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Effect of cardiac rehabilitation on cardiovascular risk factors in chronic heart failure patients

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ABSTRACT

Introduction: Cardiac rehabilitation improves disease-related symptoms, quality of life, and clinical outcomes. This study was done to evaluate the effect of cardiac rehabilitation program on cardiovascular risk factors in chronic heart failure patients as well as functional capacity and health related quality of life.
Methods: The study was conducted on 80 Patients with chronic stable heart failure. All patients had full history and thorough physical examination. Body mass index (BMI), waist circumference, glycated hemoglobin (HbA1c), lipid profile, and echocardiography, all of which were done before and after recruitment in a 2 months cardiac rehabilitation program (through prescribed exercise training, 2 sessions/week for 2 months). The changes in functional capacity were evaluated by 6-min walk test (6MWT) and the changes in the health related quality of life were measured by Minnesota living with heart failure questionnaire (MLHFQ), both were done before and after the rehabilitation program.
Results: There was a highly significant reduction in the blood pressure, heart rate, BMI, waist circumference, the smokers' number and the glycated hemoglobin (HbA1c) ($P < 0.01$). However, there was no statistically significant reductions in low density lipoproteins (LDL), Triglycerides ($P > 0.05$). Highly significant improvements were noted in the functional capacity and the health related quality of life as evidenced by improvement in the 6MWT and the MLHFQ scores (total score, physical and psychological domains, $P < 0.01$).
Conclusion: Cardiac rehabilitation had a significant improvement of cardiovascular risk factors, functional capacity and Health related quality of life in patients with chronic heart failure.
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1. Introduction

Heart Failure (HF) is one of the most important causes of morbidity and mortality in the industrialized world.[1] HF is one of the main causes for disability regarding the self-limitation of physical activity. This limitation is closely connected to the activities of daily living, to quality of life (QOL), and to changes in the lifestyle imposed by the disease.[2] Rehabilitation of cardiac patients is the sum of activities required to influence favorably the underlying cause of the disease, as well as the best possible physical, mental and social conditions. The objective of cardiac rehabilitation services is to improve both the physiologic and psychosocial status of cardiac patients.[3] Several trials have shown that cardiac rehabilitation improves disease-related symptoms, quality of life, and clinical outcomes. Overall, prescribed exercise attenuates the fatigue and dyspnea that limit exercise intolerance. The improvements ranged from 15 to 30% in peak oxygen consumption (VO2), which is greater than or equal to the gains in exercise capacity observed in many clinical drug trials.[4] Exercise training in patients with heart failure is associated with improvements in shortness of breath, the ability to perform activities of daily living, anxiety, depression, and general well-being.[5]

The 6 min walk test (6MWT), submaximal exercise test, allows an objective assessment of the exercise capacity of patients with congestive heart failure (CHF). This test simply measures the distance covered by walking on a hallway level within 6 min. The 6MWT has been shown to be a predictor of morbidity and mortality in CHF, with its predictive value being independent from left ventricular ejection fraction (LVEF) and other potential prognostic parameters. In CHF patients a walking distance <300 m is associated with a one-year-mortality of up to 50%, whereas the one-year-mortality in patients reaching a walking distance >450 m amounts to only a few percent.[6]

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2. Aim of work

To evaluate the effect of cardiac rehabilitation program (CRP) on cardiovascular risk factors in chronic heart failure patients as well as functional capacity and health related quality of life.

3. Materials and methods

3.1. Patient selection

The study was conducted on 80 Patients with chronic stable HF (stable on treatment for at least one month), age >18 years old of both sexes with LVEF <40% and New York heart association (NYHA) class II-III on stable treatment for HF coming to the cardiac rehabilitation clinic. The following patients were excluded from the study: Patients with NYHA IV, acute decompensated heart failure, patients with recent (in the past 30 days) acute coronary syndrome, patients with acute myocarditis, recent or current acute medical condition (recent pulmonary embolism, recent stroke or transient ischemic attack), patients with contraindication to exercise (e.g. severe aortic stenosis, severe hypertrophic cardiomyopathy (HOCM), etc...), patients unable to perform 6MWT "e.g. osteoarthritis, knee surgery, cerebrovascular stroke, etc... ", patients with cardiac resynchronization therapy (CRT) or implantable cardiac defibrillator (ICD), and patients with marked cognitive impairment. Patients who were unable to complete the program were also excluded. The study was accepted by the ethical committee of Ain Shams University, faculty of medicine and all patients were involved in the study after an informed consent was taken from them.

