Randomized controlled evaluation shows the effectiveness of a home-based cardiac rehabilitation program

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ABSTRACT

الأهداف: تقييم تأثير برامج إعادة التأهيل القلبي المنزلي على مرضى القلب بعد العمليات الجراحية للشرايين.

الطريقة: أُجريت هذه الدراسة العشوائية في مستشفى الملك فهد للقوات المسلحة، جدة، المملكة العربية السعودية خلال الفترة من يونيو 2008م إلى يناير 2010م. لقد تم توزيع 49 مشارك بصورة عشوائية إما إلى مجموعة الشاهد (الرعاية المعتادة الطبية، العدد: 21)، أو مجموعة الدراسة (إعادة التأهيل القلبي المنزلي، العدد: 28). وبعد ذلك جُمعت البيانات قبل الخروج من المستشفى (القياس القبلي) وكرر تحليل البيانات بعد 6 أشهر من الخروج من المستشفى (القياس البعدي).

النتائج: أشارت نتائج الدراسة إلى عدم وجود فروق ذات دلالة إحصائية بين المجموعتين في مؤشر كتلة الجسم، و ديناميكية الدم، ومستويات الدهون، وطبيعة الحياة ($p>0.05$)، مع وجود اختلافات في المجهود البدني، والقلق والاكتئاب ($p<0.05$) في القياس القبلي. أما في القياس البعدي فقد أظهرت مجموعة الدراسة تحسناً ملحوظاً في العوامل ذات الصلة بالصحة والحياة، والبعد عن العوامل المسببة لمرض القلب مقارنةً بمجموعة الشاهد، مع اختلافات كبيرة في مستوى السكر في الدم، والدهون الثلاثية، والكولسترول مرتفع الكثافة، والمجهود البدني، وطبيعة الحياة، والقلق والاكتئاب ($p<0.05$). وأظهرت مجموعة الدراسة أيضاً تحسناً ملحوظاً في طبيعة الحياة، والقلق والاكتئاب، ومؤشر كتلة الجسم، ومعدل ضربات القلب، والكولسترول مرتفع الكثافة، والمجهود البدني ($p<0.05$)، في حين لوحظ تحسناً ملحوظاً في مجموعة الشاهد وذلك فيما يخص معدل ضربات القلب، وطبيعة الحياة، والمجهود البدني ($p<0.05$).

خاتمة: أثبتت هذه الدراسة بأن برنامج إعادة التأهيل القلبي المنزلي يحسن حياة مرضى القلب بعد عمليات القلب الجراحية، كما يساعد على إبعاد مرضى القلب من العوامل المسببة لمرض القلب إلى حد أكبر من الرعاية الصحية المعتادة في المستشفيات.

Objectives: To evaluate the effectiveness of a home-based cardiac rehabilitation (CR) program on post-coronary arteries bypass graft patients.

Methods: This is a randomized study conducted in King Fahd Armed Forces Hospital, Jeddah, Kingdom of Saudi Arabia between June 2008 and January 2010. Forty-nine participants were randomized to either a control group (standard hospital treatment, n=21) or an intervention group (home-based CR, n=28). Data were collected before hospital discharge (baseline test) and repeated 6 months after hospital discharge (follow-up test).

Results: There were no significant differences between the groups in the body mass index, hemodynamics, serum fasting lipid profile, and Quality of Life questionnaire (QoL) ($p>0.05$), with differences in physical function and Hospital Anxiety and Depression Scales (HADS) ($p<0.05$) at the baseline test. At the follow-up test, the intervention group showed greater improvement in health-related QoL and risk factors compared to the control group, with significant differences in fasting blood glucose, triglycerides, high density lipoprotein cholesterol, physical function, and both QoL and HADS questionnaires ($p<0.05$). The intervention group also demonstrated significant improvements in QoL, HADS, body mass index, heart rate, high density lipoprotein cholesterol and physical function ($p<0.05$), while significant differences were observed in the control group in heart rate, QoL and physical function ($p<0.05$).

Conclusion: The home-based CR program improves health-related QoL and risk factor profiles for patients following coronary arteries bypass graft to greater extent than the standard hospital care.

