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Cardiac Rehabilitation and Psychological Symptoms in Patients Undergoing Coronary Artery Bypass Graft Surgery: A Randomized Clinical Trial

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Abstract

Background: Coronary artery bypass graft (CABG) surgery significantly affects both the physical and psychological well-being of patients. It is essential to address the psychological symptoms which may arise during recovery in order to improve overall health outcomes. Cardiac rehabilitation programs can enhance psychological well-being and improve recovery process for these patients.

Aim: This study was conducted with aim to investigate the effect of cardiac rehabilitation on improving psychological symptoms in patients undergoing CABG.

Method: This randomized clinical trial study was performed on 60 patients referred to a specialized hospital of cardiovascular diseases in Hamadan from April to December 2021. The participants were divided into intervention and control groups using the permuted block randomization method. Along with the routine care after CABG surgery, the intervention group also received physical exercise and physiotherapy for heart rehabilitation. The exercises were tailored to each patient's cardiovascular condition and included walking on a treadmill, using a stationary bike, and doing aerobics and stretching exercises. The 60-minute sessions were held three times a week for one month. Data was collected using the SCL-90-R and analyzed by SPSS software (version 16). $p<0.05$ was considered significant.

Results: At the beginning of the program, the mean psychological indices score in the intervention and control groups was 182.1±14.9 and 196.5±25.1, respectively ($p=0.503$). After the intervention implementation, the mean psychological score was 113.7±14.9 and 272.2±32.0 in the intervention and control groups, respectively ($p<0.001$).

Implications for Practice: This study demonstrated that cardiac rehabilitation following CABG positively impacts patients' psychological symptoms.

Keywords: Coronary Artery Bypass Graft, Cardiac rehabilitation, Mental health, Psychological symptoms

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Introduction

Cardiovascular diseases are the most common cause of death and the most important cause of disability worldwide (1). Despite the significant progress in diagnostic and treatment methods in recent decades, acute myocardial infarction remains a major global health issue in industrialized and developing countries. Still, one-third of the individuals who suffer from acute myocardial infarction die, and half of these people die in the first hour and before reaching the hospital (2). In other words, half of the fatalities caused by cardiovascular diseases occur directly due to atherosclerotic involvement of coronary arteries (3), which is treated through elective or emergency coronary artery bypass graft (CABG) surgery (4). CABG, like any other surgery, is very stressful for patients. Anxiety is the most common mood disorder in the population with a lifetime prevalence of over 15%, which leads to depression (5,6). Anxiety and depression have harmful effects on social functioning, quality of life, and daily activities in cardiac patients (5). These disorders causes defects in adaptation mechanisms, ability to adapt to lifestyle changes, and following the treatment and drug regimen. Therefore, it can increase the pain caused by angina pectoris (7). Furthermore, mortality and fatal cardiac events occur more frequently in the cardiac patients with anxiety symptoms (8). Therefore, it is essential to perform necessary intervention after surgery to reduce psychological complications and improve the quality of life in these patients.

One of the most important care measures in the patients undergoing CABG is the implementation of an exercise-based rehabilitation program, which is carried out at different stages after the surgery (1). This program is a set of individual and group trainings and physical activities with aim to improve the quality of life, return to pre-disease lifestyle, improve psycho-social status, and prevent cardiac events. In other words, the ultimate goal of cardiac rehabilitation is to restore and maintain the patient's optimal physiological, psychosocial, and occupational status (9, 10). The cardiac rehabilitation program, which is held with the presence of a treatment team consisting of cardiology, rehabilitation, nursing, physiotherapy, nutrition, and psychology specialists, provides the opportunity to comprehensively evaluate patients, emphasizing mental health dimensions (11). Several tests have been designed to evaluate the mental health of the patients undergoing CABG, the most widely used of which is the Mental Disorders Symptom Checklist-90-Revised (SCL-90-R), which is a self-report questionnaire for screening and measuring the symptoms of mental disorders (12).