3.2. Methods

All patients were subjected to thorough history taking and physical examination including general health status, body mass index (BMI),[7] waist circumference, heart failure signs, cardiac and carotid murmurs, resting pulse, resting arterial blood pressure, extremities for presence of arterial pulses and orthopedic pathology, neurological abnormalities. Laboratory assessment was done (including glycated hemoglobin (HbA1c) and lipid profile). 2D trans-thoracic echocardiography was done (by using a GE vivid S5N Ver. 10.3.0 b.114 machine with an RS3 probe), left ventricular end systolic dimension (LVESD) and left ventricular end diastolic dimension (LVEDD) as well as left ventricular ejection fraction (LVEF) (measured by Simpson's method) were recorded and other diseases were excluded (as severe aortic stenosis,...etc). 6-Minute walk test was performed according to ATS statement, 2002. Before the test, the patient sat on a chair near the starting position where blood pressure & pulse were measured, baseline dyspnea and overall fatigue were recorded using the Borg scale & the worksheet was fulfilled.[8,9] Borg scale[8] (Table 1) for dyspnea and fatigue were recorded. At the beginning of the 6-min exercise, show the scale to the patient and ask the patient this: "Please grade your level of shortness of breath using this scale." Then ask this: "Please grade your level of fatigue using this scale." At the end of the exercise, remind the patient of the breathing number that they chose before the exercise and ask the patient to grade their breathing level again. Then ask the patient to grade their level of fatigue, after reminding them of their grade before the exercise.

Minnesota living with heart failure questionnaire (MLHFQ) was fulfilled[10]: The MLHFQ measures patients' perception of the effects of HF in their lives. It included 21 items that contemplate the physical, socioeconomic and psychological limitations that patients frequently report and connected with their heart failure. Participating patients were asked to complete the MLHFQ at baseline and at the end of the study. For Each of the 21 questions the patients were asked to indicate how much a possible effect of heart failure prevented them from living as they wanted during the past month (It was important to explain previously to patients that they should consider the last month to answer the questionnaires.), using a scale from 0 (not present or no effect), 1 (very little), 2, 3, 4, or 5 (very much). The score of the physical dimension corresponds to the sum of eight questions (# 2, 3, 4, 5, 6, 7, 12 and 13) related to dyspnea and fatigue. The score of the emotional dimension is formed by five questions (# 17, 18, 19, 20 and 21). The remaining questions (# 1, 8, 9, 10, 11, 14, 15 and 16) plus the physical and emotional dimensions determined the total score. Higher scores indicate worse Health-Related quality of life (HRQOL). The tests were done within a week preceding the exercise training program.

Prescribed exercise training (2 sessions/week for 8 weeks) was performed for all patients[11]: Warm-up & cool-down: 5–10 min of low level aerobic exercise, stretching. Aerobic exercise: starting at 15–20 min up to 30–45 min using treadmill (1.6–4 km/h, 0% grade) (<25watts) to reach HR: HR rest +20 beats/min at least, with slow increase in the duration and intensity of exercise according to patient's response and capacity. The formal exercise regimen was supplemented with physical activity counseling as patients are consistently encouraged to accumulate 30–60 min per day of moderate-intensity physical activity on $\geq$5 (preferably most) days of the week. On completion of the Cardiac Rehabilitation program (within a week interval), the patients were subjected to thorough history taking and clinical and laboratory assessment including (Smoking status, Functional capacity according to NYHA classification, BP measurement, Heart rate, BMI and waist circumference, HBA1c and Lipid profile), 6 min walk test and MLHFQ.

The primary endpoint was to evaluate the effect of cardiac rehabilitation program on cardiovascular risk factors and the secondary endpoint was to stress on its value in improving functional capacity and health related quality of life.

