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Does the Effect of Supervised Cardiac Rehabilitation Programs on Body Fat Distribution Remained Long Time?

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ABSTRACT

Introduction: An increased accumulation of fat in the intra-abdominal cavity is highly correlated with adverse coronary risk profiles. Cardiac rehabilitation (CR) produces a host of health benefits related to modifiable cardiovascular risk factors. Further research is needed to define better program for weight loss and risk improvement in coronary patients. The aim of this study was to determine the effect of supervised and unsupervised cardiac rehabilitation program on body composition and body fat distribution in a population with coronary artery disease.

Methods: The study investigated 167 patients with coronary artery disease (73% males; mean age = 52.67±9.11 years) before and after a supervised protocol cardiac rehabilitation program, and 12-months later. Target variables included body fat distribution indices (waist and hip circumference and waist to hip ratio), weight and body mass index.

Results: Weight, waist circumference, waist to hip ratio and body mass index significantly decreased with 2 month supervised program ($P<0.001$), but hip circumference was not significantly changed. Males improved to a greater extent than the female patients. All of measurements relatively returned to baseline at the end of program (after 12 months).

Conclusion: Supervised cardiac rehabilitation program results in improvements in body composition and body fat distribution. The effects of non-supervised program were minimal and the program needed to be reviewed.

Introduction

Obesity affects 33% of the general population in the United States, with more than 60% categorized as overweight.[1] Coronary populations display a higher prevalence of obesity than is observed in non-coronary population.[2] From 1996 to 2006, the mean body mass index (BMI) for Coronary Heart Disease (CHD) patients increased from 28.5 to 30.1 kg/m^2. Currently, more than 80% of CHD patients are overweight (BMI> 25 kg/m^2), the prevalence of obesity (BMI> 30 kg/m^2) is 40%, and 50% have insulin resistance manifest as metabolic syndrome.[3,4]

Thereby, a focus on secondary prevention and risk profile reduction in CHD patients has emerged.

The calculation of body fat distribution indices such as BMI is provided in the most current evidence-based guidelines on the identification, evaluation and treatment of overweight or obese adults. In addition, waist circumference (WC) and Waist-to-Hip Ratio (WHR) which have been shown to correlate strongly with abdominal obesity provide simple and sensitive measures to evaluate cardiovascular risks associated with body fat distribution and therefore are recommended as part of the contemporary guidelines on obesity.[2,5,6]

General overweight and general and abdominal obesity are independently associated with an increased risk of death, recurrent events and HF.[7-9] It can interact with or amplify the effects of other cardiovascular risk factors such as hypertension, dyslipidemia, insulin resistance, and hyperinsulinemia.[1,2,5,10,11]

Low fitness and central obesity are independently and cumulatively associated with increased mortality and morbidity in CHD patients. The association of BMI with mortality is complex and altered by fitness levels.[9-13]

Nowadays, cardiac rehabilitation (CR) is defined as an effective non-pharmacological modality to reduce coronary risk profiles including total cholesterol, body fat, systolic blood pressure, metabolic syndrome and can improve peak aerobic capacity.[5,6,14-21] Peak aerobic capacity, measured as peak oxygen consumption, is corrected for total body weight and is reported in milliliter

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per kilogram of body weight per each minute.[22,23]
Weight loss in CR has been linked to diminished cardiovascular events.[19] Unfortunately, the current CR protocols not only result in little weight loss[3] during the program but also overweightness remains a prevalent and persistent risk factor after CR.[24] Failure to weight reduction may be due to low energy expenditure in rehabilitation or the relatively short duration of the program.[25] Monitoring weight loss after program completion is important to observe the effect of CR on long-term outcomes. The purpose of this study was to determine the effects of a 12-month (supervised and unsupervised) CR program on body composition and fat distribution in patients with coronary heart disease.