The findings of a meta-analysis study in 2023, reviewing 85 RCT studies and including 23,430 participants, showed that the quality of life has significantly improved in the patients participating in exercise-based cardiac rehabilitation programs. In addition, a significant reduction was observed in the rate of myocardial infarction (Risk Ratio (RR): 0.82), mortality (RR: 0.74), and prehospitalization (RR: 0.77) (13). Moreover, a systematic review reported that the cardiac rehabilitation program has a positive effect on managing anxiety and reducing depression in patients with myocardial infarction (14). Additionally, the results of another meta-analysis (15), which examined 63 studies involving a total of 14,486 participants with Coronary heart disease, indicated that the rehabilitation program following heart surgery reduces both mortality rates and re-hospitalization.

Cardiovascular diseases are one of the leading causes of death and disability worldwide, and research indicates that CABG is associated with numerous psychological issues. The positive outcomes of cardiac rehabilitation programs in improving the quality of life for patients after CABG and reducing cardiac event rates have been well established, however, there is still limited studies specifically examining the impact of these programs on reduction of psychological symptoms in patients undergoing CABG. Preliminary evidence suggests that effective management of psychological issues can lead to better recovery outcomes; however, there is still a need for more thorough evaluations to determine the efficacy of cardiac rehabilitation programs in alleviating these symptoms. Considering the special role of mental health in improving the heart condition after CABG, and the high importance of cardiac rehabilitation courses emphasizing mental health maintenance, the present study was conducted with aim to determine the effect of cardiac rehabilitation on improving mental indicators in patients undergoing CABG in Farshchian Heart Hospital, Hamadan.

Methods

This randomized clinical trial study was conduced on the patients undergoing CABG in the greatest cardiovascular disease specialty and subspecialty center in Hamadan, Iran, from April to December 2021. Patients in the rehabilitation phase referred to the hospital's rehabilitation department as

outpatients were recruited in this study. To determine the sample size, an online calculator (https://clincalc.com/stats/samplesize.aspx) was used. Although Bahari et al.'s study (16) involved a different population and healthy individuals, the statistical characteristics (mean and standard deviation) of the mental health scores were deemed suitable for estimating the sample size needed to achieve the desired power and confidence levels in this study. In their study, the average level of mental health in the intervention group was 109.20±45.20, while in the control group, it was 145.40±32.80. To ensure accurate statistical analysis, with a test power of 90% and a confidence coefficient of 95%, 25 participants were estimated in each group. Considering the possible dropout rate of 20%, the sample size was increased to 32 participants in each group. However, four individuals were excluded because they did not meet the inclusion criteria or declined to participate. Thus, 30 patients were assigned to each group.

The participants included CABG patients who had undergone surgery approximately 10 to 12 weeks earlier and had been referred to the outpatient rehabilitation department. Randomization was done through permuted block randomization method. The samples were assigned into intervention and control groups using randomly varying block sizes. To avoid bias and allocation concealment, a random sequence of two, four, and six numbers was created using a computer (17), which was coded. Therefore, the moderator was completely unaware of the process of sample randomization. In general, 60 patients were selected. Two patients withdrew participation in the study process and a participant did not meet the inclusion criteria (Figure 1).

