Research Article

Effectiveness of Cardiac Rehabilitation for Patients after Coronary Artery Bypass Graft: Randomized Controlled Trial

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Running Title: Effectiveness of Cardiac Rehab After CABG: An RCT

Abstract

Background: Cardiac rehabilitation is a program designed to help patients adopt healthy lifestyles. This study aims to investigate the effectiveness of the comprehensive cardiac rehabilitation program (CCRP) on anxiety, depression, perceived health status (PHS), and 90-day readmission rate for Coronary artery bypass grafting (CABG) patients.

Methods: 122 patients were randomized into two groups; the intervention group received a CCRP. The program was 12 weeks. Anxiety and depression were assessed using the hospital anxiety and depression scale, and PHS was assessed using the short form-36 health survey. The effectiveness of the CCRP was measured using ANOVA.

Results: The sample comprised 122 participants, most of them were male (n = 85; 69.7%), with a mean age of 53.01 (±7.26) years. At baseline, the groups had no significant differences. At 12 weeks and one month later, significant differences have been observed with between-group effect of (F (1) = 937.69, P <.001, partial η2 = .90), (F (1) = 1036.00, p<0.001, partial η2 = .91), (F (1) = 14.73, p <.001, partial η2 = .13), (F (1) = 13.87, p <.001, partial η2 = .121)

for anxiety, depression, physical component summary and mental component summary of perceived health status respectively.
Conclusion: CCRP appeared to be an effective intervention that could significantly improve anxiety, depression, and PHS. Although the difference in the readmission rate was not significant, it may result in substantial rewards.
- The protocol of the present study was registered and approved in ClinicalTrials.gov PRS
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Keywords: Cardiac rehabilitation, Anxiety, Depression, Health status

Introduction

Cardiovascular disease (CVD) continues to be a prominent contributor to mortality and morbidity across the world (1). While the number of deaths related to CVD was 17.5 million in 2012, it increased to 17.9 million in 2016, and is expected to reach 22.2 million by 2030. CABG is the most common surgery applied globally. It has been confirmed to be one of the most efficient and long-lasting treatments for CAD (2). To reduce post-CABG complications, improve quality of life, and avoid unplanned hospitalization for CABG patients, international associations like the American Heart Association (AHA) and the European Society of Cardiology recommended the use of cardiac rehabilitation program (CRP) (3).
According to the AHA and the American College of Cardiology, CR is classified as a Class IA recommendation, and enrollment in CR is considered to be one of nine performance measures for secondary prevention (4). As identified by the AHA and the American Association of Cardiovascular and Pulmonary Rehabilitation, the main components of CRP are education, exercise, and psychological support (5). CRPs generally include three main phases: inpatient (phase I), early outpatient (phase II), and long-term outpatient CR (phase III) (3).
It is widely acknowledged that CVD patients, including CABG patients, experience anxiety and depression after acute cardiac events or major interventions (6). Studies have shown that 34-35% of CABG patients experience moderate anxiety, and 15-33 % experience mild depressive symptom (7-9). Patients with persistent symptoms of anxiety and depression have poorer outcomes, which affect their recovery journey and reduce the benefits of the treatment (10, 11).
Perceived health status (PHS) encompasses both physical and mental well-being, relating to people's personal beliefs and assessments of their general state of health, based on their personal experiences and perceptions in addition to their experience of healthcare services and knowledge of clinical indicators (12). In recent years, clinical consideration of how patients perceive social, emotional, and physical health has increased, especially for the management of chronic diseases where a complete recovery is unlikely (13). In cardiovascular studies, PHS has been extensively used to indicate the effectiveness of pharmacological and non-pharmacological interventions. Evaluating the impact of any treatment on PHS became a valuable measurement of that treatment (14, 15).
While the impact of CRPs on various outcomes for patients with CVD has been extensively studied, a critical review of the existing literature revealed some gaps and areas that need further research. Firstly, in the cardiac rehabilitation (CR) field, despite the widespread research on CAD patients, there is insufficient knowledge concerning CABG patients. This unique population experiences distinct emotional and physical outcomes due to their complex condition before the surgery and their treatment nature, which differ significantly from other CAD patients (16). This lack of focus results in insufficient insight into CABG patients during their recovery.
Secondly, many existing randomized controlled trials (RCTs) lacked structured interventions