Methods

The study population consisted of 167 coronary patients who were referred for CR and exercise training program from 2009 since 2011. Subjects were clinically stable and all patients entered the program 8±3 weeks after a major coronary event including coronary artery bypass grafting surgery, acute MI or unstable angina, and catheter revascularization for acute coronary syndrome. Each subject read and signed an informed consent form. Descriptive characteristics, personal history, medications and other data were collected at the baseline. Subjects maintained their normal medication throughout the course of the study. Height, weight, waist and hip circumference were measured in the fasting state in the morning by two nurses before entering the program. Weight measurements, using a balance machine, Seca 900946 model, were performed to evaluate BMI. Measurements were taken in duplicate and the average was used, waist to hip ratio was measured using a metal tape with measurements taken at the level of the umbilicus and the greatest protrusion of the buttocks, as recommended by Lohman.
Each patient was evaluated by a dietitian who prescribed a phase I diet AHA. Furthermore, if the patient was found to be obese, further caloric restriction was recommended. Patients with significant hypercholesterolemia and obesity were periodically followed up by the dietitian during 2 month program to ensure compliance with and understanding of the prescribed therapy. All patients participated in six classroom (25 minutes each) teaching sessions on a heart-healthy diet with a dietician, and also in a dietary motivation session with a physician.
The CR protocol consisted of two phases: supervised and unsupervised program. In this study patients, first participated in supervised exercise program, which lasted approximately 8 weeks and generally included 24 exercise training sessions over 2 months. Each session consisted of approximately 5 to 10 minutes of warm up and light exercise (stretching) followed by 35 to 40 minutes of aerobic exercise including walking (treadmill), bicycling and rowing, then approximately 10 minutes of resistance training exercise; 3 exercises of 10 repetitions for upper and lower body, (Both aerobic endurance and strength training programs improve cardiovascular health in obese adults specially in heart failure patients[26-29]) and finally 10 minutes cool down period (stretching). Exercise intensity was prescribed individually so that the patient heart rate reached to approximately 60% to 80% (gradually increased) of the maximum heart rate calculated after exercise stress test. Before entering the program, patients underwent exercise testing and we estimated exercise capacity.
In second phase, unsupervised exercise program, we encouraged patients to perform approximately 3 to 4 exercise sessions per week at home and control their heart rate during exercise. Physicians frequently encouraged patients to comply with both the exercise and dietary portions of rehabilitation program.
After two months and again at the end of 6th and 12th months of study, several measurements: weight, BMI, waist and hip circumference and WHR were obtained by two nurses who were blinded to the previous anthropometrical data.

Statistical Analysis

The results were expressed as mean±SD. For statistical analysis we used chi-square test, analysis of variance, and paired *t*-tests to assess differences among patients before and after rehabilitation, analysis of variance with repeated measures in 6 and 12 months after supervised rehabilitation program. The SPSS 15 (SPSS Inc., Chicago, IL, USA) was used for all statistical analysis and *P*-value of 0.05 is considered significant.

Results

Coronary artery disease patients (n=167; age= 52.67±9.11 years; 73% males) were revascularized by percutaneous coronary intervention (37%), coronary artery bypass graft (CABG) surgery (43%) or received medical treatment after acute coronary syndrome (20%). Age mean in female and male groups was not of significant difference. Medical record documentation revealed a previous acute myocardial infarction (AMI) in 18%, a previous CABG in 8%, and a previous percutaneous coronary intervention (PCI) in 21% of participants. They were taking evidence-based medications, including beta-blockers (78%), lipid-lowering agents (92%), aspirin (88%), clopidogrel (67%), and angiotensin-converting enzyme inhibitors (32%). They were attended to the phase II rehabilitation program 8±3 weeks after an event, and they did not have any previous CR course. Before initiation of rehabilitation program, mean of patients' weight was 72.38±9.8 kg being more in male than female patients. Mean BMI was 26.19+3.05 Kg/m^2 in all patients and was more in female than male patients. Both WC and hip circumference means were more in female than male patients but WHR was less in females significantly (Table 1).
At the end of supervised CR program, WC, weight and Hip circumference (HC) were significantly reduced (*P*<

0.001). The reduction of BMI in males was more than females and this change was statistically significant at the end of second month ($P< 0.001$). The reduction of WC and WHR was significant totally, whereas there was no change in the female group (Table 2). The weight loss was more prominent in female group and its standard deviation was less.

At the end of 12th month, not only measured body indices did not show any significant improvement compared to baseline but also the mean of weight and WC showed insignificant increases in measures. BMI in females increased after 12 months. The results showed the improvements in body indices were decreased during the time (Tables 3 and 4).

The trend of changes

Weight: The mean weight significantly reduced at the end of the first, second and 6th months of CR participation; however, the most reduction (by averaged 1.37 ± 2.80 Kg weight loss and by 2% reduction in BMI) was seen during the first 2 months of program. The least weight loss was seen between third to 6th months (0.17± 2.86 Kg). Not only the mean of weight at the end of 12th months did not show significant changes compared to baseline, but also this variable increased in female group.