According to the World Health Organization, cardiac rehabilitation (CR) is defined as including "all measures aimed at reducing the impact of disability for an individual, enabling him or her to achieve independence, social integration, a better quality of life (QoL) and self actualization".[1] Evidence supporting the effectiveness of CR programs for post-cardiac events patients.[2-4] However, many cardiac centers in the Kingdom of Saudi Arabia (KSA) are still slow to start CR programs for post-cardiac events patients. Comprehensive CR programs require a multifactorial approach that offer monitored exercise, medical evaluation, psychological adjustment, counselling and health education for post-cardiac events patients and their families, which involve specialist health professionals.[5] The comprehensive hospital-based CR programs with highly qualified healthcare providers, costly equipment, and spaces to run the programs may not benefit many post-cardiac events patients who fail to take part and limitations of the programs have been identified, some of which included elderly, females, limited social support, financial resources, lack of transportation, and medical issues.[6-8] However, home-based CR programs with fewer requirements have been found almost as effective as the hospital-based CR programs for low and moderate risk post-cardiac events patients.[9-11] A systematic review of randomized controlled trials of home-based CR compared to hospital-based CR in patients with acute myocardial infarction, angina and/or heart failure found no significant difference in terms of mortality, cardiac events, exercise capacity, modifiable risk factors, total cholesterol, low-density lipoprotein, health-related QoL, with the exception of high-density lipoprotein at follow-up or relative risk for proportion of smokers.[12] Another study found that myocardial infarction participants in a home-based CR program reported a significant improvement in the terms of angina and daily activities compared with a standard hospital care.[13] Therefore, the aim of this study was to assess the effectiveness of a new strategy of home-based CR program on post-coronary arteries bypass graft surgery patients' health-related QoL, psychological well-being, physical activity, risk factors, and re-hospitalization.

Methods. *Setting and recruitment.* Following consultation with a statistician in respect with the sample size, between 8 June 2008 to 3 January 2010, forty-nine male participants were recruited from patients who had initially been admitted at the Cardiac Surgery Department at King Fahd Armed Forces Hospital in KSA, for coronary arteries bypass graft (CABG) surgery. Patients who consented to participate in the study, were randomly assigned to either an intervention group (home-based CR n=28) or a control group (standard hospital care n=21). Patients with history of ejection fraction less than 30%, poor mobility leading to difficulty in walking, chronic atrial fibrillation, repeat CABG or implantable pacemaker were excluded from the study.

Ethical approval was obtained from the King Fahd Armed Forces Hospital, Jeddah, KSA and accepted by the University of Chester, United Kingdom as being in compliance with the requirements of the Helsinki Declaration.

Study procedures. In the intervention group, 28 patients participated and received 3 additional interventions: pre-CABG, immediately post-CABG, and home-based CR program. Twenty-four to forty-eight hours prior to CABG surgery, participants and their families were invited to the pre-CABG one-hour education talk which included: understanding blood circulation, coronary artery disease (CAD) and CABG; modifiable and non-modifiable risk factors; patients' condition in the cardiac intensive care unit and cardiac ward; preparing the patient for using the incentive spirometry and post-CABG program. All pre-CABG participants were also able to meet a patient who had already undergone CABG surgery. This helped to reduce stress, anxiety and depression for new patients and their families prior to undergoing CABG. The post-CABG program was administered in the cardiac ward, and included a further education session. On day-2 in the cardiac ward, the participants received a one-hour education talk which included: how the heart looks like after CABG; advice on modifiable and non-modifiable risk factors; advice on chest pain, leg pain and sexual activity; change in lifestyle; breathing exercise; active life; and the benefits of a 30-minute daily walk. Whilst in the cardiac ward, the participants also walked daily for 30 minutes. The first walk was with one of the authors, who was present for safety reasons and encouraged them to walk until they either experienced limiting symptoms (namely, chest discomfort, shortness of breath, fatigue, dizziness or leg pain) or finished the performance time. Additionally, before discharge from the hospital, the participants climbed one flight of stairs with one of the authors. They were then asked to walk unaided at a comfortable pace 30 minutes per day until they completed the 6-month home-based CR program. As a part of the home-based CR program, the authors contacted each participant after hospital discharge for 6 months by telephone calls. Typically, a telephone call

was made on day 2 and then followed every 3 weeks such as week 3, week 6, week 9 for 6 months after hospital discharge. The purpose of the 5-10 minutes phone contact was to check participant's progress, to support them, to follow their walking program and to encourage them to walk briskly. Four weeks after hospital discharge, participants and their families were invited to attend a food management education session conducted by the dietetics department. Two months after hospital discharge, participants and their families invited to attend one-hour group workshop which included: advice on modifiable and non-modifiable risk factors, change of lifestyle, active life, stress and then discussed participant's problems and feeling during the past 2-month. This group workshop was repeated 4-months and 6-months after hospital discharge.

