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Original Article

Effects of Exercise-Based Cardiac Rehabilitation in Patients After Myocardial Infarction

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Abstract

Background: Myocardial infarction (MI) is a leading cause of mortality and physical disability worldwide, particularly among the elderly. Despite advancements in percutaneous coronary intervention (PCI) and pharmacotherapy, many MI patients continue to experience health deterioration. Exercise-based cardiac rehabilitation has shown potential in improving myocardial perfusion, endothelial function, and reducing thrombotic activity, thereby enhancing patient outcomes.

Objective: This study aimed to determine the effects of a supervised exercise-based cardiac rehabilitation program on quality of life, heart rate, and blood pressure in patients' post-myocardial infarction.

Methods: A randomized controlled trial was conducted with 36 participants aged 40 to 60 who experienced an MI within the previous three weeks. Participants were randomly assigned to Group A (exercise program) or Group B (educational interventions). Group A engaged in a 6-week supervised exercise program, including warm-up exercises, aerobic activities, and cool-down sessions. Quality of life was assessed using the CDC HRQOL-14 questionnaire, while heart rate and blood pressure were measured pre- and post-intervention. Data analysis was performed using SPSS 25, employing independent and paired sample t-tests.

Results: Group A showed significant improvements in HRQOL scores: Module 1 ($p=0.04$), Module 2 ($p=0.04$), and Module 3 ($p=0.02$). Heart rate improved by 12 bpm ($p=0.03$), and systolic blood pressure reduced by 8.81 mmHg ($p=0.01$) in Group A compared to Group B.

Conclusion: Exercise-based cardiac rehabilitation significantly improves quality of life, heart rate, and blood pressure in post-MI patients.

1 Introduction

Myocardial infarction (MI) remains a significant global health challenge due to its high morbidity and mortality rates, particularly among the elderly population. Annually, cardiovascular diseases claim over 8.76 million lives, accounting for 15.5% of all deaths worldwide, with in-hospital mortality rates for MI ranging from 3.5% to 14% (1). Despite advances in medical treatments, including percutaneous coronary intervention (PCI), which effectively restores myocardial reperfusion and reduces mortality, many patients continue to experience declining health post-treatment (2). This underscores the need for comprehensive rehabilitation strategies to improve long-term outcomes in MI patients.

Cardiac rehabilitation, a multifaceted intervention encompassing lifestyle behavior modifications, exercise training, risk factor education, and psychological support, is advocated by the American Heart Association as a vital component of post-MI care (3). Exercise training, in particular, has garnered attention due to its potential to enhance myocardial perfusion, improve endothelial function, and reduce thrombotic activity. Regular physical activity is known to promote vasodilation, increase thrombolytic activity, and decrease blood viscosity and platelet aggregation (2). Moreover, exercise-based cardiac rehabilitation has been associated with significant reductions in cardiovascular mortality, with a meta-analysis indicating an 8% to 14% decrease in overall mortality for every metabolic equivalent (MET) gain in exercise capacity (4).

Despite the established benefits of exercise-based rehabilitation, the optimal exercise regimen remains unclear, especially in the context of myocardial revascularization (5). Previous studies have utilized various exercise protocols to assess their impact on post-MI outcomes, focusing on quality of life, heart rate, and blood pressure. The Centers for Disease Control and Prevention Health-Related Quality of Life Measure (CDC HRQOL-14) is often employed to evaluate quality of life, offering a comprehensive assessment through its modules on general health, physical limitations, and symptom-free days (6).

Research has shown that cardiac rehabilitation can improve quality of life in MI patients, with studies demonstrating enhanced scores on health-related quality of life measures following exercise-based interventions (7). These findings highlight the potential of cardiac rehabilitation to address the complex needs of MI patients beyond mere symptom management, encompassing improvements in physical health, mental well-being, and social functioning. However, there is ongoing debate about the efficacy of cardiac rehabilitation in the context of modern medical advancements, with some arguing that its benefits may be diminished given the improved outcomes achieved through current invasive and pharmacological treatments (8).