Table 1
The BORG scale.[8]

0	Nothing at all
0.5	Very, very slight (just noticeable)
1	Very slight
2	Slight (light)
3	Moderate
4	Somewhat severe
5	Severe (heavy)
6	
7	Very severe
8	
9	
10	Very, very severe (maximal)

3.3. Statistical analysis

Data were collected, revised, coded and entered to the statistical package for social science (SPSS) version 17. Categorical data were expressed as frequencies and percentages, while continuous data were expressed as mean ± standard deviation (SD) or median according to data distribution. McNemar's test was used to compare data changes in the study group. Comparison between continuous variables was done using unpaired t-test. Pearson correlation coefficient was done to evaluate the studied parameters before and after the rehabilitation program. Unadjusted and adjusted odds ratio (95% confidence intervals) were used to detect significant predictors. P value was considered significant if <0.05.

4. Results

The present study was a prospective study which was conducted on 80 patients, diagnosed with chronic stable heart failure, who were recruited from cardiac rehabilitation clinic. The demographic, clinical, laboratory, echocardiographic, 6MWT and MLHFQ data were evaluated.

4.1. Demographic data and clinical risk factors

The study included 80 patients as shown in Table 2, 14 (17.5%) were women and 66 (82.5%) were men. The mean age of the included patients was 55.6 years. The mean BMI of the studied group was 27.83 kg/m^2, the mean ejection fraction (EF) (Simpson's method) of the studied group was 31.28%. Diabetes mellitus was the most prevalent risk factor among the included patients where 80% of the patients were diabetics.

4.2. Correlation between 6MWD and the studied parameters at baseline and at the end of the programme (Table 3)

At baseline, 6MWD was correlated significantly with BMI, waist circumference, resting systolic arterial blood pressure (ABP) and resting diastolic ABP, while, no correlation was found with age, EF, LVESD, LVEDD, low density lipoproteins (LDL), high density lipoproteins (HDL), Triglyrerides and HbA1c (although it was significantly reduced by the end of the program in comparison with the baseline HbA1c readings). The results at the end of program were statistically similar to those at baseline.

4.3. Effect of cardiac rehabilitation on studied parameters

By the end of cardiac rehabilitation program, the incidence of smoking decreased from 75% to 37.5% (60 patients were smokers before the program where 30 of them stopped smoking after the program) (P < 0.01). As shown in Table 4: Following CRP, reductions were noted in BMI (31.19 ± 1.89 kg/m^2 to 30.33 ± 2.19 kg/m^2, P < 0.001); waist circumference (110.23 ± 5.91 cm to 106.68 ± 6.02 cm, p < 0.001); systolic blood pressure (135.38 ± 15.75 mmHg to 119.63 ± 11.4 mmHg, p < 0.001) and diastolic blood pressure (84.88 ± 9.37 mmHg to 75.25 ± 7.42 mmHg, p < 0.001). By the end of the study, significant reduction was noted in the glycated hemoglobin (7.13 ± 1.34 g/dl to 6.65 ± 0.9 g/dl, P < 0.001), while non-significant changes was noted in serum LDL (113.10 ± 31.7 mg/dl to 104.45 ± 21.08 mg/dl, P = 0.155); serum HDL (36.55 ± 6.96 mg/dl to 38.20 ± 6.84 mg/dl, P = 0.288) and serum triglycerides (146 ± 51 mg/dl to 133.43 ± 45.06 mg/dl, P = 0.246).

Table 2
Distribution of age, sex, BMI, echocardiographic parameters, and risk factors among the study group.

		No.	%
Sex	Male	66	82.5%
	Female	14	17.5%
Age (years)	Mean ± SD	55.63 ± 11.42	
	Range	32–80	
	Range	Mean ± SD	
BMI (kg/m^2)	21–40	27.83 ± 4.94	
EF (%)"Simpson's method"	15–39	31.28 ± 6.71	
LVESD (mm)	30–70	50.12 ± 9.27	
LVEDD (mm)	48–78	63.28 ± 7.88	
	No.	%	
Smoking	60	75.0%	
DM	64	80.0%	
HTN	60	75.0%	
FH	14	17.5%	

No = number, SD = standard deviation, BMI = Body mass index, EF = Ejection fraction, LVESD = left ventricular end systolic dimension, LVEDD = left ventricular end diastolic dimension, DM = diabetes mellitus, HTN = hypertension, FH = family history of IHD.

4.4. Effect on NYHA class and premature termination of 6MWT before and after program

The NYHA class was highly significantly improved after the program as shown in Table 5. In the baseline 6MWT, 70 patients completed the 6 min and 6 patients prematurely terminated the test due to severe dyspnea and another 4 patients prematurely terminated the test due to severe fatigue. By the end of the program all the patients completed the 6 min (P < 0.001) Table 5.

