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Original Article

COMPARISON OF EFFECT OF WEIGHT LOSS AND PHYSICAL EXERCISE ON THE CARDIAC RISK PROFILES OF MIDDLE-AGED WOMEN WITH OVERWEIGHT: A QUASI-EXPERIMENTAL STUDY

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Abstract

Background & Aims: Cardiovascular risk is reduced by both sports training and losing weight, but the independent value of these two plans is unclear. This study examined the influence of physical exercise and weight loss on cardiac risk profiles (CRP) in overweight inactive middle-aged women.

Materials & Methods: Seventy-six individuals in a quasi-experimental design with a control group were classified for 12-week into four groups: a sports group (S, n = 20), a group with energy-restricted diet (E-rD, n = 19), a sports group with boosted diet (S-bD, n=20), and a control group (C, n = 17). The rate of energy reduction was equal (approximately 15% of the daily need for calories) to physical exercise in S and energy restriction in E-rD. The S-bD group performed the same amount of exercise but remained in energy balance due to the 15% increase in calorie intake during training. The components of CRP were measured at baseline and post-study.

Results: Body weight was similarly diminished between S (-5.9 ± 2.8 kg) and E-rD (- 5.4 ± 2.9 kg), whereas it stayed stable in S-bD (-0.9 ± 2.9 kg), and C (-0.2 ± 5.6 kg). Levels of TC and LDL-C were lowered in S compared to C ($P < 0.001$ for both), but not found in E-rD ($P > 0.05$). Changes in TC and LDL-C were associated with changes in body weight ($P < 0.05$). In S-bD, a rise in HDL-C was observed ($P < 0.001$).

***Conclusion*:** Weight loss due to exercise reduces pro-atherogenic lipoproteins, whereas physical activity compensated by energy consumption raises the HDL-C level.

Keywords: Lipid Metabolism, Lipid Regulating Agents, Middle Aged, Overweight, Physical activity, Problems and Exercises, Weight Loss Diet

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Introduction

Over the past decades, the prevalence of obesity has increased worldwide (1). Based on the recent estimates of obesity, at least 30% of men and 35% of women suffer from obesity around the world (2, 3). Dyslipidemia is a prominent cardiovascular risk factor linked to obesity and physical inactivity (4, 5). Management of dyslipidemia depends on lifestyle (Physical activities and diet) and pharmacological intervention using statins (6). In the previous studies, the effect of physical activity and losing weight on cardiac risk profiles (CRP) or dyslipidemia were examined. In

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two studies, researchers found that both physical activity and diet have favorable effect on CRP and body composition, with additional beneficial effects when superimposing exercise to a low-cholesterol diet (7, 8). Most often, weight loss is accompanied by lowering total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C) and triglycerides (TG), while exercise independently of weight loss increases high-density lipoprotein cholesterol (HDL-C) (9, 10). In spite of these elegant results, separate and combined effects of physical exercise and losing weight on CRP of overweight subjects with inactive lifestyle are not well known.

Objectives:

This research investigated the independent and combined effects of physical exercise and losing weight on CRP in inactive middle-aged women who are overweight. We hypothesized that weight loss independently would promote most of the beneficial effects on CRP.

Materials and Methods

1. Study design

The design of the study has been carried out based on a quasi-experimental design with a control group, without any random pre-selection processes. Healthy and normolipidemic participants (n = 76) were selected among all overweight females (n = 95) aged 45–65 years that had come to the nutrition clinic over the three months before the study (Summer 2017) for weight loss counselling. The research team had three members: a physician and two volunteers (nutrition expert and sports coach) who were working in the clinic. Participants were eligible for participation based on the following inclusion criteria: body mass index (BMI) of 25 to 29.9 kg/m^2, sedentary lifestyle, weight-stable (± 2kg, for over one year), non-smokers, blood pressure (BP) less than 140/85 mmHg and without a history of cardiovascular disease, diabetes, eating disorders, food allergies, chronic medication usage, kidney disease, cancer, and depression. Enrollment, classification, and assignment of participants in the experiments were accomplished under the supervision of the physician.