In the control group, 21 patients participated and received standard hospital care, which included: regular advice from their doctors and followed usual hospital instructions. During hospital stay, participants received advice that focused on medications, washing, some physical activities such as walking in the cardiac word and gave the participants a diet sheet. This group followed the usual hospital care and did not receive rehabilitation program or telephone calls by the authors.

Data were collected before hospital discharge (baseline test) and repeated 6 months after hospital discharge (follow-up test) for both groups. The QoL and psychological well-being questionnaires, participants' risk factors, the physical function, and re-hospitalization were assessed at baseline test and follow-up test.

Outcome variables. Quality of life was measured by a 36-item Short Form (SF-36 version 1). This is a short questionnaire with 36 questions, to achieve representation of multi-dimensional health concepts measuring operational definitions of health, distress and well-being. It is also designed to evaluate medical outcomes and to reflect changes in health-related QoL associated with changes in disease severity.[14] The SF-36 includes 8 independent scales: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, and mental health. For each scale, the SF-36 is scored as a number between 0 (worst) and 100 (best). Psychological well-being was measured by the Hospital Anxiety and Depression Scale (HADS). The HADS is a 14-items questionnaires that includes 7 questions to measure anxiety (HADS-A) and 7 questions to measure depression (HADS-D).[15] For each group of 7 items, subjects were provided with a 4-option scale (scored 3-0) and asked to choose one that most closely represents their feeling such as 3 = extensive experience with situation to 0 = no experience with situation, with 6 reversed items. The 2 subscales have been found to be independent measures and

responses relate to feelings in the past week only. In its current form, the HADS is interpreted into: normal case (0-7), borderline case (8-10), and definite case for both anxiety and depression ($\geq$11). Both SF-36 and HADS questionnaires were provided to the participants in Arabic and were translated into Arabic by using the Arabic version (copy) from the SF-36 and HADS websites and some minor changes from the authors, which included forward and backward translation by qualified individuals.

Physical function was measured by the well validated 6-minute walk test (6-MWT).[16] Participants were welcomed, introduced to the Cardiac Surgery Department, and informed of the test procedure by one of the authors. Participants were instructed to cover as much ground as possible in 6 minutes and were asked to walk continuously if possible. If necessary, they could slow down or stop, but were instructed to resume walking as soon as they are felt able. No encouragement was given in order to avoid over-exertion in ambitious patients and the difficulty in giving standardized encouragement.

Participants' risk factors were included that hemodynamics profile such as resting heart rate and resting blood pressure; serum fasting lipid profile such as fasting blood glucose (FBG), triglycerides (TG), total serum cholesterol, high density lipoprotein cholesterol (HDL) and low density lipoprotein cholesterol (LDL), body mass index (BMI), and smoking habits.

Re-hospitalization data was obtained from either the hospital medical records or participants who were informed that if they re-admitted to another hospital, they should send a copy of the re-admission and discharge report to the authors. In case, participants forgot to inform the authors, they were asked the number of times they had made an unplanned hospital visit, including cardiac related hospital re-admission and visits to the emergency department in the past period since discharge from the hospital.

Statistical analysis. Mean, standard deviation (SD) and 95% confidence intervals (95% CI) for all variables were calculated. Comparison of data was performed by using SPSS Version 18. After exploring the outcome data by using Shapiro-Wilk that confirmed the *p* value in each variable, independent samples T test and paired-samples T test were used for the parametric data and Mann-Whitney U test and Wilcoxon test were used for the non-parametric data. These tests were used to determine if a significant difference existed between the study variables. The level of the significance selected for this data was set at alpha = 0.05, indicating a 5% risk of committing a type I error.

