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CHANGES IN BLOOD LIPIDS AND LIPOPROTEINS FOLLOWING A STRENGTH TRAINING INTERVENTION

INTRODUCTION

Among the multiple proposed mechanisms for the protective effect of regular physical activity against coronary heart disease is its favorable effect on blood lipids [4, 7]. Varied exercise interventions have consisted of efforts to quantify the exercise dose needed to change lipids and lipoproteins levels [4]. Cross-sectional studies have mostly demonstrated benefits of aerobic activities [4, 7]. The volume of physical activity, in which a relatively large muscle mass is employed, related to caloric expenditure seems to be the greatest stimulus for altering blood lipids and lipoprotein levels. Many investigators have reported relationships between blood lipid levels and the volume of running, swimming, cycling and recreational sports participation [3]. Several investigators have reported favorable changes in blood lipids and lipoproteins following a strength training intervention [6, 8].

The purpose of the study was to investigate the influence of an 8-week resistance training on the lipid profile of blood serum in young men.

METHODS

The study was performed on 10 healthy male students aged between 20-25 years (mean age of 23.8±1.76 years) with 1-6-year experience in strength training (mean 3.3±1.87 years). For one month before the study they had not performed resistance exercises. During the study the subjects participated in a 8-week resistance exercise training.

Before the study (term I) and after 4 (term II), and 8 weeks (term III) of the training program the body content was measured and the blood for the analysis was drawn from the ulnar vein in the morning, in a fasting state. The body content was measured by way of bioimpedance analysis using the 101/S analyzer (Akern, Italy). The venous blood serum was used to determine concentrations of total cholesterol, HDL-cholesterol and triglycerides using the Cormay tests. The concentration of LDL-cholesterol was calculated using the Friedewald formula. The composition and energy intake of each subject's three-day habitual diet were assessed before each term of the study. The nutrition mode assessment was based on the 24-hour dietary history by recall method [1]. Diet records were analyzed using the "Dietetyk 2003" software.

The exercise training equipment used in this investigation was Olimp (Poland) resistance machines. During the eight weeks, the participants trained three times a week for 90 minutes. The subjects completed from three to four sets of 6-10 repetitions. In each set the load increased progressively from 60% to 80% of the maximal load, according to Weider progressive resistance program. The training involved all major muscle groups: muscles of the upper extremities (trapezius, latissimus dorsi, pectoralis major, pectoralis minor, serratus anterior, rhomboideus, biceps brachii, triceps brachii), muscles of the trunk (rectus abdominis, transversus, external and internal oblique, quadratus lumborum) and muscles of the lower extremities (quadriceps femoris, iliopsoas, gluteus maximus, gluteus medius, adductor group, hamstring group, triceps surae).

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The results obtained in three terms of the study were statistically analyzed using the GraphPad InStat 3.06 package. The analysis included standard descriptive statistics and Analysis of Variance (ANOVA) for repeated measures to examine training-induced changes. When differences were observed, a Tukey post-hoc analysis was performed to identify the source of differences. The values were expressed as means and standard deviation (SD).

The study was approved by a Local Committee of Ethics in Research.

RESULTS

Table 1 presents the mean values of anthropometrical parameters of bodybuilders at three terms of the study. There were no significant differences between the values of the three terms with respect to all studied parameters.

No differences in daily energy intake and diet composition were found between the terms of the study (Table 2). Diets consisted of high caloric intake ranged from 4350 kcal to 5320 kcal per day at three terms of the study. The mean daily protein intake ranged from 2.04±0.22 to 2.16±0.20 gram per kg of body mass at three term of the study.

Concentrations of the serum lipid and lipoprotein indices and ANOVA analysis results are presented in Table 3. Significant differences ($p<0.05$) were noted with respect to the concentrations of total cholesterol, LDL-cholesterol, HDL-cholesterol and triglycerides. The comparative analysis showed a significant increase ($p<0.05$) between terms I and II, and a decrease ($p<0.05$) between terms II and III in the total cholesterol concentrations. The LDL-cholesterol concentration signifi-cantly decreased from term II to term III ($p<0.05$). The HDL-cholesterol increased between terms I and II ($p<0.05$), and the concentration of this lipoprotein was not significantly changed between terms II and III. The concentration of triglycerides significantly decreased from term I to term III ($p<0.05$).