In conclusion, while exercise-based cardiac rehabilitation offers promising improvements in post-MI patient outcomes, further research is needed to delineate the most effective exercise protocols and to assess the long-term benefits of such programs in the context of evolving medical therapies. This study aims to contribute to the growing body of evidence by examining the effects of a structured exercise-based rehabilitation program on quality of life, heart rate, and blood pressure in patients recovering from myocardial infarction.

2 Material and Methods

The study was a randomized controlled trial conducted at the Sialkot Medical Center from April 2021 to August 2021, following approval from the research ethics committee of Riphah College of Rehabilitation and Allied Health Sciences (Ref: REC/RCR & AHS/21/0339). The study adhered to the principles outlined in the Declaration of Helsinki to ensure ethical standards were maintained throughout the research process. Participants provided informed consent before being enrolled in the study, and their confidentiality was preserved.

The study population consisted of male and female participants aged 40 to 60 who had experienced a myocardial infarction within the previous three weeks. Using an online G power analysis tool, a sample size of 36 participants was determined, taking into account a 10% expected dropout rate. Participants were recruited using non-probability convenient sampling based on specific inclusion and exclusion criteria. Inclusion criteria encompassed patients from both community and hospital settings within the designated age range who had suffered a recent myocardial infarction, regardless of gender. Exclusion criteria included individuals with specific cardiac conditions or treatments, such as heart valve replacement, heart failure, atrial fibrillation, or those with implanted cardiac devices like CRT or ICD. Allocation into the clinical (Group A) and control (Group B) groups was randomized using a coin toss procedure to reduce bias.

Group A underwent a 6-week supervised exercise program consisting of three sessions per week, which included warm-up exercises, graded aerobic activities (mainly on treadmills), and cool-down sessions. The exercises were tailored to each participant's heart rate reserves using the Rate of Perceived Exertion scale. In contrast, Group B received educational treatments focused on lifestyle changes, such as quitting smoking, losing weight, modifying dietary patterns, and practicing relaxation techniques.

Data collection was conducted at two time points: baseline (pre-intervention) and post-intervention, to track changes over time. Quality of life variables were evaluated both before and after the intervention using the established Centers for Disease Control and Prevention Health-Related Quality of Life Measure (CDC HRQOL-14) questionnaire. This measure comprises three modules: Module 1 addresses general health, Module 2 examines physical restrictions, and Module 3 deals with days when symptoms are present but the person is otherwise healthy. The CDC HRQOL-14 consists of HRQOL-4 core questions, five activity limitation questions, and five Healthy Days HRQOL questions, assessing recent symptoms of pain, depression, nervousness/anxiety, and insomnia (9). Heart rate was measured by counting the number of radial pulses per minute, and blood pressure was determined using a sphygmomanometer. Baseline measurements of HRQOL, heart rate, and blood pressure were taken just before the first session. After six weeks, following the completion of the intervention for both groups, a physiotherapist took the post-intervention HRQOL, blood pressure, and heart rate measurements without being informed of which intervention had been administered to ensure blinding.

Data analysis was performed using SPSS version 25. Descriptive statistics, including means and standard deviations, were calculated to summarize participant characteristics. The Shapiro-Wilk normality test was used to assess data normality, revealing that all variables had a p-value greater than 0.05, indicating parametric data. To compare the outcomes between groups, an independent sample t-test was employed, while paired sample t-tests were utilized to analyze changes within each group. A p-value of less than 0.05 was considered statistically significant, reflecting a robust methodology to determine the efficacy of the exercise-based rehabilitation program compared to the educational interventions.

By adhering to these rigorous methodologies, the study aimed to accurately evaluate the impact of exercise-based cardiac rehabilitation on patients recovering from myocardial infarction, contributing valuable insights to the field of cardiovascular rehabilitation.

3 Results

The results of the study are presented in tables and described in the text below. The Shapiro-Wilk normality test confirmed that the data were normally distributed, with p-values greater than 0.05 for all variables, indicating parametric data. Descriptive statistics of the demographic characteristics for both groups are presented in Table 1.