BMI: Initially the changes in BMI trended to be decreasing; however, this decrease was more prominent during the first six months and was negligible during the second six months by averaged 0.86±1.68 Kg/m^2. The BMI had increasing trend to achieve the base values in females during the second half of study ($P= 0.078$). The most reduction in BMI was seen during the first 3 months that was more prominent in males ($P< 0.001$).

WC: The changes in WC, similar to BMI, trended to be decreasing; however this decrease was more significant during the first six months, and was not statistically significant in female group during the second half of study course.

WHR: This index had significant reduction in all patients after 2, 6 and 12 months ($P< 0.01$); however, this improvement was more prominent at the end of supervised CR program. Males showed more reduction in WHR in compared to females ($P< 0.001$). Table 4 shows the mean±SD of the changes of body indices at the end of each phase.

Discussion

At the initiation of the study, weight mean and WHR

Table 1. The baseline body indices of patients as mean± SD

Parameter	Male	Female	Test	Total
Weight (kg)	74.40±9.4	66.46±8.3	S	72.38± 9.8
WC (cm)	94.4± 7.2	96.8± 8.4	NS	95.02± 7.5
Hip circumference (cm)	95.12±5.5	99.78± 8.08	NS	96.32± 6.5
WHR	0.98±0.048	0.97± 0.070	S	0.98± 0.054
BMI (kg/m^2)	26.76± 2.81	27.15±3.60	S	26.19± 3.05

Table 2. The mean± SD of body indices and changes at the end of supervised CR program

Body index and its change (mean± SD)	Male	Female	Total
Weight (kg)	72.93 ± 9.2 (1.43 ± 8.20)	65.25±8.2* (1.19±.2.8)	70.92±9.6* (1.37±2.80)
WC (cm)	91.43± 6.8* (2.74±3.2)	94.78±7.8 (1.98±5.4)	92.35±7.2* (2.53±3.9)
Hip circumference (cm)	94.81±5.8 (0.22±2.45)	98.01±6.7 (1.76±6.5)	95.62±6.2* (0.63±4)
WHR	0.98 ±0.040* (0.025±2.9)	0.97±0.079 (0.003±0.04)	0.96±0.052* (0.020±4.47)
BMI (Kg/m^2)	25.24 ±2.6* (0.51±1)	26.85±3.50* (0.49±1.13)	25.64±2.98* (0.51±1.03)
*statistically significant			

Table 3. The body indices of patients at the end of 12th month as mean± SD

Body index	Male	Female	Total
Weight (kg)	73.68 ±8.7	70.21 ± 6.4	72.52 ±8.03
WC (cm)	95.68 ± 6.8	99.71 ± 7.4	96.91±6.7
Hip circumference (cm)	98.20 ± 3.7	102.00 ± 5.4	96.37±6.5
WHR	0.94 ± 0.058	0.97 ± 0.070	0.95 ± 0.062
BMI (Kg/m^2)	25.17±2.4	28.69±2.6	26.05 ± 2.90

Table 4. The mean±SD of the reductions of body indices at the end of each phase

Body index	First month	Second month	6th month	12th month
Weight (kg)	0.80±1.5*	1.37±2.80*	1.57±4.1	-0.16±4.6
WC (cm)	1.75±3.3*	2.53 ± 3.9	2.22±6.2	0.34±5.4
Hip circumference (cm)	-2.21±5.4*	0.63 ± 0.4	-1.16±6.18	-1.27±4.1
WHR	0.019±0.078*	0.020±0.044*	0.030±0.063*	0.023±0.053*
BMI (Kg/m^2)	0.30±0.56*	0.51±1.03*	0.55±1.52*	0.086±1.68*

*Statistically significant

were higher in males than females but BMI, WC and hip circumference were higher in females. In a study by Rasulinejad *et al*., baseline BMI in female coronary patients was shown to be more than males.[30] According to Mccannell *et al*., mean weight was more in males than females but the fat percentage was more in females. Weight mean in their study was 73.5 kg and 85.5 kg in females and males respectively. However, in our study, female mean weight was about 66.5 kg and 74.5 kg in females and males respectively; about 10kg less than that of Mccanell's study.[31] Although in our study females were more obese, fat distribution in males was more unsuitable. WHR more than 0.85 in females and more than 1 in males is accompanied by abnormalities in lipoprotein metabolism and insulin-glucose responses.[2] WHR more than 0.9 and WC more than 100 cm in males and WHR more than 0.8 and WC more than 90 cm in females have been reported as the risk factors in cardiovascular disease.[32,33] In our study WHR, in 47.5% of patients (42 males and 14 females), was more than 1 that shows the fat distribution in their body was not balanced. 16.5% of participants were diabetic; WHR in 11 patients was more than 1 (WHR≥ 1). In our study, WC in 24 patients (22.9 %) was less than 100 cm (≤100) and including 8 females and 16 males. Various classifications have been presented for BMI, in Lavie's study about heart rehabilitation in BMI> 27.8 kg/m^2 in females was obese[34]; however, 20 <BMI <25 in ideal, 25 ≤ BMI ≤30 is unanimously accepted as overweight and BMI ≥30 as obese. Furthermore, in people more than 18 years, 25 <BMI is high risk for cardiovascular diseases. It has also been suggested that, people with BMI ≥25, WC ≥90 cm and triglyceride≥2 mmol/lit are at increased risk for vascular disease and must be treated promptly.[35]