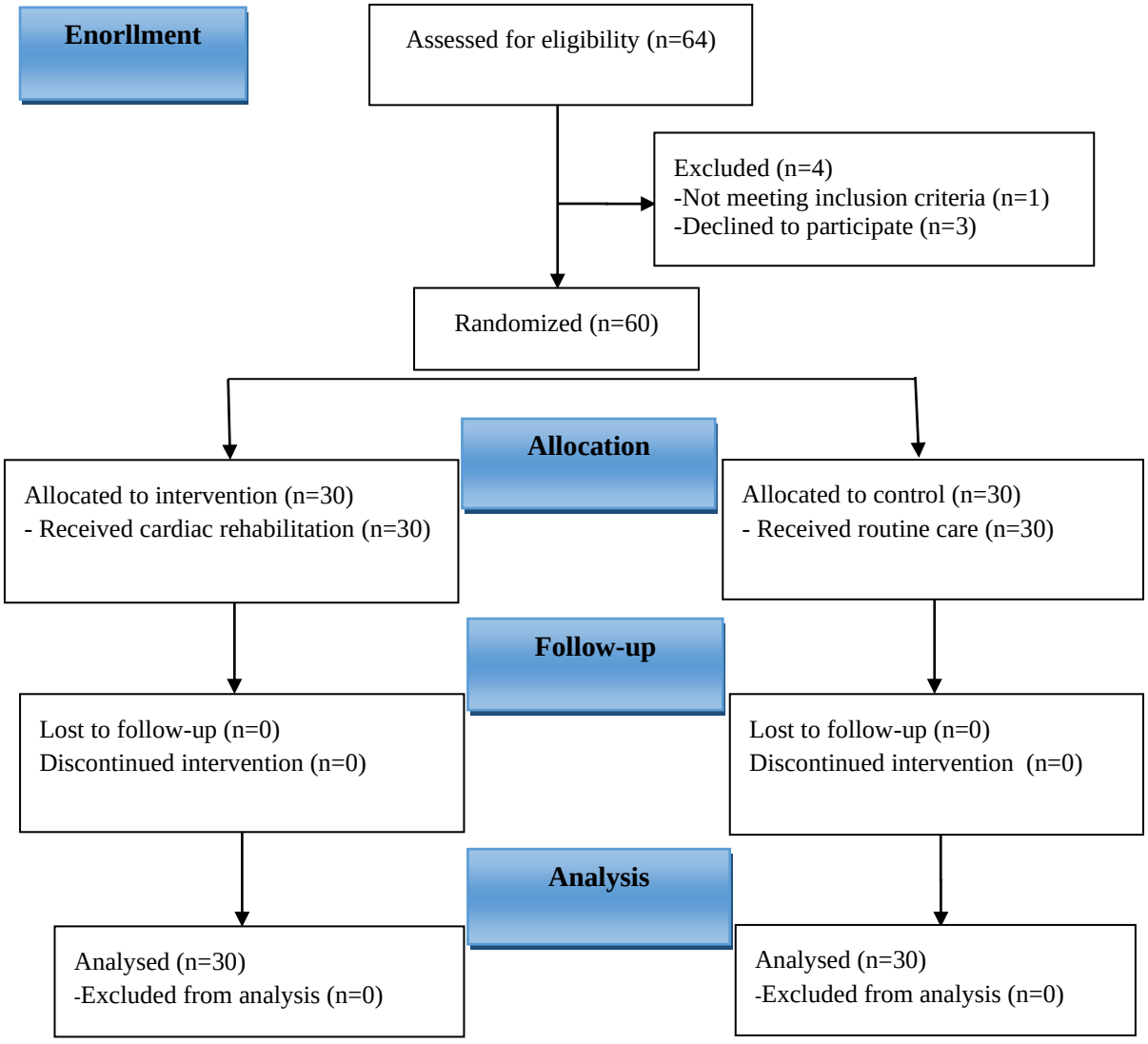

Figure 1. Flowchart of the effect of cardiac rehabilitation on improving psychological symptoms in patients undergoing CABG

The inclusion criteria consisted of patients aged 40-70 years old, with a history of CABG, ability to read and perceive sufficiently in order to use educational materials, and ability to exercise and participate in all the sessions. The ability to participate in this program was evaluated by specialists, including cardiologists and sports medicine specialists. The individuals with a history of CABG along with other actions such as valve replacement, taking sedative and anti-anxiety drugs were excluded from the study if they missed even one session of the training course.

Before designing this research, the rehabilitation program was conducted in this hospital with less discipline and coherence. However, after reviewing the available scientific resources and analyzing the strengths and weaknesses of the previous program, during numerous meetings and receiving expert opinions, the research team and the cardiac rehabilitation team finally reached a consensus to reorganize and re-plan it. Thus, an educational program and content was developed by a physical medicine specialist, a sports rehabilitation specialist, a physiotherapist, a nurse holding a Master's degree, a specialist in psychology, and a nutritionist, using available reliable sources.

For the proper implementation of the rehabilitation program, the first author participated in the relevant training workshop, obtained the certificate of competence for implementation of this care technique, and was one of the main members of the post-surgery patient rehabilitation and treatment counseling group at the hospital. After obtaining the permission and the introduction letter, and coordinating with the hospital officials, the researcher visited the study center. While introducing himself to the study units, he provided the participants with explanations regarding the study objectives, the research method, and the duration of applying the intervention. Moreover, the research units were assured of voluntary participation and data confidentiality, and written informed consents were obtained.

