

## Effectiveness of resistance interval training versus aerobic interval training on peak oxygen uptake in patients with myocardial infarction

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### Abstract

Cardiac rehabilitation reduces the risk factors and improves the aerobic exercise capacity of patients after they have experienced cardiac events. This study compared the effects of two types of interval training in patients with myocardial infarction (MI). A single-blinded randomised controlled trial was conducted on 26 patients with MI which included 16 males and 10 females. After screening via non-probability convenience sampling, patients were randomised into two groups using toss and trial method. The control group was given aerobic interval training (AIT), consisting intervals of stationary cycling and walking on the treadmill. The experimental group received both AIT as well as resistance interval training comprising exercises of the upper and lower limbs. After 6 weeks, the outcomes of peak oxygen uptake (VO<sub>2</sub>) and 6-minute walk test distance (6MWT) were measured against the baseline. Non-parametric tests were applied for statistical analysis. In the group comparison, the experimental group showed significant improvement in peak VO<sub>2</sub> and 6MWT ( $p=0.003$  and  $0.003$  respectively), as well as in the quality of life measures. The combination of resistance interval training plus AIT proved more effective in improving cardiac outcomes and aerobic capacity.

**Keywords:** Aerobic exercise, Cardiac Rehabilitation, Cardio respiratory Fitness, Myocardial infarction, Resistance training.

### Introduction

According to the Centers for Disease Control and Prevention, the American Heart Association and the World Health Organization, heart diseases remain the leading cause of mortality worldwide. Ischaemic heart disease account for 1.4 million deaths in developed regions and 5.7 million deaths in the developing world. Yet the rising death rate due to cardiovascular diseases (CVD) can be prevented by lifestyle modification and

risk factor reduction.<sup>1</sup>

CVD occur due to reduction or cessation of myocardial blood flow, along with atherosclerotic or arteriosclerotic coronary artery disease (CAD). The standard management for significant CAD is coronary revascularization through surgical intervention.<sup>2</sup> Cardiac rehabilitation is a comprehensive interventional programme, which aims to optimise the physical, psychosocial and vocational functioning of a patient with CVD, by limiting or reversing the atherosclerotic changes.<sup>3</sup> Exercises for endurance significantly increases the aerobic capacity, whereas resistance training increases the muscle strength and endurance, ultimately improving the quality of life (QOL) and functional capacity.<sup>4</sup>

Interval training consisting repetitions of alternate rounds of high intensity exercise and recovery phases — either light intensity exercise or complete rest — is now the recommended form of training for cardiac rehabilitation, as it improves the cardiorespiratory fitness (CRF).<sup>5</sup> CRF is objectively measured by assessment of peak VO<sub>2</sub> which is the peak oxygen consumed during dynamic muscle performance.<sup>6</sup>

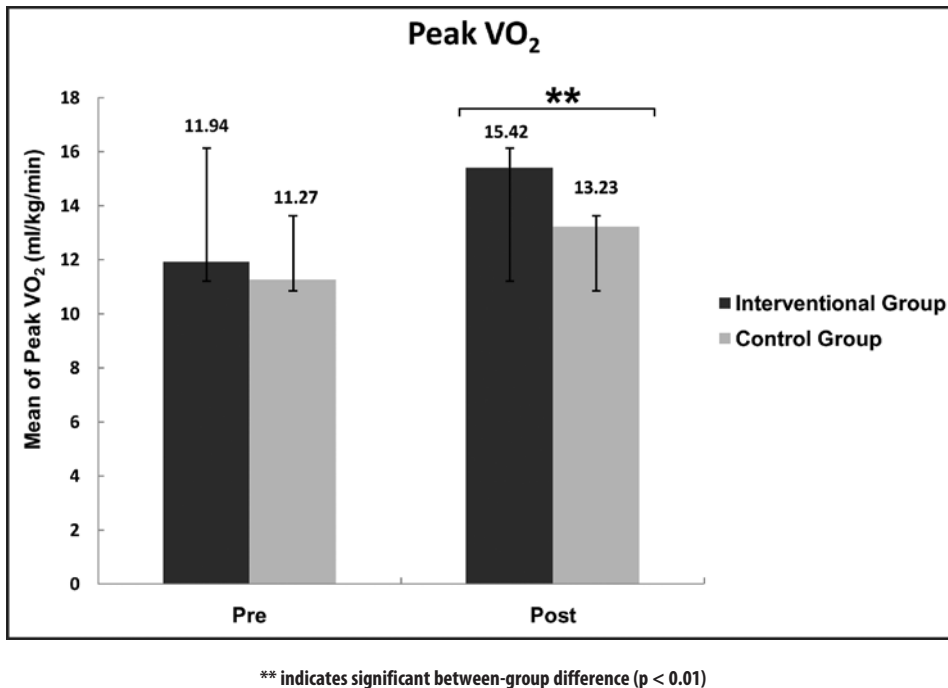
Latest recommendations for rehabilitation exercise professionals and researchers is to focus on utilizing resistance exercises in a circuit training fashion.<sup>7</sup> A systematic review and meta-analysis of high intensity interval training highlighted a literature gap, and recommends future researchers to study the interaction between interval training and resistance exercises in patients with CVD in order to establish optimal standardised protocols.<sup>5</sup> Therefore the aim of this study was to determine the effectiveness of resistance interval training as compared to aerobic interval training on peak VO<sub>2</sub>, in patients with MI.