Before rehabilitation, 52% of patients were overweight. After two months, this rate decreased to 42% and obesity from 12% to 10.2%. Our results suggested that the mean reduction of weight and BMI was approximately 2% and was more prominent in overweight patients in contrast to Milani's study in which the rate was 3% and more frequent in obese patients.[36]

Simialr to the study of Buenmann *et al*., these changes in males and young people of our study were more frequent than females and old people. Lavie has observed that body composition changes in young people was better than old peoples.[5]

In 1997, Lavie in another study on 588 coronary patients after three months supervised CR, showed a 2% reduction in BMI which even reached to 5% in obese patients.[37] It was then strongly suggested that supervised CR program could modify risk profile especially in more obese patients. Attention to this note is very important that even very tiny changes in body competition can affect other cardiac risk factors such as hypertension, hyperglysemia and blood lipides significantly.[10-14] Also 1% improvement in body indices up to 12% has positive effect on weight adjusted peak aerobic capacity.[2] Results of rehabilitation and patient responses have been reported to be the same in surveyed programs and programs without surveillance; in order to decrease cost and resources, patients can be rehabilitated in their homes.[38,39] In another study, patients in two separate groups took rehabilitation at home and hospital, rehabilitation in home had a better progress in health-related quality of life than group who had been rehabilitated in hospital. Later, it was suggested that low risk patients with coroner surgery can have better rehabilitation at home.[40] In contrast to the study of Ilarrazed *et al*.[41], in our study, most of proper changes from rehabilitation for patients occurred during the first six months, especially in the first two months; however, they were very low in the second half of the study. When patients were under the CR in their home and in this time return of body composition indices to baseline was observed. However, no studies have investigated the effect of home-based CR among different groups of patient such as elderly[42], diabetic, obese and other subgroups of patients with coronary heart disease in a long-term follow-up. The altercative note is that in our study patient mean age was 53.83±8.01 (77.1% males) our population was more younger than the same studies in rehabilitation such as Milani's study (mean= 63±11; 80% male) or Brochu's study (mean=61.2±12.2; 72% male) which means that cardiovascular disease prevalence in young people is increasing in our country. Our population was the same as other studies regarding sex distribution which is due to high prevalence in males[10,11] and the fact that males also come to rehabilitation centers which should be considered in in the future studies.

A few studies have demonstrated that significant weight loss can be achieved but at high cost and effort [29,43,44], however these questions remain: are patients willing to high energy expenditure exercise? is there the long term

weight maintenance in the CR patients follow up?

It should be emphasized that a less successful reduction in body indices does not undermine the beneficial effects of exercise training[45], as the Heijden's study showed no significant changes were observed in any parameter in lean participants except a small increase in lean body mass. However, in their study, they found a controlled aerobic exercise program, without weight loss, reduced hepatic and visceral fat accumulation, and decreased insulin resistance in obese adolescents.[46]

From a public health perspective, few patients seem to participate in rehabilitation programs after coronary interventions.[47] so, exercise should be encouraged even if its weight loss effect is small, it can produce physiological[48] and psychological benefits[49] in the management of obesity, including prevention of weight gain.

Another subject that should be remembered is that education level is very low in our society now and media and different organization should pay attention to public education at different social levels. Physicians and scientific staff beside people with establishing charities and nongovernmental organizations should pay attention to the education as the best way for prevention.

Study limitation

1. Lack of control group.
2. The less number of female participants in comparison with males.
3. Lack of direct controlling on the patient diets.
4. The psychological control programs were discontinued and were not maintained in unsupervised course.

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Ethical issues: All patients gave written informed consents and the study was approved by our local Ethics Committee.

Conflict of interests: The authors declare no conflicts of interest.

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