The cardiac rehabilitation program was implemented 3 times a week for one month, and each session lasted for about 60 minutes. This program included examining the health status, lifestyle modification training, and exercising, as follows:

-Checking the health status: At first, the preliminary examination was done by a specialist in order to check the patient's physical strength and limitations. While doing the examination, attention was paid to the cardiovascular risk factors during the exercise in order to make sure that the actions would cause no threat to the patient's cardiovascular system, besides improving his/her activity level. A psychologist with a PhD degree was also present to examine the patient's mental state, depression and anxiety symptoms, sleep disorders, self-confidence, and return to social-occupational activities. Thus, the patients were provided with emotional and psychological support.

-Educational program: Specific content for lifestyle and nutrition modification, such as having a healthy diet, proper exercise, proper weight, no smoking or opium consumption, and quitting smoking was taught by a nurse and a nutritionist through lectures, educational videos, and pamphlets. The contents were provided to the participants at the beginning of the first, second, and third rehabilitation sessions (during the first week of the intervention). In order to know if the contents had been perceived by the participants, they were asked every session. Moreover, the participants were also requested to ask any questions they had about the contents.

-Exercise: Considering the patient's condition, a low-intensity exercise program with the least possible harm, such as cycling, walking on a treadmill, aerobic and stretching exercises, or a combination of them, was prescribed. The care team also taught the patient the correct exercise program, and how to warm up and cool down. While exercising, changes in the patient's heart rate, blood pressure, and ECG were monitored by the rehabilitation team.

After assigning the research units into two groups, the questionnaires were completed by the participants, once before the intervention and once at the end of the study. The control group received routine care, and at the end of the study, they also received the educational content provided to the intervention group. The primary outcome was status of mental health in the patients undergoing CABG surgery. Data collection tools consisted of the demographic and clinical data questionnaire and Symptom Checklist-90-Revised.

The demographic and clinical data questionnaire included age, gender, marital status, education, occupation, smoking, income level, and opium use.

The Symptom Checklist-90-Revised is a self-report questionnaire including 90 questions to measure

the physical and mental conditions that the respondents have recently experienced. In 1973, Derogatis, Lipman, and Covi made changes in the grading and implementation methods. In Iran, the questionnaire has undergone psychometric evaluation by Najjarian and Davoudi (18). Exploratory Factor Analysis was conducted to examine the construct validity of the questionnaire; the Cronbach's alpha of 0.97, and the stability reliability of 0.78 were reported (18). This questionnaire includes nine dimensions of somatization (12 questions), obsessive-compulsive (10 questions), interpersonal sensitivity (9 questions), depression (13 questions), anxiety (10 questions), hostility (6 questions), phobic (7 questions), paranoid thinking (6 questions), psychoticism (10 questions), and additional questions (7 questions). The responses given to each of the test items are determined on a 5-point scale of discomfort, ranging from (none) to (severe). To interpret the obtained result, the total score of each dimension should be divided by the number of questions, with a higher score indicating a better status. In the present study, ten faculty members, who were experts in designing questionnaires, performed the qualitative content analysis. The reliability of the questionnaire was evaluated through measuring the internal consistency, and the Cronbach's alpha was 0.81.

The self-report questionnaires were provided to the participants in both group and they were asked to complete the questionnaires before and after the intervention. To ensure randomization, a blind researcher scored the questionnaires. Additionally, participants were encouraged to reach out to the researchers if they had any questions.

The data were analyzed by SPSS software (version 16) and Pearson's chi-square test, independent and dependent t-test, and Fisher Exact test. The Mann-Whitney U test was used for nonparametric data. $p<0.05$ was considered to be significant.