Results. Forty-nine males (aged 45-74 years) agreed to participate in this study. At the baseline test, data were obtained for 28 participants in the intervention group and 21 participants in the control group. At the follow-up test, data were available for 22 participants in the intervention group and 20 participants in the control group. Seven of the participants did not complete the 6 months study period: one participant from control group died 2 weeks after hospital discharge and 6 participants from the intervention group could not complete the study requirements (**Table 1**).

Table 2 summarizes the participant characteristics, illustrating that there were no significant differences between the 2 groups in age and risk factors at baseline ($p>0.05$). At the follow-up test, there were no differences between the 2 groups in BMI, hemodynamics profile, total cholesterol, and LDL ($p>0.05$). However, there were significant differences between the 2 groups in FBG, HDL, and TG.

In addition, 64% of the participants (n=18) in the intervention group and 62% of the participants (n=13) in the control group were ex-smokers after the operation. The ex-smokers were able to quit and remain non-smoking after hospital discharge. However, 33% of the participants in the intervention group (5 out of 15 ex-smokers) and 31% of the participants in the control group (4 out of 13 ex-smokers) returned to smoking within 6-months after hospital discharge.

Table 3 shows that whilst there was no significant difference between the 2 groups in the baseline test of SF-36 (p=0.358), 6-MWT, and HADS (HADS-A and HADS-D) were significantly different in the intervention group ($p<0.05$). This indicated a higher perception of general health in the intervention group compared to the control group, perhaps a reflection of the influence of the additional pre-CABG and post-CABG educational talks. Six months after hospital discharge, the results demonstrated highly significant differences between the

Table 1 - Demographic data and baseline clinical characteristics for the participants in home-based cardiac rehabilitation (intervention group) and standard hospital care (control group).

Demographic data	Intervention group n (%)	Control group n (%)
Participants (all males)	28 (57)	21 (43)
Marital status		
Married x1	25 (89)	18 (86)
Married x2	1 (4)	1 (5)
Single	2 (7)	2 (10)
Education		
University	7 (25)	4 (19)
High school	9 (32)	6 (29)
Intermediate school	12 (43)	11 (52)
Occupation		
Retired	13 (46)	12 (57)
Employed	12 (43)	7 (33)
Self-employed	3 (11)	2 (10)
Health status		
Ex-smokers	18 (64)	13 (62)
Diabetic	20 (71)	20 (95)
Hypertensive	19 (68)	19 (90)
Hyperlipidimic	26 (93)	20 (95)
Married x1= married with one wife, Married x2= married with 2 wives		

Table 2 - Characteristics of participants according to age and risk factors (mean and 95% confidence interval [CI]) for the intervention and control groups at baseline and follow-up (N=49).

Measure	Intervention group (n=28)		Control group (n=21)		P-value
	Mean	95% CI	Mean	(95% CI)	
Outcomes at baseline test					
Age (years)	56.75	53.6 - 59.8	57.22	54.4 - 60.2	0.457
Body mass index (kg/m²)	28.78	27.5 - 29.9	28.86	26.6 - 30.5	0.691
Heart rate (bpm)	81.18	76.8 - 85.5	84.62	80.1 - 89.1	0.270
Systolic blood pressure (mm Hg)	116.46	112.3 - 120.9	115.71	110.5 - 120.8	0.776
Diastolic blood pressure (mm Hg)	68.68	65.5 - 71.8	69.81	66.6 - 72.9	0.730
Fasting blood glucose (mmol/L)	6.90	6.2 - 7.5	8.69	7.1 - 10.2	0.080
Total cholesterol (mmol/L)	4.26	3.7 - 4.7	3.78	3.3 - 4.2	0.166
High density lipoprotein cholesterol (mmol/L)	0.94	0.8 - 1.0	0.87	0.7 - 0.9	0.327
Low density lipoprotein cholesterol (mmol/L)	2.55	2.1 - 2.9	2.18	1.8 - 2.5	0.196
Triglycerides (mmol/L)	1.74	1.4 to 2.0	1.60	1.2 - 2.0	0.275
Outcomes at follow-up test					
Body mass index (kg/m²)	27.03	25.5 - 28.5	28.21	25.7 - 30.6	0.386
Heart rate (bpm)	71.41	69.1 - 74.4	76.80	71.4 - 82.1	0.082
Systolic blood pressure (mm Hg)	125.86	124.0 - 127.6	127.60	120.3 - 134.8	0.616
Diastolic blood pressure (mm Hg)	77.95	76.7 - 79.1	76.35	73.1 - 79.5	0.648
Fasting blood glucose (mmol/L)	6.77	6.0 - 7.5	9.92	8.6 - 11.1	0.000
Total cholesterol (mmol/L)	4.24	3.9 - 4.5	4.09	3.6 - 4.5	0.573
High density lipoprotein cholesterol (mmol/L)	1.03	0.9 - 1.1	0.85	0.7 - 0.9	0.005
Low density lipoprotein cholesterol (mmol/L)	2.49	2.1 - 2.8	3.04	2.3 - 3.7	0.135
Triglycerides (mmol/L)	1.60	1.3 - 1.8	2.26	1.6 - 2.8	0.033