2. Interventions

After the initial evaluation, eligible participants (n=76) were randomly assigned to 12-weeks ofintervention in one of the four groups: a sports group (S, n = 20), a group with a 15% energy-restriction in dietary (E-rD, n = 19), a group of sports with a 15% boost in the diet (S-bD, n = 20), and group of control (C, n=17). All study groups got a low-calorie diet (Details: 15% protein, 55% carbohydrate and 30% fat) based on dietetic recommendations of USDA (the United States Department of Agriculture) and FSA (the United Kingdom Food Standards Agency) (11-13). A deficit of 15% in daily calorie needs was considered to determine weight loss at a healthy and effective rate (11, 12, 14). The lacks of energy were set to equal (approximately 15% of the daily need for calories) by physical exercise in S and restriction of caloric in E-rD. S-bD performed the same exercise but remained in energy balance because the 15% increase in calorie intake was used during training. The exercise was performed in AVA Sports Club (Zahedan, 2017) and energy costs rose equally in sports groups (S, S-bD) as they underwent supervised training five days a week (three sessions of endurance training with modalities such as running, stationary cycling and jogging as well as two weight-training sessions a week).

3. Measurement

The parameters of weight loss evaluation included body weight, BMI, and CRP components were carried out pre- and post-study for all individuals and then they were compared together. Participant’s selection with the inactive lifestyle, the physical activity level (PAL), blood sampling, as well as measurements of BMI, BP, and components of CRP were described in more detail (12, 13, 15, 16). The evaluation of CRP components for further analysis was as follows: the concentration of TC in plasma below 200 mg/dl, LDL-C below 130 mg/dl, TG below 150 mg/dl and, finally, HDL-C levels in plasma below 40-60 mg/dl.

The maximum oxygen consumption was 65-85% (starting from 40% of the maximum oxygen consumption). Heart-Rate Monitors (Bowflex, Nautilus Inc., Canada) were used for the measurement of exercise-induced heart rate [220 – age × (65% to 85%)]. In addition, the time taken to consume 15% of the daily calorie needs per session for each participant was measured using an indirect calorimeter (Fitmate, Cosmed, Italy).

Daily calorie needs for each participant was estimated by multiplying the basal metabolic rate (BMR) and PAL. For a more accurate evaluation of the BMR in women of 31 to 60 years old equation (1) [(weight in kg × 8.7) + 829] was utilized and for women over 60 years, equation (2) [(weight in kg × 10.5) + 596] was used (11, 14, 16). Daily caloric needs, its levels of change, and daily energy intake are shown in Table 1.

Table 1. Daily Caloric Needs, Its Levels of Change and Daily Energy Intake

Group	Daily caloric needs*	Levels of change	Daily energy intake** (kcal)
S (n = 20)	2334 ± 13	n.a.	2334 ± 13
E-rD (n = 19)	2327 ± 18	- 15%	1977 ± 93
S-bD (n = 20)	2343 ± 14	+ 15%	2694 ± 35
C (n=17)	2355 ± 1	n.a.	2355 ± 1

All data are expressed as mean ± SD. Abbreviations: S = sport; E-rD = Energy-restriction in dietary; S-bD = Sport with boosted diet; C = Control group

* Daily caloric needs = BMR × PAL

** Daily energy intake = (BMR × PAL) – Levels of change

4. Method management

Participants presented permission and stated that the intended research was not contraindicated for them. All methods and conditions have been clarified to participants. They voluntarily signed the form of consent before taking part in the research. This study was carried out following the Helsinki Declaration and approved by the institutional ethical committee. The method has not changed during the study. Changes in PAL or diet during periods of such studies are associated with potential confounding effects. Therefore, it was recommended that they maintain their PAL and current regimens during the study. They have learned how to report any issues that might influence their research contribution. A rigid approach to implement and monitor dietary adherence was conducted; all participants in E-rD and S-bD received face-to-face instructions in order to comply with caloric targets. In addition, weighted dietary registrations of food consumption were performed during the second, sixth and tenth weeks of intervention by all participants and were immediately checked by staff for diet compliance by processing these records in the 'Diets In Details' software to assess dietary composition and quantity (11-13). Also, all participants except group C met the staff twice a week to ensure compliance with both the exercise and diet interventions. These face-to-face meetings included an assessment of one or both exercise and diet assignments, as well as the trajectories of weight loss.

