative analysis between the group was >0.05, which indicates non-significant difference in maximal strength test between the group after 4 weeks of exercise. For analyzing distance of 6 MWT within groups, Friedman test was applied. Group A, the pre value of median (IQR) was 1.67 (0.8) and post value of median (IQR) was2.07 (0.7), while the group B pre and post value of median (IQR) was 1.93 (0.6) and 2.35 (0.6) whereas group C value of median (IQR) was 1.87 (0.5) and 2.25 (0.6). The p-value of these comparative analysis within the group was <0.05, which indicates significant difference in distance 6MWT within the group after 4 weeks of exercise.

Likewise analyzing peak VO_2 within groups, Friedman test was applied. Group A, the pre value of median (IQR) was 4.98 (0.0) and post value of median (IQR) was4.99 (0.0), whereas the group B pre and post value of median (IQR) was 4.99 (0.0) and 5.0 (0.0) while group C value of median (IQR) was 4.9 (0.0) and 4.9 (0.0). The p-value of these comparative analysis within the groups was <0.05, which indicates significant difference of peak VO_2 after 4 weeks of exercise as presented in Table 3.

Table 1. Shows the frequency of genders among groups

Gender	Group A (n=30) frequency (%)	Group B (n=30) frequency (%)	Group C (n=30) frequency (%)
Male	7 (23.3%)	18 (60.0%)	18 (60.0%)
Female	23 (76.7%)	12 (40.0%)	12 (40.0%)

Table 2. Comparative analysis of 6MWT distance and peak VO2 across three groups over 4 weeks

		Group A		Group B		Group C		p (Kruskal Wallis Test)
		Median (IQR)	Mean+ Std.	Median (IQR)	Mean+ Std.	Median (IQR)	Mean+ Std.	
Distance 6MWT	Baseline	1.67 (0.8)	169.4+38.74	1.93 (0.6)	191.7+39.61	1.87 (0.5)	185.3+34.65	0.09
	Week 4	2.07 (0.7)	216.6+41.84	2.35 (0.6)	235.2+44.05	2.25 (0.6)	231.4+35.67	0.16
Peak VO2	Baseline	4.98+0.00		4.99+5.00		4.99+0.00		0.09
	Week 4	4.99+0.00		5.00+0.01		5.001+0.00		0.16

Table 3. Median (IQR) of peak VO_2 among groups at 1st to 4th weeks

Variable	Median (IQR)		
peak VO_2	Group A	Group B	Group C
Baseline	4.98 (0.0)	4.99 (0.0)	4.9 (0.0)
Week 4	4.99 (0.0)	5.0 (0.0)	4.9 (0.0)
p – value (Friedman Test)	0.00	0.00	0.00

Table 4. Median (IQR) of heart rate among groups at 1st to 4th weeks

Variable heart rate		Group A median (IQR)	Group B median (IQR)	Group C median (IQR)
week 1	Pre-exercise training	90 (16)	80 (18)	80 (13)
	Post exercise training	95(20)	105 (18)	110 (22)
week 2	Pre-exercise training	87 (21)	77 (15)	70 (12)
	Post exercise training	93 (23)	105 (20)	115 (23)
week 3	Pre-exercise training	87 (21)	78 (10)	71 (15)
	Post exercise training	93 (19)	105 (11)	120 (26)
Week 4		83 (22)	75 (15)	75 (11)
		90 (23)	105(24)	117 (31)
p – value (Freidman test)		0.00	0.00	0.00

In Table 4, Freidman test was presented in regard to comparing heart rate within the groups,the baseline value of median (IQR) was 90 (16) and post value of median (IQR) was 90 (16), whereas the group B pre and post value of median (IQR) was and 105(24). while group C value of median (IQR) was 80 (13) and 117 (31). The p-value was <0.05, which indicates significant difference in heart rate within the groups.

DISCUSSION

For this study, we endeavored to explore the impacts of aerobic exercise for ischemic heart failure patients. These sessions of aerobic exercise extended over a number of weeks, utilizing a treadmill and cycle ergometer. The results demonstrated a marked increase in peak VO_2 and heart rate in only four weeks after this rehabilitation program.

Prior studies have shown that autonomic function influences the time taken by heart rate to normalize after exercising. For example, immediately following exercise when the sympathetic activity is lowered and there is a slight vagal dominance, the heart rate reduces to its resting level[13]. It also depends on what type and how intense the exercises are. For example, heart rates are back to normal after an hour if it is a light to moderate aerobic exercise but may take as long as four hours when involved in longer durations of aerobic exercises[14]. Other study concluded that response of heart rate recovery depends on interaction sympathetic and parasy mpathetic nervous system. Recovery of heart rate is a combination of withdrawal of sympathetic and reactivation of parasympathetic system mainly vagal reactivation[15]. Another study conducted on heart failure patients, shows improvement in symptoms when aerobic exercise was performed in cardiac rehabilitation three days weekly with additional walking at home for two to three days weekly[16]. These finding are reinforced by this

current study which shows a considerable impact of aerobic training on heart rate for ischemic heart failure patient.

Peak VO_2 is an indictor to assess the prognosis of heart failure patients[17]. Other research studies suggest that peak VO_2 max and other indicators improve over a period of 3 months exercise program for heart failure patients[18]. This aligns with our study too, demonstrating that each of the aerobic exercise groups improved its peak VO_2 but no significant differences emerged between them in 4 weeks or more.

Various exercise modalities have also been examined using another established tool in evaluating health outcome, e.g., the 6-minute walk test[19]. The 6 MWT offers important insights on a person's endurance and aerobic capacity. It can be especially helpful for tracking the development of chronic diseases or the progress of patients undergoing rehabilitation. The test can also assist medical practitioners in customizing treatment plans or exercise recommendations based on a patient's functional capacity[20]. Patients that had gone through an aerobic training program showed increased distances during a 6-minutes walking test at 4th week as compared to their initial status.

Current study's main shortcoming was the lack of a diverse sample, since we failed to take into consideration people from different cultural origins, educational levels, or living arrangements (alone or with other family members). The follow-up period was also extremely brief, and the COVID-19 epidemic made it difficult to gather ample data. Based on these data, we suggest increasing the exercise program's duration to 8 to 12 weeks in order to benefit heart failure patients more. Additionally, the study population should be widened across other hospitals by reaching out to different cities in Pakistan in order to have a broader viewpoint.

CONCLUSION

This study conclusively shows that structured aerobic exercise programs dramatically improve peak VO_2 and hasten heart rate recovery in patients with ischemic heart failure. These results provide unique insights into the physiological advantages of aerobic exercise in addition to validating earlier research. Patients following the aerobic training program in particular showed considerable gains in their peak VO2 max, a sign of improved cardiovascular fitness and endurance. Additionally, they returned to normal heart rates more quickly after exercise, indicating improved cardiac and autonomic function. These findings clearly relate to our main goal, highlighting the crucial part that planned aerobic exercise plays in improving cardiovascular outcomes for those with ischemic heart failure.

DECLARATION

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