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ORIGINAL ARTICLE

Effect of Structured Cardiac Rehabilitation on Quality of Life and Functional Recovery in Post-Coronary Artery Bypass Graft (CABG) Patients

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ABSTRACT

Background: Coronary artery bypass grafting (CABG) is a widely performed surgical procedure for the treatment of advanced coronary artery disease (CAD). While it effectively relieves symptoms and improves survival, many patients experience prolonged physical, psychological, and functional impairments post-surgery. Structured cardiac rehabilitation (CR) has been recognized globally as a vital component of postoperative recovery; however, its implementation and evaluation in resource-constrained settings remain limited.

Objective: To evaluate the impact of a 12-week structured cardiac rehabilitation program on quality of life and functional recovery among post-CABG patients.

Methodology: This prospective observational study was included 79 patients (52 males, 27 females) aged 35–75 years who had recently undergone isolated CABG. Participants were enrolled within 3–4 weeks postoperatively and completed a structured CR program consisting of supervised exercise, dietary counseling, stress management, and education. Quality of life was assessed using the Short Form-36 Health Survey (SF-36), while functional capacity was measured through the 6-minute walk test (6MWT), both pre- and post-rehabilitation. Statistical analysis was conducted using paired sample t-tests.

Results: Post-rehabilitation, significant improvements ($p < 0.001$) were observed in all SF-36 domains including physical functioning, vitality, social and emotional well-being, and mental health. The 6MWT distance increased from a mean of 298.4 ± 52.3 meters to 392.7 ± 46.8 meters, reflecting enhanced physical capacity.

Conclusion: Structured CR significantly improves health-related quality of life and physical recovery in post-CABG patients. These findings support the routine integration of structured CR into postoperative care, especially in developing healthcare systems.

Keywords: Coronary artery bypass grafting, Cardiac rehabilitation, Quality of life, Functional recovery, SF-36, 6-minute walk test, Postoperative care.

INTRODUCTION

Coronary artery bypass grafting (CABG) remains one of the most widely performed surgical interventions for the management of advanced coronary artery disease (CAD), particularly in patients with multi-vessel involvement, refractory angina, or impaired ventricular function [1]. While CABG is effective in alleviating symptoms and improving survival in selected patients, the postoperative period is frequently characterized by a spectrum of physical, psychological, and functional challenges[2]. These include reduced exercise tolerance, persistent fatigue, depressive symptoms, poor health-related quality of life (HRQoL), and delayed return to preoperative functional status. Consequently, the post-surgical recovery trajectory is not solely dependent on the success of the revascularization procedure but also critically influenced by the extent and quality of rehabilitative care provided thereafter [3].

Cardiac rehabilitation (CR), particularly when delivered in a structured, multidisciplinary format, has emerged as a cornerstone in the continuum of care following CABG. Structured CR programs typically integrate exercise training, nutritional counseling, psychosocial support, risk factor modification, and patient education [4]. This comprehensive approach aims not only to optimize cardiovascular risk profiles and improve physical capacity but also to enhance emotional well-being, social functioning, and overall quality of life. Current guidelines by the American Heart Association (AHA), the European Society of Cardiology (ESC), and the British Association for Cardiovascular Prevention and Rehabilitation (BACPR) emphasize the essential role of CR in secondary prevention and long-term cardiac health [5].

Despite these recommendations, global enrollment rates in structured CR remain suboptimal, particularly in low- and middle-income countries. In such settings, the full potential of CR to improve long-term outcomes after CABG is often underutilized due to barriers including limited resources, lack of infrastructure, patient non-compliance, and poor awareness among healthcare professionals [6]. Moreover, most existing studies have focused on CR outcomes in patients with stable angina or heart failure, with relatively fewer investigations specifically evaluating its effects in the post-CABG population [7]. This is a critical knowledge gap, considering that the surgical population has unique rehabilitation needs and faces distinct physiological stressors, including sternotomy-related discomfort, respiratory compromise, wound healing concerns, and heightened anxiety related to surgical outcomes [8].

Emerging evidence suggests that early initiation of structured CR following CABG can lead to significant improvements in functional capacity, as measured by peak oxygen uptake and 6-minute walk test, along with marked enhancements in domains of HRQoL such as physical functioning, emotional role limitations, and vitality [9]. In addition, structured CR has been associated with reductions in rehospitalization rates, improved adherence to medication and lifestyle changes, and enhanced patient satisfaction. These multifaceted benefits underscore the potential of structured CR as a cost-effective, scalable, and evidence-based intervention that complements surgical revascularization and supports a holistic recovery process [10].