5. Statistical analyses

This study was an efficacy study and only the participants that completed the study were included in data analysis. Descriptive pre- and post-intervention data are described as means ± SD. Intra-group changes were assessed using a paired t-test, and intergroup differences were evaluated using a covariance analysis (ANCOVA) with post-intervention values as a dependent variable and baseline values and group assignment as covariates. All pairwise comparisons were adjusted using the Tukey procedure. Associations between baseline scores and change scores were assessed using Pearson's correlation analysis. The significance level was chosen as $P < 0.05$ and 95% confidence interval (CI). Statistical analysis was accomplished with SPSS software (version 19.0; SPSS Inc.; USA) for Windows.

Results

1. Study population

In all four groups, seventy participants completed the intervention; thus out of 76 participants randomized, six participants dropped out: three because of dissatisfaction with their randomization and two participants were afraid of needles and one subject lost his/her motivation to continue the study during the intervention phase. Restriction on the size block and blocking did not exist (15, 16). Subjects' morphological characteristics are presented in Table 2

Table 2. Subjects' Morphological Characteristics in Each Group at Baseline

	S (n = 20)	E-rD (n = 19)	S-bD (n = 20)	C (n=17)
Age, years	60.2 ± 10.3	59.4 ± 8.7	58.9 ± 9.6	59.6 ± 7.8
Height, m	1.61 ± 6.2	1.65 ± 5.6	1.63 ± 6.0	1.62 ± 4.5
BMI	28.6 ± 2.1	27.3 ± 2.3	28.4 ± 2.6	27.1 ± 2.4
SBP, mm Hg	128.9 ± 6.7	129.3 ± 7.6	130.5 ± 4.6	129.1 ± 5.7
DBP, mm Hg	79.9 ± 4.3	80.1 ± 2.1	79.7 ± 3.5	79.8 ± 3.1

Data are means ± SD. BMI= Body Mass Index; SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure; S = sport; E-rD = Energy-restriction in dietary; S-bD = Sport with boosted diet; C = Control group

2. *Baseline characteristics*

No significant changes were found between groups in terms of the percentage of energy consumed as dietary fat, at least moderate intensity, and minutes of physical activity of leisure. There were no significant differences in body weight, TC, HDL-C, TG, and LDL-C before the intervention. The demographic characteristics of subjects are presented in Table 3.

Table 3. Subjects' Demographic Characteristics in Each Group at the Pre-test and Post-test Plus the P-Value of Comparing Mean within

	S (n = 20)	E-rD (n = 19)	S-bD (n = 20)	C (n=17)
Pre-test				
Weight, kg	73.4 ± 6.4	74.3 ± 7.2	75.4 ± 5.3	71.2 ± 6.1
T-C, mg/dl	166.3 ± 8.2	170 ± 9.2	167.5 ± 6.9	169.5 ± 7.8
HDL-C, mg/dl	39.8 ± 2.5	46.0 ± 3.1	36.4 ± 2.3	36.8 ± 2.8
LDL-C, mg/dl	112.2 ± 6.3	108. 4 ± 7.1	104. 3 ± 6.8	108.6 ± 6.9

Post-test				
Weight, kg	67.5 ± 3.7*‡Δ	68.9 ± 4.2*‡Δ	74.5 ± 2.3	71.0 ± 1.6
T-C, mg/dl	135.0 ± 2.9*‡Δ	150.6 ± 3.8	175.2 ± 4.1	169.9 ± 7.5
HDL-C, mg/dl	37.9 ± 2.7	48.7 ± 2.9	42.3 ± 2.0Δ	37.4 ± 3.0
LDL-C, mg/dl	85.2 ± 5.4Δ	96.8 ± 6.3	112.3 ± 6.9	106.7 ± 6.3

All data are expressed as mean ± SD. TC = total-cholesterol; HDL-C = high-density lipoprotein cholesterol; LDL-C = low-density lipoprotein cholesterol; * *P* < 0.05 in compare to C, § *P* < 0.05 in compare to E-rD; ‡ *P* < 0.05 in compare to S-bD; Δ *P*<0.05 in compare to baseline; S = sport; E-rD = Energy-restriction in dietary; S-bD = Sport with boosted diet; C = Control group

3. *Outcomes of study*

After research, S and E-rD lost weight; losing weight in S and E-rD were significantly different in comparison with S-bD and C (P < 0.05). TC reduction in S was mediated by a decline in LDL-C level (P <0.01), and changes in TC were connected with modifications of the LDL-C level (P <0.001). TC and LDL-C were not affected in E-rD compared to C (P > 0.05), although there was a tendency towards a decrease within E-rD (TC: P = 0.05; LDL-C: P =0.08). HDL-C (P > 0.05 for all comparisons) was not affected by the interventions, but in S-bD, HDL-C increased from baseline within the group (P < 0.001). Modifications of TC and LDL-C were associated with changes in body weight (P < 0.01). The duration of the physical activity of leisure time did not show significant differences between the groups (P > 0.05).