4.5. Six minute walk distance(6MWD) heart rate, BORG (dyspnea) and BORG (fatigue) before and after program

As shown from Table 6, by the end of the study, the 6MWD increased from 317.60 ± 64.45 m to 395.75 ± 49.24 m (P < 0.001). The HR decreased from 78.75 ± 9.45 beats per minute (bpm) to 7 1.70 ± 7.23 bpm (P < 0.001). The BORG (Dyspnea) decreased from 0.58 ± 0.78 to 0.33 ± 0.47 (P = 0.003), while the BORG (Fatigue) decreased from 0.53 ± 0.78 to 0.45 ± 0.71 (P = 0.083).

4.6. MLHFQ total score, physical domain, psychological domain before and after program

By the end of the program, reductions were found in the total MLHFQ score (42.63 ± 7.58 to 32.60 ± 5.19, P < 0.001); the physical domain score (20.58 ± 4.68 to 15.38 ± 3.48, P < 0.001) and the psychological domain score (4.33 ± 2.73 to 1.10 ± 1.22, P < 0.001), as shown in Table 6 and Fig. 1.

5. Discussion

This study was done to evaluate the effect of cardiac rehabilitation program on improving cardiovascular risk factors in chronic heart failure patients as well as functional capacity and health related quality of life. There was a highly significant reduction in the blood pressure, resting heart rate, BMI, waist circumference, the smokers' number and HbA1c. However, there was no statistically significant reduction in LDL, Triglycerides. No statistically significant increase in HDL after the rehabilitation program was found. There was also highly significant improvement in the functional capacity and the health related quality of life as evidenced by improvement in the NYHA class a, the 6MWD and the MLHFQ scores.

In the present study the mean age of patients with CHF enrolled in the cardiac rehabilitation program was 55.63 years. Females constituted 17.5% of patients (14 out of 80 patients). The small percentage of women in our study was similar to most studies in CR. This may be attributed to the lower incidence of ischemic heart disease and consequently ischemic cardiomyopathy in females in comparison to males of the same age group as shown in the Framingham heart study.[12]

5.1. Baseline six minute walk distance

The Distance walked during the 6-MWT is an independent predictor of mortality and mortality or hospitalization for cardiovascular reasons in men with stable systolic HF.[13] Although not every study reaches the same prediction distances, they all show a high risk for "low" 6-MWDs.[14] Arslan and colleagues showed mortality rates for patients with mild-to-moderate HF who walked <300 m to be significantly higher than those whose walked

Table 3
correlation between 6MWD and the studied parameters at baseline and after the program.

Baseline parameters	6MWD at baseline		6MWD after program	
	R	p-value	R	p-value
Age	−0.159	0.328	−0.159	0.328
BMI	−0.513**	0.001	−0.782	<0.001
Waist circumference	−0.781**	<0.001	−0.801	<0.001
Systolic ABP	−0.445**	0.004	−0.568	<0.001
Diastolic ABP	−0.424**	0.006	−0.469	0.002
EF	0.205	0.204	0.205	0.204
LVESD	−0.189	0.244	−0.189	0.244
LVEDD	−0.206	0.202	−0.206	0.202
LDL	−0.021	0.898	−0.026	0.872
HDL	−0.288	0.072	−0.291	0.068
TG	−0.015	0.927	−0.008	0.963
HbA1c	0.054	0.742	0.118	0.468

6MWD = 6-min walk distance, BMI = body mass index, ABP = arterial blood pressure, EF = ejection fraction, LVESD = left ventricular end systolic dimension, LVEDD = left ventricular end diastolic dimension, LDL = low density lipoproteins, HDL = high density lipoproteins, TG = triglycerides, HbA1c = glycated hemoglobin.
** Significant correlation.

Table 4
BMI, waist circumference, blood pressure, lipid profile and HbA_{1C} before and after program.