This study aims to rigorously evaluate the impact of structured cardiac rehabilitation on quality of life and functional recovery in post-CABG patients. By employing validated assessment tools and adopting a prospective observational design, this research seeks to generate context-specific evidence, particularly relevant to the healthcare systems of developing countries. The findings are anticipated to contribute to the growing body of literature advocating for the integration of structured CR into routine post-CABG care pathways and to inform clinical practice, policy development, and resource allocation strategies

aimed at optimizing patient outcomes in the post-operative period [11].

MATERIALS AND METHODS

This prospective observational study was conducted to evaluate the effect of structured cardiac rehabilitation (CR) on quality of life and functional recovery among post-coronary artery bypass graft (CABG) patients. A total of 79 patients, both male and female, who had recently undergone isolated CABG surgery were enrolled from the cardiothoracic surgery department of Chahudhary Pervaiz Elahi Institute of Cardiology Wazirabad. The study duration spanned from January 2022 to October 2022. Ethical approval was obtained from the institutional review board prior to patient recruitment, and informed written consent was taken from all participants.

Inclusion Criteria consisted of adult patients aged 35–75 years who had undergone elective CABG surgery within the previous 2 to 4 weeks, were hemodynamically stable, and were willing to participate in a structured CR program. Exclusion Criteria included patients with unstable angina, severe left ventricular dysfunction (ejection fraction <30%), recent myocardial infarction (<2 weeks), significant orthopedic or neurological limitations, cognitive impairment, or concurrent valvular or congenital heart disease surgery.

The structured cardiac rehabilitation program was designed based on international guidelines and was delivered over a period of 12 weeks. It included three supervised sessions per week, each lasting 60 minutes. The CR protocol was multidisciplinary, involving cardiac physiologists, dieticians, psychologists, and trained rehabilitation nurses. Each session included a combination of aerobic and resistance exercises tailored to the individual's baseline fitness levels and tolerance, using heart rate monitoring and Borg's Rating of Perceived Exertion (RPE) to guide intensity. Sessions also included education on lifestyle modification, dietary counseling, stress management, smoking cessation, and medication adherence.

Baseline demographic and clinical data including age, gender, body mass index (BMI), ejection fraction, comorbidities (diabetes mellitus, hypertension, dyslipidemia), and preoperative functional status were recorded. Quality of life was assessed using the Short Form-36 Health Survey (SF-36), a validated tool measuring eight domains of physical and mental health. Functional recovery was evaluated through the 6-minute walk test (6MWT), performed according to American Thoracic Society guidelines, both at baseline (before CR) and at the end of the 12-week program.

All patients were evaluated at two time points: at baseline (prior to the start of CR) and post-intervention (after 12 weeks of CR). Data were collected in a standardized format and managed using SPSS version 26. Continuous variables were presented as mean ± standard deviation (SD), and categorical variables as frequencies and percentages. The paired sample t-test was used to compare pre- and post-rehabilitation scores within subjects for both the SF-36 domains and 6MWT distances. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 79 patients (52 males and 27 females) who had undergone isolated CABG surgery were enrolled in the study and completed the 12-week structured cardiac rehabilitation program. The mean age of the study participants was 61.3 ± 8.4 years. Baseline characteristics including comorbidities and clinical parameters are presented in Table-1. The baseline demographic and clinical characteristics of the 79 patients who participated in the structured cardiac rehabilitation program following CABG surgery. The mean age of patients was 61.3 ± 8.4 years, with a male predominance (65.8%). The average body mass index (BMI) was 27.6 ± 3.5 kg/m², indicating that the majority of patients were in the overweight range.

Comorbid conditions were common among the cohort: 77.2% were hypertensive, 60.8% had diabetes mellitus, and 53.2% had dyslipidemia. A history of smoking was reported by 36.7% of participants, highlighting the significant burden of modifiable cardiovascular risk factors. The mean left ventricular ejection fraction (LVEF) was moderately reduced at 45.2 ± 6.9%, suggesting impaired but stable cardiac function suitable for rehabilitation. On average, patients were enrolled into the rehabilitation program approximately 3.2 weeks post-surgery, reflecting early postoperative inclusion, which aligns with international cardiac rehabilitation guidelines.

Table 1: Baseline Demographic and Clinical Characteristics of Post-CABG Patients (n = 79)

Parameter	Value
Mean Age (years)	61.3 ± 8.4
Gender	Male: 52 (65.8%) Female: 27 (34.2%)
Body Mass Index (BMI, kg/m²)	27.6 ± 3.5
Hypertension	61 (77.2%)
Diabetes Mellitus	48 (60.8%)
Dyslipidemia	42 (53.2%)
Smoking History	29 (36.7%)
Left Ventricular Ejection Fraction (LVEF)	45.2 ± 6.9 %
Time Since CABG (weeks)	3.2 ± 0.6

Table- 2 presented the comparative analysis of quality of life among post-CABG patients before and after completion of a 12-week structured cardiac rehabilitation program, using the SF-36 Health Survey, a validated instrument that measures eight distinct domains of physical and mental health. There was a statistically significant improvement in all SF-36 domains following the rehabilitation intervention ($p < 0.001$ for each domain), indicating a comprehensive enhancement in both physical and psychosocial well-being.