Table 1: Comparison of demographic and clinical variables in two study groups

Variable	Control (n=30) N (%)	Intervention (n=30) N (%)	Statistics	*p*-value
Gender				
Male	18 (60.0)	18 (60.0)	<0.001	1.00*
Female	12 (40.0)	12 (40.0)		
Marital status				
Married	22 (73.3)	18 (60.0)	1.200	0.273*
Single, other	8 (26.7)	12 (40.0)		
Education				
Diploma and less	21 (70.0)	23 (76.7)	0.340	0.559*
University	9 (30.0)	7 (23.3)		
Job				
Housewife	10 (33.3)	9 (30.0)	4.183	0.123*
Employee and retired	12 (40.0)	6 (20.0)		
Unemployed, freelance job	8 (26.7)	15 (50.0)		
Smoking				
Yes	19 (63.3)	12 (40.0)	3.270	0.071*
No	11 (36.7)	18 (60.0)		
Income				
Sufficient	13 (43.3)	10 (33.3)	0.634	0.426*
Insufficient	17 (56.7)	20 (66.7)		
Opium consumption				
Yes	17 (56.7)	12 (40.0)	1.688	0.196*
No	13 (43.3)	18 (60.0)		
Age (year)				
≤50	6 (20.0)	4 (13.3)	0.365	0.731*
>50	24 (80.0)	26 (86.7)		
Surgery type				
Emergency	14 (46.7)	12 (40.0)	0.271	0.602*
Elective	16 (53.3)	18 (60.0)		
Duration of surgery (min) (Mean±SD)	167.3±42.1	179.7±44.9	-1.096	0.277**
Length of hospitalization (days) (Mean±SD)	6.6±1.8	7.3±1.8	-1.407	0.164**

*Chi-square test; **t-test

Ethical Consideration

The study was approved by the Ethics Committee of Hamadan University of Medical Sciences (ethical code: IR.UMSHA.REC.1399.564) and registered in the Iranian Registry of Clinical Trials (IRCT20120215009014N389). All methods were performed in accordance with Helsinki declaration.

Results

The findings of Chi-square test or Fisher's exact test showed no statistically significant difference between the two groups in terms of demographic and clinical variables (p>0.05) (Table 1).

Table 2: Comparison of the mean scores of psychological indices between the intervention and control groups

Dimension	Group / Time	Control Mean±SD	Intervention Mean±SD	Mann-Whitney U Test U	Mann-Whitney U Test *p*-value	ANCOVA
Hostility	Pre-intervention	16.2±4.3	15.5±2.2	1.528	0.126	
	Post-intervention	17.6±2.6	11.6±3.6	5.342	0.001	p< 0.001
Anxiety	Pre-intervention	23.4±9.7	19.6±10.9	1.327	0.184	
	Post-intervention	25.4±5.5	11.0±6.3	5.873	0.001	p< 0.001
Obsessive-compulsive	Pre-intervention	22.3±9.2	19.4±8.9	0.940	0.347	
	Post-intervention	27.7±5.7	11.7±3.4	6.448	0.001	p< 0.001
Interpersonal sensitivity	Pre-intervention	19.7±7.4	17.1±8.6	0.808	0.419	
	Post-intervention	25.7±5.1	10.8±3.1	6.555	0.001	p< 0.001
Somatization	Pre-intervention	26.6±11.3	21.3±13.1	1.367	0.171	
	Post-intervention	33.9±7.3	11.8±4.3	6.397	0.001	p< 0.001
Psychoticism	Pre-intervention	20.2±10.3	19.0±11.2	- 0.030	0.976	
	Post-intervention	27.9±10.4	11.2±3.7	5.557	0.001	p< 0.001
Paranoid thinking	Pre-intervention	13.7±6.2	11.8±71	0.765	0.444	
	Post-intervention	17.2±4.5	7.4±4.0	5.738	0.001	p< 0.001
Depression	Pre-intervention	26.8±14.8	21.1±16.4	0.955	0.339	
	Post-intervention	36.2±11.5	11.8±7.0	5.992	0.001	p< 0.001
Phobic	Pre-intervention	18.7±5.4	15.2±10.3	1.311	0.190	
	Post-intervention	23.3±5.8	10.0±7.1	5.609	0.001	p< 0.001
Additional items	Pre-intervention	15.4±7.4	12.4±7.6	1.548	0.121	
	Post-intervention	20.1±4.8	8.9±3.7	6.080	0.001	p< 0.001

At the beginning of the program, the mean psychological indices score in the intervention and control groups was 182.1±14.9 and 196.5±25.1, respectively (p=0.503). Also, there were no significant differences between the two groups in psychological indices scores and its different dimensions (p>0.05) (Table 2). After the intervention, the mean psychological indices score was 113.7±14.9 and 272.2±32.0 in the intervention and control groups, respectively (p<0.001). The independent t-test showed that after the intervention, the mean scores of all psychological symptom evaluation sub-scales were significantly lower in the intervention group compared to the control group (p<0.05) (Table 3).