that include all essential components of comprehensive cardiac rehabilitation program (CCRP) (i.e., exercise training, risk factors modification, and psychological management) (17). Thirdly, despite extensive epidemiological literature evidence validating the beneficial effects of stress management in improving cardiac health, it is not included as a part of routine CR (18).
The present study thus seeks to address these literature gaps. Adopting a holistic interventional approach, the present study provides insights into the effectiveness of CCRP in enhancing emotional and physical outcomes, offering an understanding of lifestyle modification. This study also highlights the benefits of incorporating stress management in CCRP to enhance cardiac health. The main aim of this study is to examine the effect of CCRP on anxiety, depression, PHS, and 90-day for patients undergoing CABG.

Methodology

Design

An RCT was performed to assess the effectiveness of the CCRP on PHS, anxiety, depression, and 90-day readmission rates for CABG patients. This study was guided by the Consolidated Standards for Reporting Trials (CONSORT) guidelines, which provide a framework for apparent and complete reporting of RCTs. Adherence to the CONSORT guidelines ensures that the trial design, conduct, analysis, and results are reported in a standardized manner.

Location and Setting

The present study was conducted at two hospitals in Amman, Jordan: Al Bashir Hospital and Prince Hamzah bin Alhussien Hospital. These are the two leading governmental hospitals in the capital city.

Inclusion and Exclusion Criteria

The selection criteria outlined below were designed to ensure the participants' safety and capability to participate in the study. They were also established to ensure alignment with ethical standards. Therefore, patients were eligible to participate in this study subject to the following inclusion criteria:

- aged > 18 years.
- have undergone CABG.
- Free from ECG abnormalities.
- Able to read and write in the Arabic language.
- Able to use a smartphone and have access to the internet network.
- Have a family member who can help, supervise, and take care.
- Agree to participate and sign the informed consent form voluntarily.

Patients were excluded if they had physical or mental problems that limited their participation in the study (such patients require tailored CRPs to fit their needs), or if they complained of dyspnoea or fatigue while performing ordinary daily activities (which renders them class III or IV according to the New York Heart Association (NYHA) Classification), because the exercise component might be unsafe for such patients.

Sampling Method and Randomization

Participants were recruited randomly to participate in this study using the block randomization method, with a block size of two. Every second eligible patient was asked to participate in this study if they agreed to participate. A closed envelope approach was then used to randomly allocate participants to either the intervention or control groups. The closed envelope contained two papers, one for the intervention and another for the control group; the participants were asked to choose one paper from the closed envelope, which consequently determined their group.

Sample Size

The sample size was calculated based on a similar previous study (19). The calculation was done four times for the following outcomes: anxiety, depression, PHS physical component, and PHS mental component. A large sample size guaranteed adequate participants for all measured outcomes. With a desired two-tailed significance level (alpha) of 5%, and a power of 0.80, it was calculated that 47 participants were necessary per group. Consequently, the required number of participants for the present study was 94, to offset a potential dropout rate of 30%, in order to increase the chances of required participant retention until the end of the study and providing essential analytical power to interpret the statistical results. The final number needed for this study was thus 122 (61 per group). Figure 1 displays the CONSORT flowchart for the sampling and recruitment process.