Table 3 - Results of Quality of Life, psychological well-being, and 6-minute walk test (mean and 95% confidence itnerval) for the intervention and control group at baseline and follow-up (N=49).

Measure	Intervention group (n=28)		Control group (n-21)		P-value
	Mean	95% Confidence interval	Mean	95% Confidence interval	
Outcomes at baseline test					
SF-36	34.32	31.5 - 37.0	31.81	31.8 - 26.4	0.358
HADS-A	6.93	6.0 - 7.8	9.14	7.6 - 10.6	0.007
HADS-D	5.86	4.7 - 6.9	8.24	6.7 - 9.6	0.011
6-minute walk test (m)	177.18	163.8 - 193.6	119.05	96.4 - 141.6	0.000
Outcomes at follow-up test					
SF-36	90.14	87.9 - 92.2	60.55	52.9 - 68.1	0.000
HADS-A	2.73	1.9 - 3.4	7.45	6.5 - 8.3	0.000
HADS-D	2.91	2.1 - 3.7	7.45	6.4 - 8.4	0.000
6-minute walk test	522.91	522.9 - 557.9	325.95	283.6 - 368.2	0.000

SF-36 - 36 item short form survey questionnaire, HADS-A - hospital anxiety and depression scale (anxiety component), HADS-D - hospital anxiety and depression scale (depression component)

Table 4 - Characteristics of participants according to risk factors, Quality of Life, psychological well-being, and 6-minute walk test (mean ± standard deviation) for both groups between baseline and follow-up.

Measure	Intervention group Mean ± SD		P-value	Control group Mean ± SD		P-value
	Baseline (n=28)	Follow-up (n=22)		Baseline (n=21)	Follow-up (n=20)	
BMI	28.78 ± 3.09	27.03 ± 3.39	0.000	28.86 ± 4.83	28.21 ± 5.20	0.350
HR	81.18 ± 11.22	71.41 ± 6.02	0.001	84.62 ± 9.89	76.80 ± 11.47	0.011
SBP	116.46 ± 11.13	125.86 ± 4.06	0.000	115.71 ± 11.36	127.60 ± 15.54	0.005
DBP	68.68 ± 8.18	77.95 ± 2.75	0.001	69.81 ± 6.97	76.35 ± 6.87	0.011
FBG	6.90 ± 1.97	6.77 ± 1.71	0.889	8.69 ± 3.48	9.92 ± 2.65	0.113
Total cholesterol	4.26 ± 1.31	4.24 ± 0.65	0.740	3.78 ± 1.03	4.09 ± 1.04	0.169
HDL	0.94 ± 0.30	1.03 ± 0.18	0.032	0.87 ± 0.28	0.85 ± 0.20	1.000
LDL	2.55 ± 1.11	2.49 ± 0.71	0.724	2.18 ± 0.77	3.04 ± 1.51	0.008
TG	1.74 ± 0.78	1.60 ± 0.58	0.183	1.60 ± 0.87	2.26 ± 1.25	0.062
SF-36	34.32 ± 7.06	90.14 ± 4.83	0.000	31.81 ± 7.92	60.55 ± 16.21	0.000
HADS-A	6.93 ± 2.26	2.73 ± 1.72	0.000	9.14 ± 3.21	7.45 ± 1.96	0.068
HADS-D	5.86 ± 2.93	2.91 ± 1.82	0.001	8.24 ± 3.18	7.45 ± 2.06	0.328
6-MWT	177.18 ± 42.15	522.91 ± 79.08	0.000	119.05 ± 49.60	325.95 ± 90.36	0.000