Table 1. Mean (±SD) values of anthropometrical parameters in bodybuilders at three terms of the study

	Term I	Term II	Term III	ANOVA (p)
Body mass (kg)	80.5±6.65	81.1±6.43	81.4±6.32	0.0787
Fat mass (kg)	12.5±3.73	12.9±4.14	13.0±3.62	0.6984
Fat mass (%)	15.4±3.73	16.0±4.77	16.0±4.04	0.6953
Fat-free mass (kg)	68.0±5.34	68.1±6.63	68.3±6.33	0.8533
Fat-free mass (%)	84.6±3.73	84.0±4.77	84.0±4.04	0.6953
BMI (kg/m^2)	25.1±2.13	25.3±2.01	25.6±1.98	0.1839

Table 2. Mean (±SD) energy values and protein, fat and carbohydrate content at three terms of the study

	Term I	Term II	Term III	ANOVA (p)
Total energy (kcal)	4774.0±576.40	4659.7±663.06	4856.8±852.42	0.8726
Protein (g)	168.7±31.71	156.8±21.20	164.6±17.864	0.8467
Fat (g)	163.1±38.74	159.8±30.28	178.3±44.46	0.6375
Carbohydrate (g)	632.0±136.17	690.1±102.01	680.3±123.75	0.6389

Table 3. Mean (±SD) concentrations of the blood serum lipid and lipoproteins at three terms of the study and the comparative analysis

	Term I	Term II	Term III	ANOVA (p)
Total cholesterol (mg/dl)	186.6±10.17	192.4±9.92*	185.3±8.35*	0.0103
LDL-cholesterol (mg/dl)	125.2±16.68	124.0±19.46	116.8±14.12$^{\#}$	0.0403
HDL-cholesterol (mg/dl)	43.9±10.60	51.2±11.15*	52.6±9.80$^{\#}$	0.0152
Triglycerides (mg/dl)	87.4±17.92	85.7±11.6	79.4±11.96$^{\#}$	0.0432

*$p<0.05$ – statistically significant value in comparison with the previous term

$^{\#}p<0.05$ – statistically significant value in comparison with term I

DISCUSSION

The obtained results showed that an 8-week progressive resistance training led to improvement of the lipid blood profile in young healthy men. Kokkinos and Hurley [6] have also reported favorable changes in blood lipids and lipoproteins following a strength training intervention. However, the lack of control in body composition and dietary factors in their studies made the explanation of the changes more complicated. The comparative analysis in our investigation showed an insignificant difference in the diet and body composition during the training program, therefore, we may conclude that physical activity was the major factor influencing lipid metabolism.

Young and Steinhard [10] reported beneficial effects of resistance training on body composition. The increasing energy expenditure during the exercise session and during recovery after the resistance training leads to the loss of fat body mass. Another favourable effect is the increase of fat-free body mass [10]. Stone et al. [9] suggested that body composition was affected by resistance training programs using the larger muscle groups and greater total volume. The reason for the lack of differences in body composition in the study seems to be a short period of training and a high level of fitness of subjects who have participated in weight training for some years.

The mechanism of physical training effects on blood lipids and lipoproteins may be multifactorial. It is well known that training increases fat oxidation during exercise in lean subjects [5]. Moreover, it cannot be excluded that the impact of physical activity on the lipoprotein lipase (LPL) and hepatic triglyceride lipase (HTGL) in the mechanism described by Després and Lamarche [2] in endurance exercise may also play a role in the strength training. In the sedentary state, the low LPL and the high HTGL activities lead to a decrease in the production of HDL-2 particles as a result of reduced catabolism of triglyceride rich lipoproteins. The high HTGL activity also contributes to the reduction of HDL-2 levels. However, in physically active individuals, the LPL activity is high, which contributes to the generation of HDL-2 particles, whereas the low activity of HTGL maintains the HDL-2 concentration at a higher level than in sedentary subjects [2].

The results of the study lead us to conclude that the 8-week resistance exercise program positively affects lipoprotein profile. More research is needed to determine if there is an optimal resistance training load and volume that positively affects the lipoprotein profile.

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