	At baseline	After program	Paired t-test	
	Mean ± SD	Mean ± SD	t	p-value
BMI (kg/m^2)	31.19 ± 1.89	30.33 ± 2.19	6.271	<0.001
Waist circumference (cm)	110.23 ± 5.91	106.68 ± 6.02	8.472	<0.001
Systolic ABP (mmHg)	135.38 ± 15.75	119.63 ± 11.40	10.400	<0.001
Diastolic ABP (mmHg)	84.88 ± 9.37	75.25 ± 7.42	8.793	<0.001
LDL (mg/dl)	113.10 ± 31.73	104.45 ± 21.08	1.436	0.155
HDL (mg/dl)	36.55 ± 6.96	38.20 ± 6.84	1.069	0.288
TG (mg/dl)	146.00 ± 51.00	133.43 ± 45.06	1.168	0.246
HbA1c (g/dl)	7.13 ± 1.34	6.65 ± 0.91	5.601	<0.001

SD = standard deviation, BMI = body mass index, ABP = arterial blood pressure, LDL = low density lipoproteins, HDL = high density lipoproteins, TG = triglycerides, HbA1c = glycated hemoglobin.

Table 5
Effect on NYHA class and premature termination of 6MWT before and after program.

NYHA class	At baseline		After program		McNemar's test	
	No.	%	No.	%	X^2	P-value
Class 1	0	0.0%	20	25.0%	31.8	<0.001
Class 2	74	92.5%	60	75.0%		
Class 3	6	7.5%	0	0.0%		
Premature termination of 6MWT						
No stoppage	70	87.50%	80	100.00%	27.2	<0.001
Dyspnea	6	7.50%	0	0%		
Fatigue	4	5.00%	0	0%		

NYHA = NewYork heart association classification, 6MWT = 6-min walk test.

Table 6
Comparison between results of 6MWD, Heart rate, BORG (dyspnea), BORG (fatigue) and MLHFQ before and after program.

	Before program	After program	Paired t-test	
	Mean ± SD	Mean ± SD	t	p-value
6MWD (meters)	317.60 ± 64.45	395.75 ± 49.24	17.690	<0.001
HR	78.75 ± 9.45	71.70 ± 7.23	5.621	<0.001
BORG (Dyspnea)	0.58 ± 0.78	0.33 ± 0.47	3.204	0.003
BORG (Fatigue)	0.53 ± 0.78	0.45 ± 0.71	1.778	0.083
MLHFQ total score	42.63 ± 7.58	32.60 ± 5.19	18.130	<0.001
Physical Domain	20.58 ± 4.68	15.38 ± 3.48	12.354	<0.001
Psychological Domain	4.33 ± 2.73	1.10 ± 1.22	12.315	<0.001

SD = standard deviation, 6MWD = 6-min walk distance, HR = heart rate, MLHFQ = Minnesota Living With Heart Failure Questionnaire.

distances greater than 300 (79% vs. 7%).[15] Accordingly, in our study, the baseline 6MWD was 317.60 ± 64.45 m and the 6MWD of 17.5% of patients was less than 300 m. by the end of the study only 5% of patients showed a 6MWD less than 300 m. indicating improved functional performance of patients participating in the CR Program.

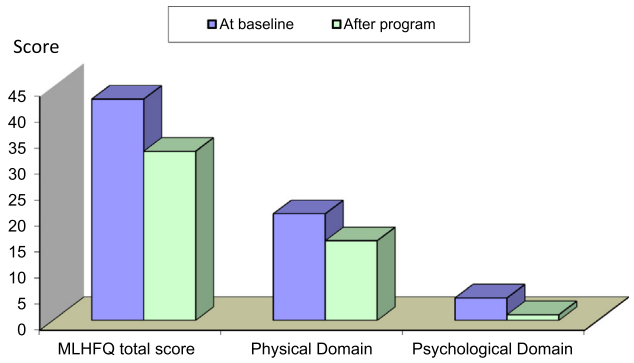

Fig. 1. MLHFQ total score, physical domain, psychological domain before and after program.