### Methodology and Results

A single-blind randomised controlled trial was conducted on 26 stable patients with MI from August 2016 to January 2017. The sample size was calculated using the formula:  $m$  (size per group) =  $2c/\delta^2 + 1$  where  $\delta = |\mu_2 - \mu_1|/\sigma$ . Non-probability convenience sampling was used for selection of the sample. The subjects were then

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**Figure-1:** Comparison of exercise training induced changes in the peak oxygen uptake in both groups.

randomised into interventional ( $n=13$ ) and control groups ( $n=13$ ) using toss and trial method.

Subjects were recruited based on inclusion and exclusion criteria. Haemodynamically stable patients, both males and females, of age  $\geq 35$  years, who were managed conservatively post MI, and who were able to complete the first three minutes of the exercise tolerance test without any aggravated signs or symptoms were included in the study. Whereas patients who had unstable MI or those who had undergone cardiac surgery having poor left ventricular ejection fraction of  $< 35\%$ , or had the presence of any arrhythmias or a significant lung disease, were excluded.

The study was carried out at Railway General Hospital Rawalpindi and the study protocol was approved by the institutional review board and ethics committee of Riphah Institute of Rehabilitation Sciences and Railway General Hospital. Written, informed consent was obtained from all the patients prior to their participation. The baseline data of variables including, anthropometric measurements, primary outcomes, i.e. six-minute-walk test (6MWT) and peak oxygen uptake ( $VO_2$ ), as well as secondary outcome (QOL) were recorded.

Treadmill-based 6MWT was performed and the initial speed was set at 1.5 mph, which was increased gradually. Training heart rate was calculated by Karvonen formula and the

intensity of exercise was kept between 60% to 85% of the target heart rate (THR). Utilising the 6MWT distance, a generalised prediction equation was used to estimate the peak  $VO_2$ .<sup>8</sup>

Peak  $VO_2$  (ml/kg/min) =  $4.948 + 0.023 * 6MWD$  (meters).