Discussion

Exercise and weight loss, as strategies of lifestyles, reduce the risk of cardiovascular attacks in overweight subjects, but their relative effects and mechanistic basis are not clear. The influence of exercise and diet on weight reduction and CRP of sedentary overweight middle-aged women were explored in this study as independent and combined. The main consequence of the study was that exercise-induced weight loss by reductions in TC and LDL-C had a significant effect on lowering the risk of cardiovascular disease while losing weight by diet did not produce significant effects. Furthermore, the study found that with an increase in dietary intake, HDL-C only increased after exercise training (hence without weight-loss) suggesting that such beneficial changes require neutral energy balance, and this finding is an important clinical feature. Blood triglyceride levels are linked to the type of diets. Since the diets in the groups were the same, the TG variable was excluded from research (11-13, 15, 16).

Elevated lipids of blood are risk factors for cardiovascular disease (CVD) and worsen with age (12, 15, 16). Previous research suggests that CRP can be strongly influenced by weight-loss (16, 17). Long-term studies from Wood and colleagues show that CRP improves more when the exercise is added to weight loss (7, 18). Further evidence suggests that exercise and diet independently has beneficial effects on lipoproteins (19). Nevertheless, contrary to dietary changes, exercise was not performed daily (i.e. daily diet vs. exercise three times per week) in these studies. The study found that TC and LDL-C were reduced with an exercise-induced weight loss, and the decline in these ratios reflects the clinical relevance of sport. These findings are partly comparable to recent studies by Weiss et al.. They evaluated the effects of a 7% weight-loss induced by either caloric restriction, exercise alone or a combination of diet and exercise in postmenopausal women and middle-aged men with overweight over 12-

14 weeks (20). That study did not include any control groups, but the TC and LDL-C were similarly reduced in all interventional groups. In this study, TC and LDL-C were reduced only in exercise-induced weight loss compared to control groups. These results are not consistent with the findings of Rezaeipour et al., which were made on models of exercise time (15, 16) and negative calorie diet (11-13), as well as outcomes of Pedersen et al., about weight-loss using dietary restrictions as well as exercise (21). However, these findings agree with the results of Rosenkilde et al. (22). In addition, in line with previous studies (16, 23), changes in body weight were positively related to TC and LDL-C variables. An obvious explanation is that the mediating factor in the improvement of cardiovascular risk is a reduction in weight.

Plasma HDL-C often increases in response to exercise training (11, 12, 24, 25), but the study showed an increase in HDL-C when calories expended during exercise were replaced by an increase in energy intake (in S-bD). It is hypothesized that HDL-C would have increased with the exercise- and diet-induced weight loss in our participants if energy balance had been restored to neutral, but participants of S and E-rD were still in a catabolic state when the post-intervention samples were obtained. The increase of HDL-C ratio in S-bD is highlighting the clinical relevance of exercise and neutral energy balance which can clinically be used to reduce the risk of cardiovascular disease. Sopko et al. used a similar design as in the present study. They indeed demonstrated incremental additive effects of exercise and diet on HDL-C (26).

One of the limitations of the current study was selection of middle-aged women. Gender differences are well-known in the metabolism of lipids and lipoproteins (27); therefore, the impact of this study on men cannot be generalized. Other limitation of this study was related to the allocation. The allocation was blinded for participants and investigators at the time of randomization; but due to the nature of the study, the allocation could not continue to be blind. Further studies are recommended to study middle-aged men. Side effects that were recorded during this study (caused by low-calorie diet intake) were headache and constipation. These clinical side effects were reported in previous studies (15, 28).

Conclusion

In summary, results showed that 12 weeks of physical activity accompanied by weight loss led to a decrease in TC and LDL-C. Therefore, exercise accompanied by weight loss robustly reduced pro-atherogenic lipoproteins particles. In addition, physical exercise compensated by energy intake increased HDL-C, and as such improves the CRP of inactive women with overweight.

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