5.2. Correlation between 6MWD at baseline and the studied parameters at baseline

In our study the correlation between age and 6MWD was not significant (p-value = 0.328), similar to the study by Camarri et al.[16] probably due to the small sample size (n = 40). In contrast to the study carried out by Bautmans et al.[6], there was a negative correlation between the 6MWT-distance and the participant's age for the whole group ($p < 0.001$), and for both males ($p = 0.019$) and females ($r = -0.47$, $p < 0.001$). The mean 6MWD was higher in males which can be attributed to the higher muscle mass and strength observed in males after the onset of adolescence. Similar to results by Iwama et al.[17], among Brazilian adult and elderly individuals, the men walked on average 61.5 m more than the women. In our study there was statistically highly significant negative correlation between 6MWD and BMI and Waist circumference similar to the study done by Iwama et al.[17] There was statistically non significant correlation between 6MWD and EF (p-value 0.204), LVESD (p-value 0.244) in contrast to the strong negative correlation found by Forman et al.[18], this difference may be attributed to the large sample size taken by Forman et al. (2054 patients), and the number of patients presented with NYHA class as in our study, most of patients were presented with NYHA class II (92.5%) and only 6 patients was presented with NYHA class III, while in Forman study, 64% were presented with NYHA II and 36% were presented with NYHA III, reflecting the better functional status in our study population.

5.3. Effect of CR program on cardiovascular disease (CVD) risk factors

There was a statistically significant decrease in the percentage of smokers by the end of the rehabilitation program. Despite the significant decrease in the percentage of smokers, 37.5% of the study population were still smokers in comparison to what was showed by Francesco et al. in (2012) as only 13% from the group enrolled into the rehabilitation program were still smokers at 6 months ($p < 0.001$) compared to 23% were still smokers in the control group ($p < 0.01$). The percentage of smokers at the end of CR Program in the present study was higher probably due to the shorter duration of the CR Program, the low socioeconomic class of the involved patients, and type of patients, as the patients in Francesco study were recovering acute myocardial infarction.

Regarding blood pressure, there was a statistically highly significant decrease in both SBP (decreased from mean 135.38 mmHg to 119.63 mmHg, p-value < 0.001) and DBP (decreased from mean 84.88to 75.25 mmHg, p-value < 0.001). These results were concordant with results shown by Sarrafzadegan et al.[20] in reducing SBP in a significant manner but in coronary patients enrolled in CR Program and results shown by Philippe et al.[21] (n = 77, mean age 43 years) in reducing DBP by 2.3% in healthy volunteers who used stairs instead of elevators in the work place for 12 weeks. The significant reduction in blood pressure is mostly due to frequent visits in which there is more accurate follow up of blood pressure & tailoring of antihypertensive medications and also due to the combined effect of exercise, healthy diet, patient education and stress management.

Resting heart rate also showed a significant reduction (from mean 78.75 to 71.7 bpm, p-value < 0.001), which was similar to the significant reduction in heart rate after CR Program in the study done by Koukouvou et al.[22] on chronic heart failure patients and this is in part due to the effect of exercise in reducing heart rate via increasing parasympathetic activity and decreasing sympathetic activity and in part due to the effect of beta blockers as one of the cardioprotective drugs used by ischemic patients which is beneficial in decreasing ischemia and mortality.

In the present study, there was a statistically non significant reduction in TG and LDL and statistically non significant increase in HDL. Sarrafzadegan et al.[20] (n = 547, enrolled in CR Program, only some of them received anti lipid drugs) where CR Program reduced the levels of TG and LDL and elevate HDL significantly, even without using anti lipid medication. The non-significant results in our study could be explained by the shorter duration of our study. Francesco et al.[19] showed that exercise lead to a highly significant reduction in LDL (20%) and TG (18%) and increase in HDL (11%) (p-value = 0.0001), however, those patients were on statins as a part of CR program.

In the current study there was a statistically highly significant reduction in glycated hemoglobin level as the HbA1c was decreased by 6.9%. Similar results were shown by Bweir et al.[23], as there was a reduction of 8% in HbA1c in inactive diabetic subjects enrolled in a 10-week exercise program. This may be attributed to the combined effect of optimization of antidiabetic treatment, diet control and the beneficial effect of exercise on glucose metabolism. The present study showed a statistically highly significant reduction in the BMI and waist circumference of the study population (BMI was decreased from 31.19 ± 1.89 kg/m^2 to 30.33 ± 2.19 kg/m^2, and waist circumference 110.23 ± 5.91 cm to 106.68 ± 6.02 cm, with p-value < 0.001). This positive effect has also been demonstrated by Sarrafzadegan et al.[20] who showed reduction in BMI from mean 27.2 to 26.6 kg/m^2 and waist circumference from 99.3 to 96.3 (p-value = 0.001).