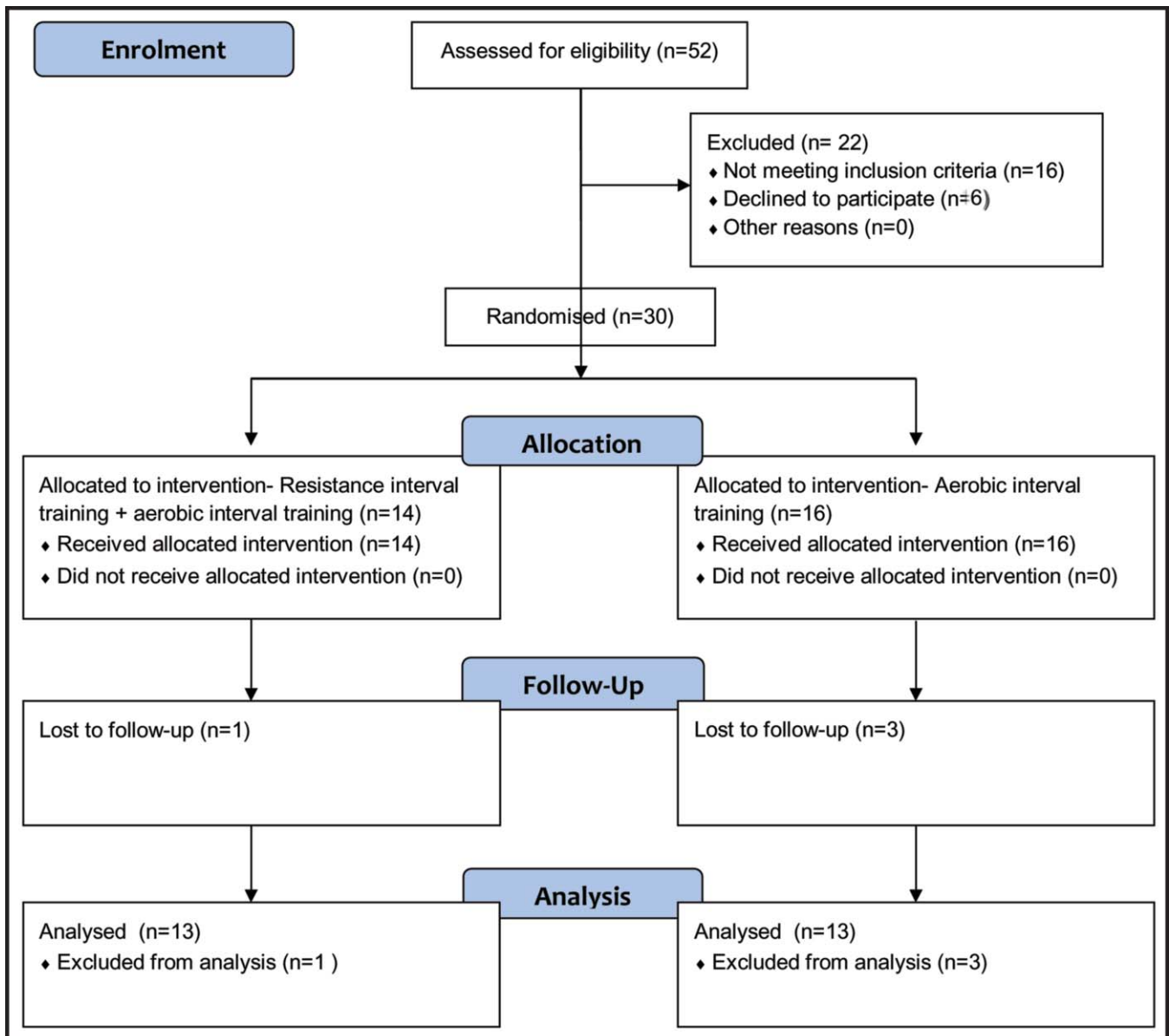
A generic standard health-related quality of life tool, SF-36 was used to determine the pre and post cardiac rehab differences in QOL parameters. The questionnaire was in English language, but was translated into Urdu for the convenience of patients.

The control group was given aerobic interval training (AIT) which consisted of intervals of aerobic exercises on stationary cycle and treadmill, interspersed with rest intervals. The regimen started with a 10 minutes warm-up period which was a maximum of 50% to 60% of HR. This was followed by 6 x 6 minute intervals of cycling and walking/uphill running on treadmill at 60% to 85% of THR, with 3 minutes of pause/recovery period between exercise rounds. The session ended with a 10-15 minute cool-down period.

The interventional group received resistance interval training in addition to AIT. In the first interval, the subjects were started on 4 minutes of exercise on stationary cycle, which was immediately followed by one set of exercises that included 10 to 12 repeats of bilateral hand grippers with 1.5 to 2.5 lbs and biceps curls lifting 1 to 3 kgs. In the second interval, these were replaced by one set of quads resistive exercises with 10 to 12 repeats on quadriceps chair, lifting between 1 to 3 kgs. The last interval included, walking/uphill running on treadmill at 60% to 85% of THR, which was followed by one set of standing calf raise exercise comprising 10 to 12 repeats, ending with a cool-down period.

The total duration of the exercise regimen was 35-40 minutes. Intensity and resistance was gradually increased to accommodate the exercise load. This supervised training protocol was followed thrice a week on alternate days for six weeks.

The data was entered and analysed on SPSS® 21.0.



**Figure-2:** CONSORT Flow diagram showing scheme of study.

Normality was tested using Shapiro-Wilk test and  $p > 0.05$  signified the use of non-parametric statistics. The groups' analysis was done applying the Mann-Whitney U-test. A two-tailed  $p$ -value  $< 0.05$  was accepted as statistically significant for all tests. The sample consisted 16 (61.5%) males and 10 (38.4%) females. The mean of age (years) in interventional group was  $57.23 \pm 9.757$  and in control group was  $55.77 \pm 10.457$ . The baseline characteristics of subjects in both groups showed no differences with regards to age, BMI, physical activity level and co-morbidities. As per the BMI categories, majority of the patients, 8 (30.8%) of the

experimental and 5 (19.2%) of the control group were categorised as normal while 5 (19.2%) of the experimental and 2 (7.7%) of the control group were overweight. Hypertension was the most frequent co-morbidity among 5 (19.2%) of the patients in the control group and 4 (15.4%) in the experimental group, with diabetes being the second most common among the patients in the experimental group. Baseline analysis of peak  $\text{VO}_2$  and 6MWT distance showed no significant difference between interventional and control group ( $p > 0.05$ ).