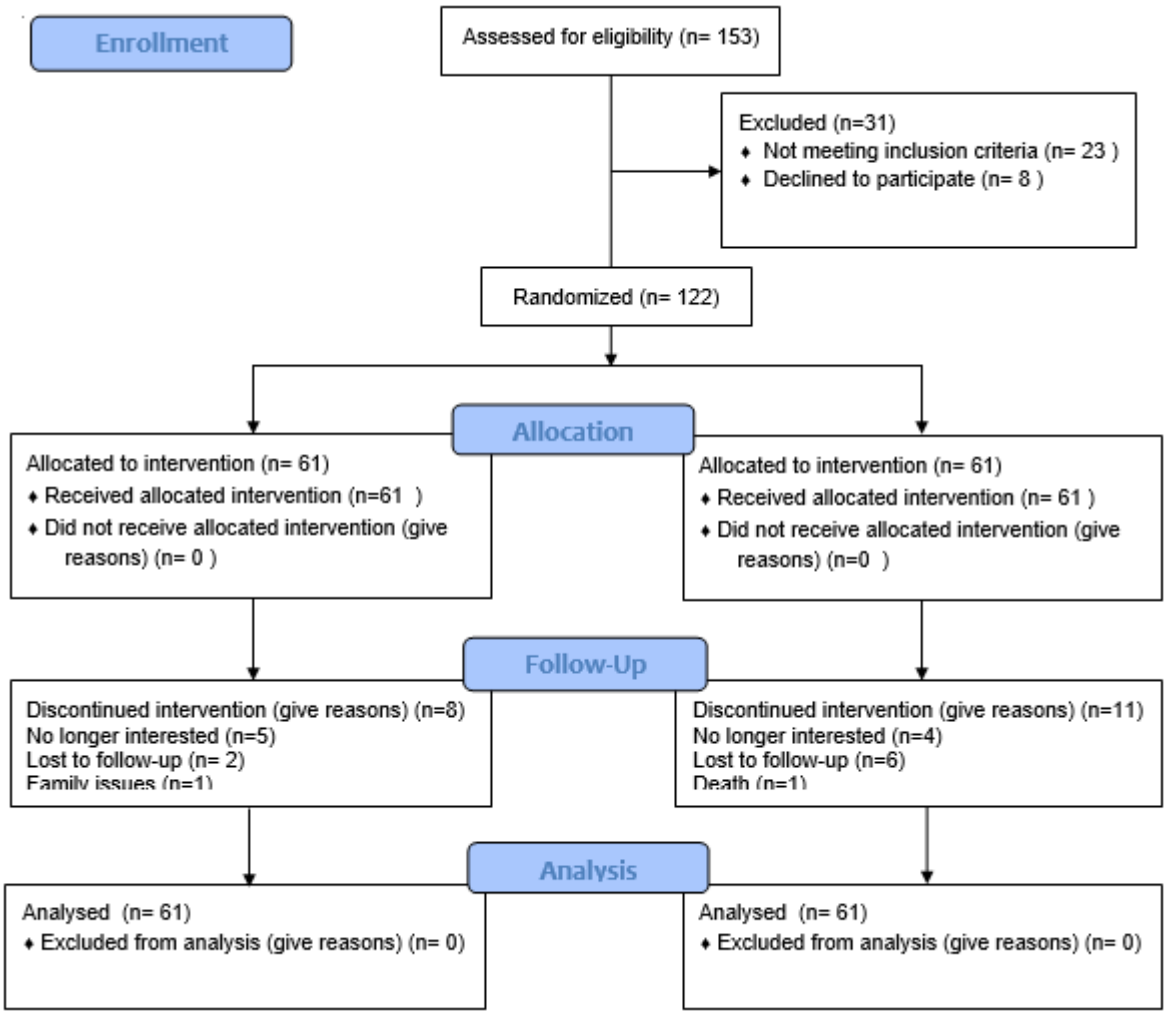

Fig 1 CONSORT flow chart

Measurement Tools

Anxiety and depression were measured using the Hospital Anxiety and Depression Scale (HADS). It has two subscales, one for anxiety (HADS–A) and one for depression (HADS–D). Its 14 items (7 items for each subscale) are rated using a four-point Likert scale (0-3). Each subscale is scored separately by summating its seven items to produce a total score of (0-21). A higher score indicates worse symptoms. A study by Terkawi et al. examined the validity of the Arabic version of HADS on 110 surgical patients, and revealed that the Cronbach's α coefficient for the HADS-A subscale was 0.83, and that for the HADS-D subscale was 0.77

(20).
The Short Form 36 Health Survey Questionnaire (SF-36) was used to measure PHS. The SF-36 is a popular generic measure designed to evaluate health status (21). It is a brief yet inclusive measure of perceived health status (22). In Jordan, the psychometric properties of the SF-36 were assessed by Khader et al., who found that the reliability of the Arabic SF-36 was satisfactory, with Cronbach's α coefficients for all eight SF-36 scales being greater than 0.70 (23). The SF-36 Health Survey consists of 36 items, with eight scales providing two component summaries; physical component summary (PCS) and mental component summary (MCS).