Table 3: Comparison of the mean scores of psychological indices of patients before and after the cardiac rehabilitation in the intervention and control groups

Groups		Psychological indices (Mean±SD) Pre-intervention	Psychological indices (Mean±SD) Post-intervention	Analysis of changes	Paired t-test Statistics	Paired t-test *p*-value
Control		196.5± 25.1	272.2±32.0	-75.7±36.2	-11.461	<0.001
Intervention		182.1±14.9	113.7± 14.9	68.4±14.91	10.175	<0.001
Independent t-test	**t**	1.998	24.595	14.366	-	
	***p*-value**	0.503	<0.001	<0.001		

Discussion

The purpose of the present study was to investigate the effect of the cardiac rehabilitation program on improving the mental indicators based on the SCL-90 scale in the patients undergoing coronary artery bypass graft surgery. The findings indicated that there was no statistically significant difference between the two groups in terms of demographic and clinical variables, surgery type, and duration and length of hospital stay. Moreover, before the intervention, the participants' mean scores of SCL-90 mental indicators were not different in the two groups, which led to more accurate results, better investigation of the changes related to the effect of the cardiac rehabilitation program, and greater generalizability.

According to the findings of this study, the one-month rehabilitation program -three times a week, 60 minutes per session- reduces the mean score of mental indices including somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic, paranoid thinking, and psychoticism. Based on the previous evidence, rehabilitation exercises after heart surgery play the role of a secondary prevention program which improves the mental status and increases heart health in patients (19). In coronary artery bypass graft surgery, patients bear more stress in comparison with other surgeries, and anxiety and depression are among the most important and prevalent disorders in these patients (20). The existence of ongoing depression significantly affects patients' involvement in cardiac rehabilitation and lifestyle changes following CABG surgery. Additionally, chronic anxiety can be severely debilitating, potentially hindering the recovery process even further.

Many studies have investigated the effect of cardiac rehabilitation on mental indicators. A systematic review and meta-analysis investigated the effect of the exercise-based cardiac rehabilitation program on reducing the mental symptoms caused by Myocardial Infarction (MI). Further analysis in the subgroup of the patients with AMI and CABG showed that the exercise-based rehabilitation program led to a reduction in anxiety symptoms. In addition, carrying out the exercise-based rehabilitation program in different time periods significantly reduced the symptoms of depression (14). The first psychological response in the patients with ischemic heart disease is anxiety, followed by depression symptoms (21). The level of depression in these patients is closely related to the survival rate, and can severely overshadow the quality of life in these individuals. Moreover, the prognosis of the patients with depression and psychological symptoms lasting more than six months is very frustrating.

Other studies also underscore the significant mental health benefits of cardiac rehabilitation programs for patients following coronary artery bypass graft (CABG) surgery (19, 22). Pourafkari et al. demonstrated that participation in an eight-week rehabilitation program effectively reduces anxiety and depression levels in CABG patients, suggesting that structured physical activity can play a crucial role in psychological recovery after heart surgery (19). Additionally, Milani et al. contributed to the discourse by linking cardiac rehabilitation not only to a decrease in depressive symptoms but also to a reduction in mortality associated with cardiovascular diseases (22). This finding is particularly noteworthy, as it indicates that the positive effects of rehabilitation may extend beyond psychological welfare to tangible improvements in patient survival rates. Furthermore, the suggestion that these benefits can be achieved without the necessity for vigorous physical exercise opens the door for more inclusive rehabilitation approaches, making cardiac rehabilitation accessible to a broader range of patients, including those who may be less physically capable. Overall, these findings reinforce the importance of integrating mental health considerations into cardiac care, highlighting the potential of rehabilitation programs as a multifaceted intervention that addresses both psychological and physical health in patients recovering from CABG.