Table 1: Descriptive Statistics of Demographic Characteristics

Characteristics	Clinical Group (A)	Control Group (B)
Age (years)	52.04 ± 7.21	54.09 ± 5.01
Height (m)	1.63 ± 0.05	1.73 ± 0.09
BMI (kg/m²)	26.91 ± 4.12	24.91 ± 4.92
Weight (Kg)	74.28 ± 11.84	75.28 ± 10.14
Smoking	15 ± 2	13 ± 1
History of Hypertension	15 ± 3	16 ± 2
History of Musculoskeletal Issues	5.1 ± 0.6	6.29 ± 0.4

The comparison between groups and within groups was analyzed using independent sample t-tests and paired sample t-tests, respectively. The results are summarized in Tables 2 and 3.

Table 2: Between-Group Comparison (Independent Sample t-test)

Variable	Time	Group A	Group B	Mean Difference	P-value
CDC HRQOL-14	Pre	24.52 ± 3.01	23.99 ± 3.22	0.53 ± 0.21	0.76
Module 1	Post	15.2 ± 1.09	4.92 ± 0.94	4.92 ± 0.94	0.04
Module 2	Pre	34.51 ± 4.05	32.60 ± 5.13	1.91 ± 1.08	0.08
	Post	19.10 ± 2.41	22.03 ± 4.91	2.93 ± 2.51	0.04
Module 3	Pre	9.01 ± 1.19	11.20 ± 1.09	2.19 ± 0.1	0.07
	Post	27.54 ± 5.10	16.44 ± 5.19	11.1 ± 0.09	0.02
Heart Rate	Pre	105.00 ± 4.01	110.00 ± 6.98	5 ± 2.97	0.061
	Post	88 ± 5.88	100 ± 6.22	12 ± 0.34	0.03
Blood Pressure	Pre-SBP	147.78 ± 11.25	145.71 ± 14.22	2.56 ± 2.97	0.10
Systolic Blood Pressure	Post-SBP	132.20 ± 12.22	141.01 ± 11.71	8.81 ± 0.51	0.01
Diastolic Blood Pressure	Pre-DBP	98.33 ± 10.01	101.31 ± 13.51	2.98 ± 3.5	0.10
	Post-DBP	88.45 ± 11.32	97.02 ± 12.65	8.57 ± 1.33	0.01

Table 2 shows that Group A demonstrated significant improvements in quality of life, heart rate, and blood pressure compared to Group B. Post-intervention HRQOL-14 scores in all three modules were significantly better in Group A, with p-values of 0.04, 0.04, and 0.02 for Modules 1, 2, and 3, respectively. Additionally, significant improvements in heart rate (p=0.03) and systolic blood pressure (p=0.01) were observed in Group A compared to Group B.

Table 3 highlights significant within-group improvements post-intervention for Group A across all measured outcomes, with p-values indicating significant differences in quality of life scores, heart rate, and blood pressure. For Group B, while improvements were observed, they were less pronounced compared to Group A, reflecting the effectiveness of the supervised exercise program.

Table 3: Within-Group Comparison (Paired Sample t-test)

Variable	Group	Time	Pre	Post	Mean Difference	P-value
CDC HRQOL-14	Group A					
Module 1		Pre	24.52 ± 3.01	15.2 ± 1.09	9.32	0.01
		Post	23.99 ± 3.22	20.12 ± 2.03	3.87	0.03
Module 2		Pre	34.51 ± 4.05	19.10 ± 2.41	15.41	0.01
		Post	32.60 ± 5.13	22.03 ± 4.91	10.57	0.04
Module 3		Pre	9.01 ± 1.19	27.54 ± 5.10	18.53	0.00
		Post	11.20 ± 1.09	16.44 ± 5.19	5.24	0.03
Heart Rate	Group A	Pre	105.00 ± 4.01	88 ± 5.88	17.0	0.00
	Group B	Post	110.00 ± 6.98	100 ± 6.22	10.0	0.03
Blood Pressure	Group A	Pre	147.78 ± 11.25	132.20 ± 12.22	15.58	0.01
Systolic Blood Pressure	Group B	Post	145.71 ± 14.22	141.01 ± 11.71	6.7	0.04
Diastolic Blood Pressure	Group A	Pre	98.33 ± 10.01	88.45 ± 11.32	9.88	0.01
	Group B	Post	101.31 ± 13.51	97.02 ± 12.65	4.29	0.04

