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Research Article

Influences of Weight Loss and Physical Exercise on Lipid Panel in Overweight Middle-Aged Men

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Abstract

Background: Cardiovascular risk is reduced by weight loss and exercise, but their relative effects and independent significance are unclear.
Objectives: The effect of weight loss and the implementation of an exercise strategy on the lipid panel of overweight middle-aged men, who lead a sedentary lifestyle, was investigated.
Methods: Eighty four men participated in this 12-week cross-sectional study. Participants were randomly assigned to the four study groups: endurance sports, energy-restricted diet, endurance sports with boosted nutrition, and control. The energy reduction rate was the same (approximately 15% of the daily calorie requirement) for the group involved in endurance sports and for the group with an energy-restricted diet. The participants in the endurance sports with boosted nutrition performed the same exercises but remained in energy balance due to a 15% increase in calories during training. Participant lipid panel profile and weight loss parameters were measured once at the start of the study, and again at the end.
Results: Weight loss was the same between the endurance sports (-6.5 ± 0.6 kg) and energy-restricted diet (- 6.2 ± 0.5 kg) groups. Whereas in the endurance sports with boosted nutrition (-0.8 ± 0.4 kg), and control (-0.1 ± 0.7 kg) groups, weight remained constant. Levels of TC and LDL-C decreased in the endurance sports compared to the control group ($P < 0.001$ for both). This change was not observed in the energy-restricted diet group ($P > 0.11$). Differences in TC and LDL-C levels were connected with changes in body mass ($P < 0.01$). In the endurance sports with boosted nutrition group, we noted a rise in HDL-C ($P < 0.001$).
Conclusions: A decrease in body weight caused by exercise reduced pro-atherogenic lipoproteins, while physical activity compensated with energy consumption increased HDL-C.

Keywords: Lipids, Men, Metabolism, Sports, Weight Loss

1. Background

The inevitable consequences of excessive weight in the elderly are physical difficulties, higher costs of medical care (1), as well as increased morbidity and mortality (2). Over the past decades, the prevalence of overweight and obesity has increased worldwide (3). Overweight is found in 70% of middle and older age groups (age ≥ 45 years). These individuals are at risk for obesity (4). Dyslipidemia is a significant risk factor for cardiovascular disease, which is connected with overweight and lack of physical activity (5, 6). Management of dyslipidemia depends on lifestyle modifications, like physical activity and diet, in addition to statin drug interventions (7). Previous studies have shown the impact of weight loss and physical exercise on lipid panel and dyslipidemia (8-11). Studies of overweight individuals have shown that exercise and diet can help reduce the concentration and composition of the lipid panel, especially when a low-cholesterol diet is added to exercise (12, 13). In most cases, weight loss is associated with a decrease in total cholesterol (TC), triglycerides, and low-density lipoprotein cholesterol (LDL-C); while exercise independent from weight loss causes an increase in high-density lipoprotein cholesterol (HDL-C) (14, 15). Despite these results, the combined and independent impacts of physical exercise and weight loss for lipid panel in overweight individuals with a sedentary lifestyle are not well known.

2. Objectives

This study examined the combined and independent impacts of physical exercise and weight loss on lipid panel levels of sedentary overweight men in the middle age category.

3. Methods

3.1. Study Population

This cross-sectional study was conducted in the Ukrainian Sports Medicine Center (Kyiv, summer, and autumn 2018) for 12 weeks. The available population included 107 sedentary, overweight middle-aged men. These individuals ranged in age from 45 - 65 and had come for a weight loss consultation. The calculation of sample size was performed using the following equation, for 0.05 (error of 5%).

$$n = \frac{C^2 Np\,(1-p)}{(A^2N) + (C^2p\,[1-p])} = \frac{1.96^2 \times 107 \times 0.5 \times (1-0.5)}{(0.05^2 \times 107) + (1.96^2 \times 0.5 \times [1-0.5])} \simeq 84 \quad (1)$$