Recruitment

Potential participants comprised male and female CABG patients, aged > 18 years. No limitations were applied regarding educational, marital, or employment status, except that participants had to be literate in Arabic in order to ensure that they understood the studied materials. In addition, participants had a family member to supervise and take care of them while completing intervention tasks.
Patients undergoing CABG have routine clinical appointment two weeks after discharge, during which physicians undertake a complete assessment, including a general physical examination, inspection of the surgical site, and history recent symptoms after discharge, such as chest pain, palpitation, fatigue or dyspnoea. The assessment includes electrocardiograph (ECG), blood samples, and echocardiography analyses. Based on this assessment, the decision was made about the patient's eligibility to participate in the study. Those who agreed to participate were asked to sign the informed consent and allocated randomly to either the intervention or control group. This process continued until the needed sample size was recruited.

Intervention Group

The intervention group received the following program (CCRP):
Comprehensive cardiac rehabilitation program is a 12-week program composed of exercise training, lifestyle and risk factors modification, stress management, and phone call follow-up. According to the current international guidelines, exercise prescription was guided by frequency, intensity, time, and type (FITT) model (17). Endurance exercise intensity was assessed using the Borg Rating of Perceived Exertion (RPE) Scale (17, 24-26). Initially, participants performed one supervised exercise session in which they were taught how to rate their exertion and monitored for symptoms of exertional angina. The rehabilitation program was designed at moderate intensity, corresponding to a score of 12-14 on the Borg RPE Scale (17, 25). Patients who achieved moderate intensity without experiencing symptoms of exertional angina were considered qualified for the rehabilitation program. This approach ensures safe and comfortable performance throughout the program.
The exercise part includes a group of exercises gradually increased in intensity (mild to moderate) and duration (30- 60 minutes). It is three sessions weekly, each session starts with five minutes of warm-up and ends with five minutes of cooling down. Exercises were delivered as short videos through the WhatsApp application providing details regarding appropriate performance techniques, body positions, repetitions, warm-ups, and cool-downs. It comprises various kinds of exercises such as supine leg raises, seated knee extension, walking, brisk walking, side walking, step box, trunk rotation, arm raising, elbow flexion and extension, neck flexion and extension, and hip rotation. The intensity of the exercise was determined using the talk test. Participants were instructed not to pass moderate intensity exercise.
Lifestyle and risk factor modification part aims to provide participants with essential knowledge that supports a healthy lifestyle and controls modifiable risk factors. It includes

several health education topics such as healthy dietary patterns, potential complications, surgical wound care, adherence to the prescribed medications, and the importance of sleeping. The stress management component was implemented utilizing a structured regimen of breathing exercises designed to enhance relaxation alleviate stress, and improve well-being, Participants in the intervention group received a training video on how to perform breathing control techniques. They were instructed to perform the technique for 10 minutes three times weekly. Details of the program are illustrated in Table 1.

Control Group

Participants in the control group received the usual care (general instructions and advice from physicians and nurses) without a structured program or any educational materials. After signing the informed consent, they were asked to complete the SF-36, HADS, and the sociodemographic data sheet; for the control group, these instruments were complete at baseline, 12 weeks, and one month later. The participants in the control group received the whole program after the end of the study.

Data Analysis

Inferential and descriptive statistics were used to describe the study variables and answer the research questions of the present study using SPSS (version 23). Before analysis, data were checked and treated for outliers, missing data and wild coding. Exploratory data analyses were carried out to determine the normality of data, using skewness, Kurtosis, and Shapiro-Wilk tests. Frequencies and percentages described categorical variables, while continuous variables were presented by means and standard deviations.

At baseline, the two groups were compared using an independent t-test for continuous variables and a chi-square for categorical variables. Repeated-measures analysis of variance (ANOVA) was employed to assess the effectiveness of the CCRP at 12-week and one month later on anxiety, depression, and PHS (MCS and PCS) after assessing all assumptions. An Independent t-test was used to compare the 90-day readmission rate between the two groups. The significance level was $p \leq 0.05$ with 95% confidence intervals (CI) between the two groups.