5.4. Effect of CR program on functional capacity and quality of life

No training-related adverse events were reported, implying that the training program was safe for that group of chronic heart failure patients.

5.4.1. Effect on functional status (NYHA class I–IV)

The present study confirmed the well known favorable effects of exercise training on cardiovascular functional capacity as there was a statistically highly significant improvement in the NYHA class of the patients in the current study population in which there was a shift of patients from NYHA class II and III to NYHA class I. similar findings were shown by Sarrafzadegan et al.[20] as he also showed significant improvement in functional capacity in the patients enrolled in CR Program.

5.4.2. Effect on functional performance (6MWD)

A mean improvement of 70–170 m is significant and indicates a change in functional status. However a recent meta-analysis estimated that an average 6MWD improvement of 45 m appeared to exceed measurement error and be associated with significant changes in either aerobic capacity and/or QOL.[24] According to the

guidelines of the American Thoracic Society (ATS), the minimal clinically significant difference reported from the 6MWT in patients with CHF is 43 m[9]. In our study the 6MWD showed a mean improvement of 78.15 m (approximately 24%) as it increased from 317.60 ± 64.45 m to 395.75 ± 49.24 m which denotes a statistically highly significant improvement (p-value < 0.001) indicating an improvement in the functional performance, the consequence of which is an enhancement of daily activity. Even better degrees of improvement of 6MWD (exceeding 70 m) were observed in the study done by Davidson et al.[25]

5.4.3. Effect on the MLHFQ total score, the physical domain and the psychological domain

(An inverse rating with health-related quality of life) By the end of our study there was a statistically highly significant improvement in the total MLHFQ score which decreased from 42.63 ± 7.58 to 32.60 ± 5 (p-value < 0.001), the physical domain score which decreased from 20.58 ± 4.68 to 15.38 ± 3 (p-value < 0.001) and the psychological domain score which decreased from 4.33 ± 2.73 to 1.10 ± 1.22 which (p-value < 0.001). These results were consistent with results of other studies: Randomized controlled studies of HF disease management programs have demonstrated substantially greater improvements of 12 to13 points, on average; in the total MLHFQ score.[26] A systematic review of eight prospective studies, found that MLHFQ Score was significantly better in the exercise group vs. sedentary control group in heart failure patients. [27]

5.5. Study limitations

It included a single medical center (Ain Shams University hospitals), the relatively small number of patients, who were characterized by predominantly male gender, cardiopulmonary exercise was not available to validate 6MWT in Egyptian patients and finally, no control group included in the study.

6. Conclusions

Cardiac rehabilitation plays an important and integral role in contemporary managements of patients with CHF as it causes significant improvement of cardiovascular risk factors, functional capacity and Health related quality of life.

Conflicts of interest

The authors have no conflicts of interest.