As per our calculation, 84 participants were selected and assigned randomly to one of the four study groups: endurance sports (n = 21), energy-restricted diet (n = 21), endurance sports with boosted nutrition (n = 21), and control (n = 21). The study inclusion criteria were as follows: body mass index (BMI) of 25 to 29.9 kg/m^2, weight stability ($\pm$ 2 kg, over three months), non-smoker, blood pressure (BP) below 140/85 mmHg; no history of cardiovascular disease, diabetes, eating disorders, food allergies, chronic medication use, kidney disease, cancer, or depression. Participants with abnormalities in their electrocardiogram or thyroid gland, including any history of taking weight control, weight loss or anti-obesity drugs, were also excluded.

3.2. Procedures

Each participant, regardless of group, received a low-calorie diet with 30% fat, 15% protein, and 55% carbohydrates based on the dietary recommendations of the United States Department of Agriculture and Food Standards Agency of the United Kingdom (16, 17). A deficit of 15% in daily calorie requirements was considered as weight reduction at a healthy and effective rate (17, 18).

The energy reduction rate was the same (approximately 15% of the daily calorie requirement) for the group involved in endurance sports and for the group with an energy-restricted diet.

The endurance sports with boosted nutrition group performed the same exercises but remained in energy balance due to the 15% increase in calorie consumption that was used during training. Energy costs in the exercise groups (endurance sports with or without boosted nutrition) were increased similarly; this was because they were controlled by three sessions of endurance exercises with modalities like stationary cycling, running, and jogging. Physical exercise was performed in the Hermas Sports Club.

3.3. Measurement

BMI was determined by dividing weight (kg) by height (m) squared. Body height and weight were measured without shoes using light street clothing by stadiometer (wall-mounted) and a digital scale (Scale-Tronix model 5002, Wheaton, IL, USA), respectively (18-20). The accuracy of both tools was 0.1 (cm or kg).

High-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and total cholesterol (TC) were assessed by enzymatic methods (using COBAS, Roche Diagnostics, Germany). Exercise intensity was set between moderate to high or 70% - 85% of maximum heart rate (20). Heart rate monitors (RS400, Polar Electro Oy, Kempele, Finland) were utilized for measuring energy expenditure. To ensure exercise program compliance, the monitors stored data on exercise frequency, duration and heart rate. Daily calorie requirements were measured for each participant by the multiplication of physical activity level PAL and basal metabolism rate (BMR). A more accurate BMR calculation for men from 45 to 60 years of age was calculated using Equation 2: [(mass in kg $\times$ 11.6) + 879]; and in men who were more than 60 years old, Equation 3: [(mass in kg $\times$ 13.5) + 487] was used (11, 17, 18).

Daily calorie requirements, levels of its changes, and daily energy consumption are noted in Table 1.

3.4. Method Management

Participants were instructed to complete diary records, 3 days per week, including 1 day on a weekend, for a period of four days prior to the research study. The same procedure was required throughout the study to control leisure-time physical activity and nutritional habits (18, 19). This study was conducted under the Helsinki Declaration and approved by the institutional ethics committee. Participants were educated about the research study

Table 1. Daily Calories Needed, Amount of Change, and Daily Energy Consumption[a]

	Endurance Sports (N = 21)	Energy-Restricted diet (N = 22)	Endurance Sports with Boosted Nutrition (N = 22)	Control (N = 19)
Daily caloric requirements[b]	2852 ± 16	2844 ± 11	2863 ± 15	2878 ± 13
Levels of change	NA	-15%	+15%	NA
Daily energy consumption, kcal[c]	2852 ± 16	2417 ± 23	3292 ± 17	2878 ± 13

[a]Values are expressed as mean ± SD.
[b]Daily caloric requirements = BMR × PAL.
[c]Daily energy consumption = (BMR × PAL) - levels of change.

details, they were also provided with a medical certificate which stated that the study was not contraindicated. Subsequently, participants provided written informed consent before enlistment.