BMI - body mass index, HR - heart rate, SBP - systolic blood pressure, DBP - diastolic blood pressure, FBG - fasting blood glucose, HDL - high density lipoprotein cholesterol, LDL - low density lipoprotein cholesterol, TG - triglycerides, bpm - beats per minute, 6-MWT - 6-minute walk test, SF-36 - 36-Item Short Form Surgery Questionnaire; HADS-A - hospital anxiety and depression scale (anxiety component), HADS-D - hospital anxiety and depression scale (depression component)

2 groups in SF-36, HADS (HADS-A and HADS-D) and 6-MWT, demonstrating the effectiveness of the rehabilitation program in terms of QoL, psychological well-being, and physical functioning.

Table 4 further illustrates the highly significant improvements in BMI, HR, HDL, SF-36, HASD (HADS-A and HADS-D) and 6-MWT for the intervention group (*p*<0.05) between the baseline and follow-up test, whereas both SBP and DBP showed an increase during the 6 months rehabilitation program with a negative significant difference. However, the control group demonstrated significant improvement in 3 variables (HR, SF-36 and 6-MWT; *p*<0.05) whilst there was an increase in SBP, DBP and LDL with a negative significant difference. Re-hospitalization data was obtained from the hospital medical records and the participants. Four participants from the intervention group were re-hospitalized within a month after hospital discharge. The incidence of the re-hospitalization was one participant with low blood sugar, one participant with elevated heart rate and 2 participants with deep sternal infection. However, 10 participants from the control group were re-hospitalized within a month after hospital discharge. The incidence of the re-hospitalization was 2 participants with drug complications, one participant with heart attack (died), 5 participants with deep sterna infection, one participant with low blood sugar, one participant with fever and one participant with pleural effusion.

Discussion. This study demonstrated the effectiveness of commencing a home-based cardiac rehabilitation following CABG on patients' health-related QoL, psychological well-being, physical activity, risk factors, and re-hospitalization when compared with the usual hospital care. The educational sessions, workshops and counselling advice, given during the 6-month rehabilitation program, form a vital part of the home-based CR, giving confidence and further understanding of the patient's condition and health, which was clearly demonstrated on the patients' recovery. It has been reported no significant difference between groups at baseline-test before hospital discharge.[17] Both groups were on medical therapy and reported no significant changes in either the hemodynamic or the serum fasting lipid profile at the baseline test. In terms of the risk factors, the intervention group improved in measures of FBG, HDL and TG at the follow-up test compared to the control group. It is believed that the food management education session and the group workshop with the home-based exercise component contributed to improve the participants' and their families' knowledge of the risk factors by following healthy lifestyle after hospital discharge. It has been found that patients who followed 3 months CR program, experienced a significant overall improvement in total cholesterol, HDL, LDL, triglycerides and glucose level.[18] Medical therapy, education and exercise training program in the CR setting resulted in relatively modest risk factor improvements in post-cardiac events patients.[19] Six months after hospital discharge, both groups reported significant changes in the hemodynamic compared to the baseline test. There was a significant rise in both SBP and DBP that was likely due to withdrawal of drugs therapy in both groups. However, HR was lower in the intervention group compared to the control group. Few studies have reported that CR could significantly decrease or no change the HR[20,21] and BP[22] of post-cardiac events patients. Apart from a significant improvement in HDL in the intervention group and a negative significant difference in the control group, there was no significant difference in the rest of the serum fasting lipid profile in both groups between the baseline and the follow-up test. Six months after hospital discharge, the outcome of the lipid profile in the intervention group was better compared to other study.[23] The main point of this study was that the intervention group reported a slight improvement in the serum fasting lipid profile compared to the control group that reported an increase in the same variables at the end of the 6 months study period. This would be attributed to the nature of home-based CR program, which did not have the direct input of the medical therapy. In addition, 33% of the participants in the intervention group were unable to quit smoking, but they managed to cut down on the daily quantity, however, 31% of the participants in the control group were unable to quit smoking and returned to the daily quantity that they used to smoke before the operation. The percentage of the smokers in the intervention group was lower than other study.[23] The combination of the strategies of the group workshops attended by the participants and their families to express their experiences, problems, feeling and solutions for the modifiable risk factors, lifestyle, active life and stress, were the key to maintaining and enhancing positive behavioral changes in the intervention group. Whilst there was no difference between the groups at the baseline test in the SF-36 health status scores, the performance of the 6-MWT and HADS score revealed a significant difference between the intervention and control group; the intervention group rating their physical function and psychological well-being better than the controls even at the outset of the program. Perhaps the educational talks given to the intervention group prior to the surgery and after the surgery may have positively influenced these results. At the follow-up test, the intervention group reported significant differences in physical function, psychological well-being and QoL compared to the control groups. Given that, by the 6-month follow-up the CR group did report a greater improvements in physical activity,[24] anxiety, depression, and QoL.[25] Clear group differences were evident in levels of anxiety and depression between baseline and follow-up test. The control group showed a higher level of anxiety and depression, suggesting that they were at a greater risk of psychological distress during the study period (HAD-A, *p*=0.068 and HAD-D, *p*=0.328). However, both groups improved the 6-MWT distance and SF-36 scores significantly, but the intervention group had improved the physical function and QoL index much more markedly. After hospital discharge, most of the participants in the intervention group reported to have changed their lifestyle and they walked regularly either on their own or with their family -a feature reflected in the highly significant increase in 6-MWT-over 300% increase in distance walked in 6 minutes. However, it was interesting to note that the controls also significantly improved 6-MWT (by approximately 200%). This result suggested a significant improvement in the BMI in the intervention group, while no change in the control group. Participants in the control group reported that they were aware of the need to change their lifestyle following their doctors' advice and the national advertising campaign by the Saudi Ministry of Health to increase the awareness of the general public on reducing cardiovascular risk factors (namely, physical activity, smoking and obesity). It is clear that lack of knowledge in the control group