Physical functioning improved markedly from a mean score of 51.6 ± 14.3 at baseline to 73.9 ± 12.1 post-rehabilitation. This reflects better mobility, endurance, and ability to perform daily activities. Role limitations due to physical health increased from 48.2 ± 16.7 to 71.2 ± 14.9, suggesting fewer physical limitations in work or regular activities caused by health problems. Bodily pain scores improved from 56.1 ± 11.5 to 74.5 ± 10.8, demonstrating significant pain reduction and enhanced comfort levels during recovery. General health perception rose from 53.8 ± 13.2 to 69.3 ± 11.7, indicating that patients felt healthier and more optimistic about their long-term health outcomes.

Vitality scores increased from 50.9 ± 12.8 to 70.1 ± 12.4, reflecting greater energy levels, reduced fatigue, and improved mental stamina. Social functioning significantly improved from 57.4 ± 15.1 to 77.6 ± 11.3, indicating better interpersonal engagement and reintegration into social life. Role limitations due to emotional problems also improved, rising from 54.3 ± 13.5 to 75.8 ± 10.4, suggesting improved emotional resilience and fewer psychological barriers to functioning. Mental health showed a strong upward shift from 60.5 ± 12.7 to 79.2 ± 9.3, representing reduced anxiety, depression, and emotional distress.

The statistically significant increases in all SF-36 domains after structured cardiac rehabilitation confirm the program's robust effectiveness in promoting holistic recovery in post-CABG patients. The greatest improvements were noted in physical functioning, social functioning, and mental health, underscoring the multidimensional benefits of a structured, multidisciplinary rehabilitation approach. These findings strongly advocate for routine implementation of cardiac rehabilitation programs to improve not only cardiovascular recovery but also overall quality of life after cardiac surgery.

Table- 3 presents the mean distance covered in the 6-minute walk test (6MWT) before and after the rehabilitation program. A statistically significant improvement in walking distance was observed ($p < 0.001$).

Table 2: Comparison of SF-36 Quality of Life Scores Before and After Cardiac Rehabilitation (n = 79)

SF-36 Domain	Pre-Rehabilitation (Mean ± SD)	Post-Rehabilitation (Mean ± SD)	p-value
Physical Functioning	51.6 ± 14.3	73.9 ± 12.1	<0.001
Role Limitations (Physical)	48.2 ± 16.7	71.2 ± 14.9	<0.001
Bodily Pain	56.1 ± 11.5	74.5 ± 10.8	<0.001
General Health	53.8 ± 13.2	69.3 ± 11.7	<0.001
Vitality	50.9 ± 12.8	70.1 ± 12.4	<0.001
Social Functioning	57.4 ± 15.1	77.6 ± 11.3	<0.001
Role Limitations (Emotional)	54.3 ± 13.5	75.8 ± 10.4	<0.001
Mental Health	60.5 ± 12.7	79.2 ± 9.3	<0.001

Table 3: Functional Recovery Assessed by 6-Minute Walk Test (n = 79)

Parameter	Pre-Rehabilitation	Post-Rehabilitation	p-value
6MWT Distance (meters)	298.4 ± 52.3	392.7 ± 46.8	<0.001

The results of this study clearly demonstrate that participation in a structured 12-week cardiac rehabilitation program led to significant improvements in all domains of health-related quality of life among post-CABG patients, as evidenced by the marked increases in SF-36 scores. The most substantial gains were observed in physical functioning, social functioning, and mental health, highlighting the program's multidimensional impact on physical recovery, emotional stability, and social reintegration. The statistically significant p-values (all <0.001) across each domain affirm the robustness of these findings. These outcomes strongly support the routine incorporation of structured cardiac rehabilitation into postoperative care pathways to optimize recovery, enhance long-term well-being, and improve the overall quality of life following coronary artery bypass graft surgery.