3.5. Statistical Analysis

Descriptive study data is noted as means ± SD. Statistical analyses were conducted with SPSS software, version 19. Intra-group changes were assessed using a paired t-test. Inter-group differences were evaluated by covariance analysis (ANCOVA) using the values after the intervention as a dependent variable, with baseline values and group distribution as covariates. All pairwise comparisons were adjusted by using the Tukey procedure. The correlation of the pre- and post-study data was evaluated using Pearson's correlation analysis. The significance level was set as $P < 0.05$.

4. Results

4.1. Study Population

Out of the 84 participants, four participants dropped out; two participants cited a loss of motivation, and two others reported a fear of needles. In total, eighty participants completed the research study; their descriptive characteristics are presented in Table 2.

4.2. Baseline Characteristics

No significant differences in group data were found between groups in terms of the percentage of energy consumed as dietary fat, and minutes of leisure-time physical activity ($P > 0.05$). As can be observed in Table 3, there were no significant differences in weight, TC, LDL-C, and HDL-C prior to the start of the study ($P > 0.05$).

4.3. Outcomes of the Study

After participating in the research study, individuals in the endurance sports and energy-restricted diet groups lost weight. The weight loss noted in the endurance sports and energy-restricted diet groups in comparison with the endurance sports with boosted nutrition and control groups was significantly different ($P < 0.05$, Figure 1A). The TC reduction in the endurance sports group was mediated by a decline in LDL-C level ($P < 0.01$), and variations in TC were connected with LDL-C level changes ($P < 0.001$, Figure 1B). LDL-C and TC were not affected in the energy-restricted diet group compared to control ($P > 0.05$), although within the energy-restricted diet, there was a there was a tendency to reduce within TC ($P = 0.05$) and LDL-C ($P = 0.08$) as shown in Figure 1B and C. HDL-C ($P > 0.05$ for all comparisons) was not impacted by the interventions, but HDL-C in the endurance sports with boosted nutrition group rose from the level noted initially within the group ($P < 0.001$, Figure 1D). Changes in the LDL-C and TC were linked to differences in weight ($P < 0.01$). Leisure time differences were not significant between groups ($P > 0.05$).

5. Discussion

The influences of physical exercise and weight loss on lipid panel in overweight middle-aged men were explored in this study both independently and collectively. Our main finding was that exercise with TC and LDL-C depletion had the most significant impact on cardiovascular risk; whereas, dietary-induced weight loss did not result in significant study outcomes (Figure 1B and C). Moreover, HDL-C considerably improved only after exercise training with boosted nutrition (and, therefore without losing weight, Figure 1A and D). This shows that such beneficial changes require a neutral energy balance. The triglyceride levels of blood depend on food intake.

Thus, similar to previous research studies (18-20), we also chose to omit this variable.

Table 2. Initial Characteristics of All Groups[a]

Descriptive Statistics	Endurance Sports (N = 21)	Energy-Restricted diet (N = 22)	Endurance Sports with Boosted Nutrition (N = 22)	Control (N = 19)
Age, years	59.8 ± 8.3	59.5 ± 7.8	59.2 ± 6.8	58.9 ± 8.5
Height, cm	173 ± 4.3	176 ± 6.2	174 ± 4.2	172 ± 5.6
BMI, kg/m^2	29.1 ± 2.3	29.2 ± 2.5	28.8 ± 2.4	28.6 ± 2.3
SBP, mmHg	126.8 ± 7.4	128.8 ± 6.5	127.3 ± 5.7	126.3 ± 6.2
DBP, mmHg	80.1 ± 3.5	81.2 ± 3.2	80.3 ± 3.5	79.7 ± 4.2

Abbreviation: BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure.
[a]Values are expressed as mean ± SD.