Table 1: Comprehensive cardiac rehabilitation program

Exercise training					
Week	**Exercise type**	**Repetition**	**Session/week**	**Intensity**	**Duration**
2	• Alternating supine leg raise • Seated knee extension • Ankle pumps • Elbow bending;	10	5 session/week	Mild	30 min
3 4	• Front and Side arm raising • Elbow bending • Shoulder rotation • Slow walking	10	5 session/week	Mild	30 min
5 6	• Front and Side arm raising • Elbow bending • Shoulder rotation • Hip rotation • Step box + Brisk walking	15	5 session/week	Moderate	45 min
7 8	• Front and Side arm raising • Elbow bending • Shoulder and hip rotation • step box + Brisk walking	15	5 session/week	Moderate	45 min
9	• Front and Side arm raising	20	5	Moderate	60 min

10	• Neck flexion and extension • Shoulder and hip rotation • Elbow bending • step box + Brisk walking		session/week		
11 12	• Front and Side arm raising • Neck flexion and extension • Shoulder and hip rotation • Elbow bending • Step box + Brisk walking	20	5 session/week	Moderate	60 min
Lifestyle and risk factor modification					
Week	**Topics**		**Session/week**	**Delivery**	**Duration**
1-12	• Unsafe movements, get-out of bed • Standing-up, cuffing, bathing • Potential complications • Healthy dietary patterns dehydration • Surgical wound care • Adherence to medications • Monitoring hypertension and hyperglycemia • The importance of sleeping • Warning sign/ When to seek help • Social involvement and family support		2 Session	A. Face-to-face tutorial B. Smartphone application C. Brochure	8-15 min.
Stress management using breathing control					
Week	**Steps**		**Session/week**	**Delivery**	**Duration**
1-12	1- Sit in a calm place, relax and focus on breathing 2- Inhale slowly through the nose counting to three. 3- Hold breathing counting to three 4- Exhale through pursed lips, counting to five 5- Pause until you feel comfortable 6- Repeat the technique		3 Session	Smartphone application	10 min
1-12	**Each week include 1 Phone call follow-up**				
1-12	**Each week include 1 Resting day**				

1. Results

Participant Characteristics and Group Comparison at Baseline

The sample comprised 122 participants, 103 of whom completed the study. The CONSORT flow chart (Figure 1) illustrates the randomization process and the number of participants. Most of the participants were male (n = 85; 69.7%), with a mean age (±SD) of 53.01 (±7.26) years. Most were married (n = 112; 91.8%) and had a high school education (n = 66, 54.1%). The largest cohort were current smokers (n = 54; 44.3%). No statistically significant differences (P > 0.05) were observed between the two groups at baseline (Table 2).

Table 2. Comparison at baseline

Variable	**Sample**	**Frequency (%)**		**X^2**	**df**	**p—value**
		Control group	**Intervention group**			
Gender Female Male	37 (30.3%) 85 (69.7%)	20 (33%) 41 (67%)	17 (28 %) 44 (72 %)	349	1	.694
Marital status	112 (91.8%)	56 (50.0%)	56 (50.0%)	.1.667	3	.644

Married Single Divorced Widowed	4 (3.3%) 3 (2.5%) 3 (2.5%)	1 (25.0%) 2 (66.7%) 2 (66.7%)	3 (75.0%) 1 (33.3%) 1 (33.3%)			
Smoking status Current smoker Ex-smoker Non-smoker	54 (44.3%) 29 (23.8%) 39 (32.0%)	26 (48.1%) 18 (62.1%) 17 (43.6%)	28 (51.9%) 11 (37.9%) 22 (56.4%)	2.405	2	.300
Comorbidities DM HTN CRF	72 (59.0%) 65 (53.3%) 76 (62.3%)	36 (50.0%) 34 (52.3%) 38 (50.0%)	36 (50.0%) 31 (47.7%) 38 (50.0%)	.000 .296 1	1 1 1	1.000 .717 .574
Education level Below high school High school Undergraduate Postgraduate	38 (31.1%) 66 (54.1%) 17(13.9%) 1 (.8%)	21 (55.3%) 34 (51.5%) 5 (29.4%) 1 (100.0%)	17 (44.7%) 32 (48.5%) 12 (70.6%) 0 (0.0%)	4.364	3	.225

DM: Diabetes mellitus, HTN: Hypertension, CRF: Chronic renal failure

Effect of CCRP on anxiety

The results of repeated measure ANOVA demonstrated a statistically significant time (within-group) effect (F (2, 202) = 28.41, p <.001, partial η^2 = .22). Additionally, the test of between-group effect revealed a significant between-group effect (F (1) = 937.69, P <.001, partial η2 = .90). Furthermore, the results presented a statistically significant interaction (group*time) effect (F (2, 202) = 60.84, p <.001, partial η^2 = .38) (Table 3).