lead to only slight improvements in the health-related to QoL at the follow-up test compared to the baseline test. It has been reported that the patients who underwent CABG and were instructed in CR program and daily activity programs after hospital discharge reported significant differences in physical activities, QoL, and psychological well-being compared with the patients who just followed standard hospital care.[26] The role of education sessions with the in-patients' physical activities program before hospital discharge plus phone calls follow-up after hospital discharge appeared to be important in reducing incidence of re-hospitalization. Four participants from the intervention group and 10 participants from the control group were re-hospitalized within a month after hospital discharge. In addition, the re-hospitalization in this study was lower compared to other study that reported 13% in the intervention group and 9% in the standard care group.[27] A small change in CR programs for post-CABG patients such as informing the patients on the serious complication and follow them by a phone call after hospital discharge may reduce the cardiac re-hospitalization and translate into a large cost saving.

Study limitation and recommendation for future studies. In this study, the home-based CR program was a comprehensive program consisting of medical, educational, workshops, counselling advice, nutrition and home-based exercise program that were offered for selected categories of patients. Therefore, some limitation of the study should be noted. First, the sample employed may limit the generalizability of the results, only patients who underwent CABG with low to moderate risk were approached to participate in this study. Second, this study focused on men and did not include women. Finally, the contact with the cardiologists who followed the participants after hospital discharge was limited, which affected the outcomes of the hemodynamics and the serum fasting lipid profile in this study. In the light of the finding and limitations of this study as already described, recommendation for future studies on these findings are suggested to extend the study and enhance the CR care of post-cardiac events patients. Future studies are needed with a generalizability of the outcomes such as different cardiac events, females and high risk cardiac patients, which may have different consequences. Furthermore, future studies are advisable to find the longer-term effects of the CR programs such as 1 or 2 years follow-up to assess the long-term effectiveness, which precluded conclusion regarding the longer-term stability of positive health change after the 6 months CR period. The issue of access to the participants in each group health care cost within a long-term follow-up should be further explored to find the cost effectiveness of the CR programs compared to usual hospital care.

In conclusion, cardiac rehabilitation for the patients after CABG surgery has an undeniable positive impact on the various aspects of health-related QoL and reduces morbidity and mortality. This study reinforces the importance of the home-based CR program in stable patients in order to improve their health-related QoL, psychological well-being and physical function and reduce the risk of morbidity or mortality, compared to more conventional programs are already in existence in KSA.

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