Table 3. Individual Characteristics in Each Group Before and After Research Participation Plus P Value of Comparing Mean Within

Study Groups	Endurance Sports (N = 21)	Energy-Restricted Diet (N = 22)	Endurance Sports with Boosted Nutrition (N = 22)	Control (N = 19)
Pre-intervention				
Weight, kg	87.3 ± 4.5	87.6 ± 5.7	86.5 ± 5.4	85.4 ± 4.7
TC, mmol/L	4.91 ± 0.18	4.94 ± 0.13	4.97 ± 0.17	4.93 ± 0.16
HDL-C, mmol/L	1.33 ± 0.06	1.32 ± 0.09	1.31 ± 0.07	1.33 ± 0.08
LDL-C, mmol/L	3.15 ± 0.11	3.25 ± 0.11	3.21 ± 0.11	3.19 ± 0.1
Post-intervention				
Weight, kg	80.8 ± 5.5[b, c, d]	81.4 ± 4.7[b, c, d]	85.7 ± 5.4	85.3 ± 5.7
TC, mmol/L	4.11 ± 0.11[b, c, d]	4.43 ± 0.12	5.16 ± 0.15	4.94 ± 0.15
HDL-C, mmol/L	1.28 ± 0.06	1.39 ± 0.08	1.48 ± 0.05[d]	1.34 ± 0.07
LDL-C, mmol/L	2.48 ± 0.13[d]	2.95 ± 0.18	3.41 ± 0.17	3.17 ± 0.15

Abbreviations: HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; TC, total-cholesterol.
[a]Values are expressed as mean ± SD.
[b]$P < 0.05$ in compare to control.
[c]$P < 0.05$ in compare to endurance sports with boosted nutrition.
[d]$P < 0.05$ in compare to baseline.

Elevated lipids levels in the blood are risk factors for cardiovascular disorders and worsen with age (21). Previous research suggests that the lipid panel can be strongly influenced by weight loss (11, 22). Wood et al. (13) show that the lipid panel improves to a greater extent when weight loss is added to exercise. Further evidence indicates that diet and physical exercise independent from each other have positively impact lipoproteins (23). However, contrary to dietary alterations, exercise training was conducted on a daily basis in these studies. Our research showed that LDL-C and TC declined with weight loss due to exercise (Figure 1B and C). In a study conducted by Weiss et al., they assessed the impacts of a 7% weight loss from caloric limitation and exercise over the course of three months (24). They examined the effects of exercise and dietary changes separately and concurrently as a mixed regiment in overweight middle-aged men and postmenopausal women. They did not include a control group in their study. Similar to the results we obtained, they noted a decrease in LDL-C and TC in all study groups. In the current research study, we observed that LDL-C and TC were reduced only in the group that lost weight from exercise compared to the control group. These results are in disagreement with the outcome reported by Rezaeipour et al. (18) and Pedersen et al. (25) about weight loss using dietary restrictions and exercise. However, our findings are in agreement with the results obtained by Rosenkilde et al. (26). Also, in line with studies conducted by Gondim et al. (27) and Rezaeipour et al. (11), changes in body weight were positively related to LDL-C and TC variables. This provides evidence that weight reduction can improve cardiovascular risk.

The plasma level of HDL-C is often increased as a result of exercise (18, 19), but in our study this mainly led to an increase in HDL-C; as the calories expended during exercise were replaced by an increase in energy consumption, as seen in the endurance sports with boosted nutrition group (Figure 1D). It was expected that the level of