At baseline, anxiety levels were similar between the CG (12.50 ± 3.44) and IG (12.59 ± 4.57) (p = .92). At 12 weeks and 1 month, the IG had significantly lower anxiety levels (9.89 ± 4.33) and 7.25 ±3.89) than the CG (12.52 ± 4.22) and 13.52 ± 4.22) (p < .001) (Table 4).

Table 3 Effect of comprehensive cardiac rehabilitation program on outcomes

Outcomes	Effect type	Df	F	P value	Partial η2
Anxiety	**Within-group effect**	2	28.41	<.001	.220
	Between-group effect	1	937.69	<.001	.903
	Interaction effect	1.17	60.84	<.001	.376
Depression	**Within-group effect**	2	54.598	<.001	.351
	Between-group effect	1	1036.00	<.001	.911

	Interaction effect	2	4.64	.011	.044
PCS	**Within-group effect**	2	6.24	.012	.06
	Between-group effect	1	14.73	<.001	.13
	Interaction effect	1.09	45.77	<.001	.312
MCS	**Within-group effect**	2	22.33	<.001	.181
	Between-group effect	1	13.87	<.001	.121
	Interaction effect	1.17	45.77	<.001	.312

*Repeated measure ANOVA, *Significant at α=0.05 (2-tailed)

Effect of CCRP on depression

The findings from repeated measure ANOVA showed a statistically significant time (within-group) effect (F (2, 202) = 54.60, p< 0.001, partial η^2 = .35). Additionally, the test of between-group effect revealed a significant group effect (F (1) = 1036.00, p<0.001, partial η2 = .91). Moreover, the results presented a statistically significant interaction (group*time) effect (F (2, 202) = 4.644, p = .011, partial η^2 = .04) (Table 3).

At baseline, depression levels were comparable between the CG (12.40 ± 4.71) and IG (11.96 ± 4.61) (p = .64). At 12 weeks and 1 month, the IG had significantly lower depression levels (9.19 ± 4.21 and 7.25 ± 0.56) than the CG (11.74 ± 4.03 and 9.40 ± 2.93) (p < .001). (Table 4).

Effect of CCRP on PHS (Physical Component)

The results revealed a statistically significant primary time (within-group) effect (F (1.09, 109.61) = 6.24, p = .012, partial η2 = .06). The test of between-group effect revealed a significant effect of the group (F (1) = 14.73, p <.001, partial η2 = .13). Furthermore, the results presented a statistically significant interaction (group*time) effect (F (1.09, 109.61) = 44.96, p <.001, partial η2 = .31) (Table 3).

At baseline, PCSs were similar between the CG (50.55 ± 12.91) and IG (48.82 ± 9.55) (p = .339). At 12 weeks and 1 month, the IG had significantly higher PCS scores (51.62 ± 11.69) and 57.19 ± 11.84) than the CG (42.82 ± 11.04 and 42.82 ± 13.50) (p < .001). (Table 4).

Effect of CCRP on PHS (Mental Component)

For the MCS score, the results of repeated measure ANOVA revealed a statistically significant time (within-group) effect (F (1.17, 118.33) = 22.33, p <0.001, partial η2 = .181). The test of the between-group effect revealed a significant effect of group (F (1) = 13.87, p <.001, partial η2 = .121). Additionally, the results showed a statistically significant interaction between (group*time) effect (F (1.17, 118.33) = 45.77, p <.001, partial η2 = .31) (Table 3).

At baseline, MCSs were similar between the CG (50.02 ± 12.91) and IG (50.19 ± 11.60) (p = .94). At 12 weeks and 1 month, the IG had significantly higher MCS scores (54.93 ± 12.24 and 65.40 ± 12.57) compared to the CG (50.12 ± 10.91 and 47.52 ± 10.27) (p < .001) (Table 4).