The study demonstrated that the exercise-based cardiac rehabilitation program significantly enhanced quality of life, reduced heart rate, and improved blood pressure in patients recovering from myocardial infarction. These findings support the inclusion of structured exercise regimens in cardiac rehabilitation protocols to optimize recovery and enhance patient outcomes.

4 Discussion

The findings of this study underscored the efficacy of exercise-based cardiac rehabilitation in improving the quality of life, heart rate, and blood pressure among patients recovering from myocardial infarction (MI). The intervention group, which participated in a supervised exercise program, demonstrated significant enhancements across various metrics compared to the control group that received only educational interventions. These results aligned with previous research, such as the work by Anderson et al., which highlighted the benefits of exercise-based rehabilitation in reducing cardiovascular mortality and improving functional capacity in MI patients (7).

The study's results corroborated the notion that structured exercise programs could significantly enhance health-related quality of life (HRQOL) in MI patients. Notably, the improvement in HRQOL scores in the intervention group was consistent with findings from Hurdus et al., who observed similar improvements using the EuroQol 5-Dimension-3 Level Questionnaire after a six-week rehabilitation period (10). Additionally, the systematic review by Anderson et al. revealed that exercise-based cardiac rehabilitation positively impacted HRQOL measures in patients with coronary artery disease (11). These findings underscored the potential of exercise-based interventions to improve various aspects of patients' lives, including physical, mental, and social well-being.

The study also highlighted the beneficial effects of exercise on cardiovascular parameters, including heart rate and blood pressure. The observed decrease in resting heart rate and improvements in heart rate recovery in the intervention group aligned with the findings of Ribeiro et al., who reported enhanced autonomic function following exercise training in post-MI patients (19). Similarly, Khorshid et al. documented significant reductions in resting heart rate post-intervention, attributing these changes to the positive effects of exercise on the autonomic nervous system and parasympathetic tone (20). The Frank-Starling mechanism may explain these results, as increased cardiac contractility and volume can lead to improved heart rate dynamics (22).

In terms of blood pressure, the study's findings were in line with previous research indicating significant reductions in both systolic and diastolic blood pressure following exercise-based cardiac rehabilitation. Parvand et al. reported similar decreases in systolic blood pressure

after cardiac rehabilitation sessions, suggesting that exercise training could effectively lower systemic vascular resistance (24). The study by Cornelissen and Fagard further supported these results, demonstrating that endurance training led to notable reductions in blood pressure through improved cardiovascular risk factors (25).

Despite the study's strengths, including its randomized controlled design and adherence to ethical standards, several limitations were acknowledged. The relatively small sample size may have impacted the generalizability of the findings. Future research with larger, more diverse populations is recommended to validate these results further. Additionally, the six-week intervention period may have been insufficient to capture the long-term benefits of exercise-based rehabilitation. Extending follow-up periods could provide insights into the sustainability of these improvements over time.

Moreover, the study did not account for potential confounding factors, such as concurrent medications or lifestyle changes outside of the intervention, which could have influenced the outcomes. Future studies should consider controlling for these variables to isolate the effects of the exercise program more accurately. Additionally, as the study was conducted in a single medical center, the results might not be applicable to other settings with differing patient populations and healthcare practices. Expanding the study to multiple centers could enhance the external validity of the findings.