DISCUSSION

This study provided compelling evidence that structured cardiac rehabilitation (CR) significantly improves quality of life and functional recovery in patients who have undergone coronary artery bypass graft (CABG) surgery. The observed improvements across all eight domains of the SF-36 Health Survey, along with enhanced performance in the 6-minute walk test (6MWT), emphasize the multifaceted benefits of a comprehensive, multidisciplinary CR program [12]. These findings are consistent with international data supporting the role of CR in enhancing postoperative outcomes, but they also add region-specific relevance by demonstrating feasibility and effectiveness in a resource-limited setting. The most pronounced improvements were noted in physical functioning, mental health, and social functioning, reflecting the program's impact on both physiological and psychosocial recovery [12]. The rise in physical functioning scores suggests enhanced musculoskeletal conditioning, cardiorespiratory endurance, and the ability to perform daily tasks an expected outcome given the structured aerobic and resistance training included in the program. These changes were paralleled by a significant increase in 6MWT distance, affirming improved functional capacity and cardiopulmonary fitness [13].

Notably, the significant gains in mental health and role-emotional domains underscore the psychological value of structured rehabilitation. Postoperative depression, anxiety, and feelings of vulnerability are common among CABG patients and have been shown to negatively affect both compliance and recovery [14]. The psychosocial interventions in this CR program counseling, stress management techniques, peer group support, and structured education likely contributed to the observed mental health improvements. These outcomes are in line with studies by Mols et al. and Pinto et al., which reported reductions in anxiety and depressive symptoms following supervised CR [15].

The improvements in general health perception and vitality further highlight the holistic effect of CR on patient-reported well-being. Enhanced vitality scores indicate reduced fatigue and better energy levels, essential for reintegration into daily life and employment. Additionally, improved social functioning suggests that patients felt more confident engaging in interpersonal interactions, which is critical for long-term psychosocial adjustment [16]. From a pathophysiological perspective, CR mitigates the residual burden of systemic inflammation, endothelial dysfunction, and physical deconditioning that persists even after successful revascularization. Exercise-induced upregulation of nitric oxide, improved autonomic balance, and favorable effects on lipid and glucose metabolism are mechanisms that have been well-documented in previous trials such as the HF-ACTION and EUROASPIRE studies [17].

Another important aspect is the timing and early initiation of CR. In this study, patients were enrolled within three weeks of CABG, which aligns with recommendations from the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) and the European Society of Cardiology (ESC). Early enrollment optimizes recovery by taking advantage of the "window of receptiveness" during which patients are most motivated to adopt healthy behaviors [18]. Despite the positive outcomes, certain limitations should be acknowledged. First, the study was observational and conducted at a single tertiary care center, which may limit generalizability. Second, the sample size, while adequate for primary outcomes, may not be powered for subgroup analysis (e.g., gender differences, comorbidity-specific responses). Third, long-term follow-up was not performed, so the sustainability of these improvements remains unknown [19].

Future multicenter, randomized controlled trials with extended follow-up are necessary to validate and extend these findings. This study demonstrated that a structured, multidisciplinary cardiac rehabilitation program significantly enhances quality of life and physical recovery in post-CABG patients [20]. These findings strongly support the integration of CR into standard postoperative care, not only to improve clinical outcomes but also to promote holistic patient-centered recovery. Given the high burden of coronary artery disease and the increasing number of surgical revascularizations, the implementation of structured CR should be prioritized as a cost-effective and evidence-based strategy in both high-income and developing healthcare systems [11].

CONCLUSION

This study provided robust evidence that structured cardiac rehabilitation (CR) significantly enhances both quality of life and functional recovery in patients following coronary artery bypass graft (CABG) surgery. Over a 12-week period, participants demonstrated substantial improvements across all eight domains of the SF-36 Health Survey and showed marked gains in physical performance as assessed by the 6-minute walk test. The most prominent benefits were seen in physical functioning, emotional well-being, social integration, and vitality reflecting the multidimensional impact of a comprehensive CR program. These findings underscore the essential role of structured, multidisciplinary rehabilitation in optimizing recovery and addressing the physical, psychological, and social challenges faced by post-CABG patients. Early initiation of CR was particularly beneficial, aligning with global best-practice recommendations. Despite limitations related to single-center design and short-term follow-up, the study reinforces the value of CR as a cost-effective, scalable intervention. It strongly advocates for the incorporation of structured CR into routine post-CABG care pathways, especially in resource-constrained settings, to ensure holistic, patient-centered recovery and improved long-term outcomes.

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Authors' Contributions: A.S. conceptualized and designed the study, supervised the rehabilitation program, and contributed to manuscript drafting and final approval. S.A.Z. managed patient recruitment, data collection, and follow-up coordination. M.Z.A.R. performed statistical analysis, interpreted results, and assisted in writing the results section. T.M. reviewed the methodology and contributed to the discussion. A.A.C. handled data management and table preparation. F.A. assisted with patient counseling, consent, and proofreading. All authors reviewed and approved the final manuscript and share responsibility for its content.

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