Effect of CCRP on 90-Day Readmission

The result of t-test showed a non-statistically significant difference between the two groups (t (120) = .59, p = .556). The mean 90-day readmission rates are (IG: M = .26, SD = .63; CG: M = .33, SD = .60). Table 4 summarises the key variables studied among the groups at the three

studied time points, from baseline to 12 weeks.

Table 4 Comparison of outcomes between the intervention and control groups at the three time-points

Outcome	Time-point	Control group Mean (SD)	Intervention group Mean (SD)	P-value
Anxiety	**Baseline**	12.50 (3.44)	12.59 (4.57)	.92
	at 12-week	12.52 (4.22)	9.89 (4.33)	<.001
	at 1 month	13.52 (4.22)	7.25 (3.89)	<.001
Depression	**Baseline**	12.40 (4.71)	11.96, (4.61)	.64
	at 12-week	11.74 (4.03)	9.19, (4.21)	<.001
	at 1 month	9.40 (2.93)	7.25 (.56)	<.001
PCS	**Baseline**	50.55 (8.65)	48.82 (9.55)	.339
	at 12-week	42.82 (11.04)	51.62 (11.69)	<.001
	at 1 month	42.82 (13.50)	57.19 (11.84)	<.001
MCS	**Baseline**	50.02 (12.91)	50.19 (11.60)	.94
	at 12-week	50.12 (10.91)	54.93 (12.24)	.038
	at 1 month	47.52 (10.27)	65.40 (12.57)	< 0.001

SD: standard deviation, * significant at α=0.05 (2-tailed)

2. Discussion

Effect of CCRP on Anxiety and Depression

Considering the impact of CCRP on anxiety and depression, the results revealed a significant effect of the primary time, group, and group*time interaction, with improved outcomes among the IG in both anxiety and depression at the 12-week time point and one month later. A possible explanation of these results could be attributed to including psychological support and stress management education in CCRP. Studies showed that patients who received stress management after cardiac events showed reduced anxiety and depressive symptoms compared to those who did not (27). Such activities allow for distraction, decrease painful sensations, improve relaxation and fatigue elimination, and help reduce anxiety and depression levels per se (28). Moreover, the CCRP utilized in this study emphasized the importance of social support, which is linked to the alleviation of psychological disorders such as anxiety and depression (29).

Exercise training is a core component of CCRP, and adhering to a regular exercise program enhances physical fitness and improves psychological well-being (30). The role of exercise in alleviating anxiety symptoms is well-documented in the literature (31). It has been suggested that exercise reduces anxiety through different physiological mechanisms, including regulation of inflammatory response, endothelial function enhancement, platelet aggregation diminution, and sympathetic-vagal activity balance (32).

Effect of CCRP on Perceived Health Status (Physical and Mental)

The results demonstrated the significant effect of the time, group, and group*time interactions, favouring the IG in both MCS and PCS. These findings indicated a holistic enhancement in patients' general health perception and point to the important role that CCRP can play in improving both the physical and mental dimensions of patients' lives. The importance of these findings is galvanized by the fact that they were self-reported, which means that patients themselves evaluated their ability and their feeling improvement.

Lower perceived health status is often experienced among patients after CABG, and persistent

symptoms such as pain and fatigue decrease patients' ability to perform daily activities, undermining their self-perception, morale, and motivation to engage in former lifestyle activities, including physical activity. A CCRP is a multi-component program whereby different components can affect physical and mental health differently. Exercise is the cornerstone of CCRP, and a growing body of evidence suggests that exercise can positively impact health perceptions and mental health among patients after CABG, in addition to its biomedical health outcomes (as per conventional exercise-health indicators) (33, 34).

The main objectives of exercise training after CABG are to enhance cardiopulmonary function, improve vascular circulation, and increase muscle endurance (35). This physiological progression accelerates the recovery process and promotes confidence in overcoming postoperative barriers; consequently, it is reflected in patients' physical and mental well-being (36). The gradual increase in exercise intensity and duration, as exercise intensity plays a vital role in CR efficiency. Previous studies suggested that moderate to high-intensity aerobic training patients reported better physical and mental health status than those who performed light or no training (37). Adults with CVD should perform 150 to 300 minutes of moderate-intensity exercise per week or 75 to 150 minutes of high-intensity exercise per week unless they have contraindications (38).