In conclusion, this study contributed to the growing body of evidence supporting the implementation of exercise-based cardiac rehabilitation programs for MI patients. By demonstrating significant improvements in quality of life, heart rate, and blood pressure, the study highlighted the potential of these interventions to enhance patient outcomes post-MI. Further research is needed to optimize exercise regimens and evaluate long-term effects to ensure the widespread adoption of these beneficial programs in clinical practice. The inclusion of exercise-based rehabilitation as a standard component of post-MI care could significantly impact patient recovery and overall quality of life.

5 Conclusion

The study concluded that a supervised exercise-based cardiac rehabilitation program significantly improved the quality of life, heart rate, and blood pressure in patients recovering from myocardial infarction compared to educational interventions alone. These findings have important implications for human healthcare, emphasizing the need to incorporate structured exercise regimens into standard post-MI care protocols to enhance patient recovery and reduce cardiovascular risk. By optimizing physical and mental well-being, such programs can contribute to better long-term outcomes and overall quality of life for MI patients.

6 References

1 Zhang Y, Cao H, Jiang P, Tang H. Cardiac Rehabilitation in Acute Myocardial Infarction Patients After Percutaneous Coronary Intervention: A Community-Based Study. Medicine. 2018;97(8).

2 Kasperowicz A, Cymerys M, Kasperowicz T. Effectiveness of Cardiac Rehabilitation in Exercise Capacity Increase in Patients With ST-Segment Elevation Myocardial Infarction. Int J Environ Res Public Health. 2019;16(21):4085.

3 Wang Y, Chien CW, Xu Y, Tung TH. Effect of Exercise-Based Cardiac Rehabilitation on Left Ventricular Function in Asian Patients With Acute Myocardial Infarction After Percutaneous Coronary Intervention: A Meta-Analysis of Randomized Controlled Trials. Healthcare. 2021;9(6):774.

4 Yamamoto S, Hotta K, Ota E, Mori R, Matsunaga A. Effects of Resistance Training on Muscle Strength, Exercise Capacity, and Mobility in Middle-Aged and Elderly Patients With Coronary Artery Disease: A Meta-Analysis. J Cardiol. 2016;68(2):125-34.

5 Yang X, Li Y, Ren X, Xiong X, Wu L, Li J, et al. Effects of Exercise-Based Cardiac Rehabilitation in Patients After Percutaneous Coronary Intervention: A Meta-Analysis of Randomized Controlled Trials. Sci Rep. 2017;7(1):44789.

6 Long L, Mordi IR, Bridges C, Sagar VA, Davies EJ, Coats AJS, et al. Exercise-Based Cardiac Rehabilitation for Adults With Heart Failure. Cochrane Database Syst Rev. 2019;2019(1).

7 Dibben G, Faulkner J, Oldridge N, Rees K, Thompson DR, Zwisler AD, et al. Exercise-Based Cardiac Rehabilitation for Coronary Heart Disease. Cochrane Database Syst Rev. 2021;2021(11).

8 Campos HO, Rodrigues QT, Drummond LR, Lima PMA, Monteiro MdC, Wanner SP, et al. Exercise-Based Cardiac Rehabilitation After Myocardial Revascularization: A Systematic Review and Meta-Analysis. RCM. 2022;23(2).

9 Moriarty DG, Zack MM, Kobau R. The Centers for Disease Control and Prevention's Healthy Days Measures – Population Tracking of Perceived Physical and Mental Health Over Time. Health Qual Life Outcomes. 2003;1(1):37.

10 Hurdus B, Munyombwe T, Dondo TB, Aktaa S, Oliver G, Hall M, et al. Association of Cardiac Rehabilitation and Health-Related Quality of Life Following Acute Myocardial Infarction. Heart. 2020;106(22):1726-31.

11 Anderson L, Oldridge N, Thompson DR, Zwisler AD, Rees K, Martin N, et al. Exercise-Based Cardiac Rehabilitation for Coronary Heart Disease: Cochrane Systematic Review and Meta-Analysis. J Am Coll Cardiol. 2016;67(1):1-12.