References

1. Fonarow GC, Adams KF, Abraham WT, Yancy CW, et al.. ADHERE Scientific Advisory Committee, Study Group, and Investigators. Risk stratification for in hospital mortality in acutely decompensated heart failure: classification and regression tree analysis. *JAMA*. 2005;293:572–580.
2. Santos JJA, Plewka JEA, Brofman PRS. Clinical quality indicators in heart failure: a multivariate analysis. *Arq Bras Cardiol*. 2009;93:159–166.
3. Jette M, Heller R, Landry F, et al.. Randomized 4-week exercise program in patients with impaired left ventricular function. *Circulation*. 1991;84:1561–1567.
4. Giannuzzi P, Temporelli PL, Corra U, et al.. Attenuation of unfavorable remodeling by exercise training in postinfarction patients with left ventricular dysfunction: results of the Exercise in Left Ventricular Dysfunction (ELVD) Trial. *Circulation*. 1997;96:1790–1797.
5. Kokkinos PF, Choucair W, Graves P, et al.. Chronic heart failure and exercise. *Am Heart J*. 2000;140:21–28.
6. Bautmans I, Lambert M, Mets T. The six-minute walk test in community dwelling elderly: influence of health status. *BMC Geriatrics*. 2004;15:70–77.
7. Mei Z, Grummer-Strawn LM, Pietrobelli A, Goulding A, et al.. Validity of body mass index compared with other body-composition screening indexes for the assessment of body fatness in children and adolescents. *AJCN*. 2002;7597–7985.
8. Borg G. Psychophysical bases of perceived exertion. *MSSC*. 1982;14:377–381.
9. ATS statement: guidelines for the six-minute walk test. ATS Committee on proficiency standards for clinical pulmonary function laboratories. *Am J Respir Crit Care Med*. 2002;166:111–117.
10. Lewis EF, Johnson PA, Johnson W, Collins C, et al.. Preferences for quality of life or survival expressed by patients with heart failure. *J Heart Lung Transplant*. 2001;20:1016–1024.
11. Haskell W, Lee I-M, Pate R, et al.. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Circulation*. 2007;116:1081–1093.
12. Wilson PW, D'Agostino RB, Levy D, Belanger AM, et al.. Prediction of coronary heart disease using risk factor categories. *Circulation*. 1998;97:1837–1847.
13. Wegrzynowska-Teodorczyk K, Rudzinska E, Lazorczyk M, et al.. Distance covered during a six minute walk test predicts long-term cardiovascular mortality and hospitalization rates in men with systolic heart failure: an observational study. *J Physiother*. 2013;59:177–187.
14. Ingle L, Cleland JG, Clark AL. The long-term prognostic significance of 6-minute walk test distance in patients with chronic heart failure. *BioMed Res Int*. 2014;2014:7. Article ID 505969.
15. Arslan S, Erol M, et al.. Prognostic value of 6-minute walk test. *Tex Heart Inst J*. 2007;34:166–169.
16. Camarri B, Eastwood PR, Cecins NM, Thompson PJ, et al.. Six minute walk distance in healthy subjects aged 55–75 years. *Respir Med*. 2006;100:658–665.
17. Iwama AM, Andrade GN, Shima P, Tanni SE, et al.. The six minute walk test and body weight-walk distance product in healthy Brazilian subjects. *Braz J Med Biol Res*. 2009;42:1080–1085.
18. Forman DE, Fleg JL, Kitzman D, Brawner CA, et al.. 6 Minute walk test provides prognostic utility comparable to cardiopulmonary exercise testing in ambulatory outpatients with systolic heart failure. *JACC*. 2012;60:2653–2661.
19. Francesco G, Wanda A, Francesca R, et al.. Effects of exercise training started within 2 weeks after acute myocardial infarction on myocardial perfusion and left ventricular function: a gated SPECT imaging study. *Eur J Prev Cardiol*. 2012;19:1410–1419.
20. Sarrafzadegan N, Rabiei K, Kabir A, et al.. Changes in lipid profile of patients referred to a cardiac rehabilitation program. *Eur J Cardiovasc Prev Rehabil*. 2008;15:467–472.
21. Philippe M, Bengt K, Francois M. Stair use for cardiovascular disease prevention. *Eur J Cardiovasc Prev Rehabil*. 2009;16(Suppl 2):S17–S18.
22. Koukouvou G, Kouidi E, Iacovides A, Konstantinidou E, et al.. Quality of life, psychological and physiological changes following exercise training in patients with chronic heart failure. *J Rehabil Med*. 2004;36:36–41.
23. Bweir S, Al-Jarrah M, Almalty A, Maayah M, Irina V, et al.. Resistance exercise training lowers HBA1c more than aerobic training in adults with type 2 diabetes. *Diabetol Metab Syndr*. 2009. https://doi.org/10.1186/1758-5996-1-27.
24. Shoemaker MJ, Curtis AB, Vangsnes E, et al.. Triangulating clinically meaningful change in the six minute walk test in individuals with chronic heart failure: a systematic review. *Cardiopulm Phys Ther J*. 2012;23:5–15.
25. Davidson PM, Cockburn J, Newton PJ, et al.. Can a heart failure-specific cardiac rehabilitation program decrease hospitalizations and improve outcomes in high-risk patients? *Eur J Cardiovasc Prev Rehabil*. 2010;17:393–402.
26. Harrison MB, Browne GB, Roberts J, et al.. Quality of life of individuals with heart failure, a randomized trial of the effectiveness of two models of hospital-to-home transition. *Med Care*. 2002;40:271–282.
27. Ismail H, McFarlane J, Smart NA. Is exercise training beneficial for heart failure patients taking β-adrenergic blockers? A systematic review and meta-analysis. *Congest Heart Fail*. 2013;19:61–69.