Moreover, exercise training, lifestyle modification, and stress management magnify the impacts of CCRP. Multiple universal guidelines recommend that CCRP comprising healthy lifestyle modification and psychological support besides exercise (39-41) these integrated programs aid in controlling modifiable risk factors that may result in severe deterioration and revascularisation.

Comparison of 90-day Cardiac Causes Readmission Rate

Regarding the 90-day cardiac causes readmission rate, the intervention group had a lower readmission rate than the control group, but this difference was not statistically significant. Despite the lack of statistical significance, this result alludes to a substantial impact of CCRP on the 90-day readmission rate. Considering the burden of readmission on patients and healthcare systems, this impact holds significant clinical benefits (42).

Reducing the readmission rate is a critical issue in the clinical setting, as readmission rate is considered a performance indicator for several healthcare outcomes such as quality of care, patient satisfaction, resource utilization, and coordination between various healthcare providers (43, 44). The present study's findings demonstrate the critical role of CCRP in reducing unplanned readmission rates. Therefore, implementing CCRP improves patient health status and enhances healthcare systems' efficiency.

3. Conclusion

Comprehensive CR appeared to be an effective intervention that could significantly improve anxiety, depression, and perceived health status. Although the difference in the readmission rate for 90-day cardiac causes was not statistically significant, it may result in substantial rewards for patients and healthcare systems.

Research Implications

This study offers valuable insights for decision-makers in the field of cardiac care in Jordan and the region, highlighting the benefits of CCRP for CABG patients. CCRP advances postoperative outcomes by supporting medical and surgical treatment, lowering readmission rates, decreasing resource utilization, and improving overall quality of care. This cost-effective program is helpful for patients, families, and healthcare professionals alike. Key findings reveal CCRP's positive effect on both physical and psychosocial outcomes, addressing gaps in the current literature. The present study recommends expanding research to Phase III CCRPs and

examining their long-term impact, as well as exploring cardiac-related readmissions through RCTs. Optimized learning and tailored CCRPs are imperative for healthcare professionals, particularly nurses, to refine patient understanding of risk factors and encourage adherence to healthy lifestyles. This study comprises recommendations, guidelines, and educational materials from key cardiovascular organizations to aid in program implementation.

Limitations

The results of the present study should be interpreted with caution, due to some limitations that may have been encountered. Firstly, although the blindness between providers and participants is recommended in RCTs, complete blindness is typically impossible in rehabilitation studies because healthcare providers are in direct contact with the participants. The lack of blinding could influence participants' behaviour and responses. Secondly, this study relied on self-reporting outcomes questionnaires, vulnerable to social desirability bias and under- or over-estimation of actual behaviours. However, validated tools can reduce the effect of such potential bias. Thirdly, the results of this study may not be suitable for generalization to illiterate patients who have difficulty accessing readable materials.

Recommendations for Practice and Research

Healthcare systems are highly encouraged to establish CCRPs, which should be structured and tailored according to patients' needs, considering clinical and sociodemographic characteristics. Additionally, healthcare systems are recommended to develop policies for discharge that include health education and focus treatment, particularly for high-risk patients, utilizing evidenced-based practice in guidelines and universal predictive models such as the Charleson Comorbidity Index Score.

Tracking and monitoring systems can be implemented to monitor patients outside the healthcare setting and elicit feedback. This will encourage patients' commitment to a healthy lifestyle and detect complications before further deterioration. Moreover, utilizing social media is a practical and widely accessed method of distributing information and increasing patient awareness.

Furthermore, it is recommended that studies investigate the impact of CCRP on physiological indicators such as cardiac biomarkers and echocardiographic parameters among patients after CABG, as such outcomes objectively measure program effectiveness and can provide a clearer image of their outcomes.

Ethical Considerations

This study was approved by the Ethics Committee of Prince Hamzah Hospital (Code: 3308/RESEARCH/HH) and it was registered at the ClinicalTrials.gov PRS (Code: ID: NCT06118918) _

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Conflict of interest

The authors declare no conflict of interest.

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Authors' contributions
All authors equally contributed to preparing this study.

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