**Table-1 (A):** Comparison of baseline and training-induced changes in QOL in both groups.

Quality of Life		Control Group (n=13)		Interventional Group (n=13)		Z-Value	P-Value
		Mean ± SD	Mean Rank	Mean ± SD	Mean Rank		
Physical Functioning	Pre	49.23 ± 15.11	15.46	41.92 ± 23.32	11.54	-1.318	0.187
	Post	77.69 ± 10.33	12.42	81.92 ± 11.99	14.58	-0.729	0.466
Role limitations (physical health)	Pre	0.00 ± 0.00	12.50	11.53 ± 29.95	14.50	-1.442	0.149
	Post	84.61 ± 28.02	11.46	98.07 ± 6.933	15.54	-1.852	0.064
Role limitations (emotional problems)	Pre	7.692 ± 27.73	12.04	28.20 ± 44.81	14.96	-1.421	0.155
	Post	98.07 ± 6.938	13.00	100.0 ± 0.0	14.00	-1.000	0.317
Energy/ Fatigue	Pre	33.46 ± 15.32	12.96	36.15 ± 11.39	14.04	-0.363	0.717
	Post	54.61 ± 15.33	9.81	71.15 ± 14.01	17.19	-2.467	0.013*

**Table-1 (B):** Comparison of baseline and training-induced changes in QOL in both groups.

Quality of Life		Control Group (n=13)		Interventional Group (n=13)		Z- Value	P- Value
		Mean ± SD	Mean Rank	Mean ± SD	Mean Rank		
Emotional well-being	Pre	46.15 ± 20.63	12.15	52.61 ± 20.05	14.85	-0.900	0.368
	Post	58.84 ± 20.3	8.54	81.23 ± 11.47	18.46	-3.329	0.001*
Social functioning	Pre	59.61 ± 16.26	12.46	63.46 ± 21.32	14.54	-0.717	0.473
	Post	80.76 ± 6.485	8.38	92.69 ± 6.077	18.62	-3.644	0.000*
Pain level	Pre	53.26 ± 12.22	14.73	49.61 ± 23.42	12.27	-0.831	0.406
	Post	80.96 ± 16.09	13.04	82.50 ± 13.91	13.96	-0.312	0.755
General health of participants	Pre	52.30 ± 23.21	14.50	44.61 ± 16.38	12.50	-0.671	0.502
	Post	73.92 ± 21.54	13.92	75.00 ± 16.58	13.08	-0.287	0.774

After 6 weeks of cardiac rehab training, a significant improvement was observed statistically in the experimental group ( $p = 0.001$ ) Figure-1. With regards to QOL, post-exercise mean in the domains of energy/fatigue, emotional well-being and social functioning, showed a statistically significant difference of  $p=0.013$ ,  $0.001$  and  $0.000$  between both groups (Table 1-A & 1-B).

## Discussion and Conclusion

The results of this study suggest that resistance interval training is more effective than AIT for the improvement of peak  $VO_2$  in cardiac patients. This is supported by a study conducted by Hussein N. et al who observed the effects of combined aerobic and resistive exercises, versus aerobic exercise alone in obese CAD patients, and found a significant increase in the MET levels depicting a greater improvement in patients' exercise capacity in the group with combined training.<sup>9</sup> Aerobic exercises increase the stroke volume and arterio-venous oxygen difference. The addition of resistance exercises to interval training led to additional benefits such as an increased cardiac output and peak  $VO_2$ .<sup>7</sup>

Similar to the results of our current study, Nilsson et al also found a marked improvement in the functional capacity of patients after 16 weeks of high intensity

aerobic interval training, which was gauged by the increase in the 6MWT distance from the baseline.<sup>10</sup> Improvement in QOL was also noted to be associated with the physiological improvements in accordance with the previous studies of UlrikWisloff et al and Klocek et al.<sup>11</sup> Mortality due to CAD can be prevented by physical activity and fitness. Peak  $VO_2$  has lately gained significance as a crucial independent predictor of cardiac morbidity and mortality. Hence exercise training induces gains in aerobic capacity and a marked increase in the chances of survival as well. Adding resistance interval training for strength in debilitated MI or CABG patients aids in a functionally independent lifestyle.<sup>12</sup> Therefore we suggest that although both aerobic interval training and resistance interval training are effective for the improvement of cardiac outcomes, the combination of resistance interval workout and AIT is superior as it significantly increases the peak  $VO_2$ , aerobic capacity and QOL in patients with MI.

## Limitations

This was a single-centre study with a relatively small sample size due to strict inclusion criteria. The number of female patients was low, due to lack of awareness on cardiac rehabilitation in our society. The trial was not registered due to non-availability of registry and a focal person during the time the study was being

conducted.

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**Conflict of Interest:** The individual signing ethical review statement on behalf of the Institutional Review Board is also a co-author of the manuscript.

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