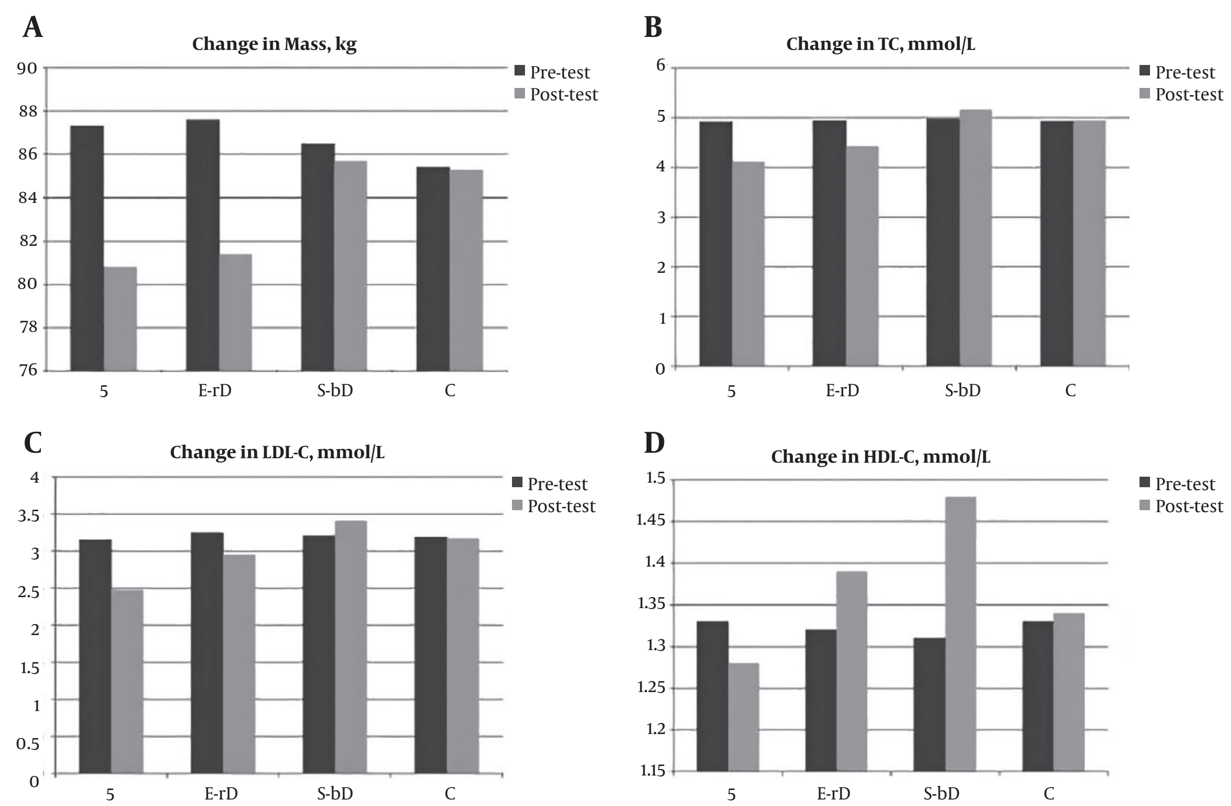

Figure 1. The mean changes of lipid panel variables, within and between the groups

HDL would have also risen during exercise or weight loss if the energy balance had been restored to neutral levels; however, participants in the endurance sports and energy-restricted diet groups were still in a catabolic condition when samples were collected after the study. Incremental beneficial impacts of exercise exercise and diet on HDL-C were illustrated in a study by Sopko et al. (28), utilizing the same study design as the current study. Due to gender differences, our results cannot be generalized to women. We recommend that future studies conduct similar studies on different genders and ages.

5.1. Conclusions

Each one of the weight loss and exercise strategies can result in independently significant health benefits. Exercise, coupled with weight loss, leads to lower TC and LDL-C, known as pro-atherogenic lipoproteins. In addition, when exercise was accompanied by additional energy intake, we noted an increase in HDL-C. Thus, this led to an overall improvement in the lipid panel of sedentary men with excess weight.

Supplementary Material

Supplementary material(s) is available here [To read supplementary materials, please refer to the journal website and open PDF/HTML].

Footnotes

Authors' Contribution: Mohammadreza Rezaeipour and Apanasenko Gennady Leonidovich made substantial contributions to study conception and design, as well as the acquisition of data, analysis, and interpretation of data. Mohammadreza Rezaeipour was also involved in drafting the manuscript, revising it for important intellectual content. All authors read and approved the final manuscript.

Conflict of Interests: The authors declared no conflict of interest.

Ethical Approval: This study was carried out under the Helsinki Declaration and approved by the institutional ethics committee [NMAPE, (2018) no.: 04112-21].

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Informed Consent: Participants were informed about the research study, and after getting a medical certificate to note that the study was not contraindicated, provided written informed consent before participation.

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