Sharif et al. (23) presented different results compared to other studies and highlighted challenges regarding the effectiveness of cardiac rehabilitation programs. In their study, which involved 80 patients undergoing coronary artery bypass graft (CABG), half of the participants underwent a rehabilitation program for four weeks, while the control group received only standard care. Using the Spielberger Anxiety Scale to measure anxiety levels and Beck's Depression Inventory for assessing depression, cardiac rehabilitation was effective on reducing depression two months post-surgery. However, the intervention did not significantly impact the participants' anxiety scores that was not in accordance with the results of the current study. This discrepancy in the results could be attributed to various factors, including differences in intervention duration, sample size, type of intervention, intervening variables, and the tools used for outcome assessment. This underscores the importance of thoroughly examining the various factors influencing therapeutic outcomes in different studies.

Notably, it suggests that the effects of rehabilitation programs may be heavily influenced by the specific characteristics, emphasizing the need for standardized and integrated methods in evaluating outcomes. Such approaches could facilitate a better understanding of the strengths and limitations of cardiac rehabilitation programs, leading to more effective interventions tailored to patients' needs.

In the present study, the results showed that at the end of the study, the mean scores of the anxiety and depression dimensions related to SCL-90 mental indicators increased in the control group, who had not received any exercise-based rehabilitation programs. On the contrary, the reduction in the mean scores of these two dimensions after the implementation of the intervention in the intervention group is a clear proof of the noticeable impact of the exercise-based rehabilitation program. Therefore, considering the high prevalence of mental symptoms in these patients and their adverse effects on recovery and survival rates, it is necessary to start and follow up exercise-based rehabilitation courses. In other words, the rehabilitation course plays a key role in improving patients' mental health, which subsequently reduces cardiovascular risk factors and enhances clinical parameters (24).

Numerous studies have demonstrated the beneficial effects of rehabilitation following heart surgery (1, 25). Furthermore, most research indicates that the quality of life for at least in one dimension improves after the implementation of a rehabilitation program. This improvement is closely linked to the alleviation of mental health disorders and the reduction of anxiety and depression symptoms often experienced following a heart attack and subsequent surgery (15).

Additionally, evidence suggests that effective rehabilitation and management of psychiatric disorders in patients undergoing coronary artery bypass graft (CABG) can significantly enhance their overall prognosis (23). However, the approach to treating psychiatric disorders post-cardiac events remains a topic of ongoing debate. Interventions such as consultations with psychiatrists or psychologists, initiation of antidepressant therapy, utilization of statins, and participation in individual or group exercises have all demonstrated positive outcomes. This highlights the need for a multifaceted treatment strategy that addresses both the psychological and physical dimensions of recovery, ultimately fostering better health outcomes and improved quality of life in these patients.

Although this study has limitations due to its relatively small sample size and the presence of some confounding variables outside the researcher's control, the knowledge gained can help improve the psychological symptoms of patients undergoing CABG surgery. In addition, the strength of this study lies in its randomized controlled trial design with a pre-test and post-test. It is recommended to investigate the impact of cardiac rehabilitation program on other psychological symptoms in patients using a larger sample size and to explore additional mental health care techniques in future studies.

Implications for practice

The results of the present study highlight that the cardiac rehabilitation program after CABG surgery improves cardiovascular symptoms, mental status and the psychiatric symptoms in patients undergoing CABG.

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Conflicts of interest

The authors declare that they have no competing interests.

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Authors' Contributions

Ali Akbari and Mohadese Babaie were responsible for designing and reviewing the study. Samira Yadollahifar prepared the ethics submission, while Ali Akbari, Ghasem Sadeghi, Samira Yadollahifar, and Mohammad Ali Jervani were in charge of data collecting. Moreover, Ali Akbari and Samira Yadollahifar taught cardiac rehabilitation, and Mohadese Babaie supervised all aspects of the study's implementation. Finally, all authors reviewed and revised the draft and approved the final manuscript.

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