12 Rauch B, Davos CH, Doherty P, Saure D, Metzendorf MI, Salzwedel A, et al. The Prognostic Effect of Cardiac Rehabilitation in the Era of Acute Revascularisation and Statin Therapy: A Systematic Review and Meta-Analysis of Randomized and Non-Randomized Studies – The Cardiac Rehabilitation Outcome Study (CROS). Eur J Prev Cardiol. 2020;23(18):1914-39.

13 Lee BJ, Go JY, Kim AR, Chun SM, Park M, Yang DH, et al. Quality of Life and Physical Ability Changes After Hospital-Based Cardiac Rehabilitation in Patients With Myocardial Infarction. Ann Rehabil Med. 2017;41(1):121-8.

14 Freitas PD, Haida A, Bousquet M, Richard L, Mauriège P, Guiraud T. Short-Term Impact of a 4-Week Intensive Cardiac Rehabilitation Program on Quality of Life and Anxiety-Depression. Ann Phys Rehabil Med. 2011;54(3):132-43.

15 Anchah L, Hassali MA, Lim MSH, Ibrahim MIM, Sim KH, Ong TK. Health Related Quality of Life Assessment in Acute Coronary Syndrome Patients: The Effectiveness of Early Phase I Cardiac Rehabilitation. Health Qual Life Outcomes. 2017;15(1):10.

16 Choo CC, Chew PKH, Lai SM, Soo SC, Ho CS, Ho RC, et al. Effect of Cardiac Rehabilitation on Quality of Life, Depression and Anxiety in Asian Patients. Int J Environ Res Public Health. 2018;15(6):1095.

17 Kraal JJ, Peek N, Van den Akker-Van Marle ME, Kemps HM. Effects of Home-Based Training With Telemonitoring Guidance in Low to Moderate Risk Patients Entering Cardiac Rehabilitation: Short-Term Results of the FIT@Home Study. Eur J Prev Cardiol. 2014;21(2_suppl):26-31.

18 Elshazly A, Khorshid H, Hanna H, Ali A. Effect of Exercise Training on Heart Rate Recovery in Patients Post Anterior Myocardial Infarction. Egypt Heart J. 2018;70(4):283-5.

19 Ribeiro F, Alves AJ, Teixeira M, Miranda F, Azevedo C, Duarte JA, et al. Exercise Training Enhances Autonomic Function After Acute Myocardial Infarction: A Randomized Controlled Study. Rev Port Cardiol (Engl Ed). 2012;31(2):135-41.

20 Khorshid HR, Adelhady Y, Elgarhy NEDM, Mahmoud HB. Effect of Cardiac Rehabilitation Program on Heart Rate Recovery in Diabetic Patients Post Myocardial Infarction Treated by Primary Percutaneous Coronary Intervention. Minia J Med Res. 2020;31(3):153-66.

21 Kingsley JD, Figueroa A. Acute and Training Effects of Resistance Exercise on Heart Rate Variability. Clin Physiol Funct Imaging. 2016;36(3):179-87.

22 Michael S, Graham KS, Davis GM. Cardiac Autonomic Responses During Exercise and Post-Exercise Recovery Using Heart Rate Variability and Systolic Time Intervals—A Review. Front Physiol. 2017;8:301.

23 Qin Y, Kumar Bundhun P, Yuan ZL, Chen MH. The Effect of High-Intensity Interval Training on Exercise Capacity in Post-Myocardial Infarction Patients: A Systematic Review and Meta-Analysis. Eur J Prev Cardiol. 2021;29(3):475-84.

24 Parvand M, Goosheh B, Sarmadi A. Effect of Cardiac Rehabilitation on Blood Pressure and Functional Capacity in Patients After Myocardial Infarction. Novel Biomed. 2016;4(2):56-60.

25 Cornelissen VA, Fagard RH. Effects of Endurance Training on Blood Pressure, Blood Pressure–Regulating Mechanisms, and Cardiovascular Risk Factors. Hypertension. 2005;46(4):667-75.

Disclaimers

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