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Effect of Aerobic Interval Training on Plasma Apolipoprotein M Levels in Young Men

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ABSTRACT

Background and Objectives: Apolipoprotein M (APOM) is a novel high-density lipoprotein (HDL)-associated protein involved in the production of pre-beta HDL and cholesterol efflux to HDL. The present study examined effect of 12 weeks of aerobic interval training on HDL-associated APOM levels.

Methods: Study population included 20 healthy men aged 20 to 24 years. The subjects were randomly and equally divided into a training group and a control group. Each training session included 10 minutes of warm-up, 35 minutes of aerobic training (5 combined cycles each including four minutes of running at intensity of 85-95% and an active resting period of treadmill running at 65-75% of maximum heart rate for 3 minutes) and 10 minutes of cool-down. Blood samples (10 mL) were taken every four weeks. Two-way ANOVA and Bonferroni's post hoc test were used to compare the groups. A P-value of less than 0.05 was considered statistically significant.

Results: At the end of the 12th week, HDL-associated APOM levels increased in the training group and decreased in the control group. However, these changes were not statistically significant ($P>0.05$).

Conclusion: This study demonstrated that the 12-week aerobic interval training does not significantly affect HDL-associated APOM levels. However, it is recommended to monitor subjects' diet throughout the study period to reach a more comprehensive conclusion.

Keywords: Aerobic interval training, Apolipoprotein M, Young men.

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INTRODUCTIN

In today's modern world, technology and mechanization of societies have led to insufficient physical activity, which can cause numerous diseases. Consumption of fatty foods and drugs as well as insufficient physical activity are closely linked with increased body fat, especially triglyceride and cholesterol, which are important risk factors for development of cardiovascular disease (CVD). Evidence has shown that CVD is associated with levels of low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein (HDL) and some HDL proteins (1). On the other hand, many studies have shown that regular exercise reduces the risk of CVD, increases HDL concentration and improves the plasma lipoprotein lipid profile. Therefore, active individuals are at lower risk of developing CVD compared with inactive counterparts.

CVD is one the leading causes of death worldwide. According to the statistics of the Ministry of Health and Education of Iran, 38.5% of all deaths in Iran are due to CVDs. The major risk factors for developing CVD are increased level of total cholesterol (TC) and decreased LDL-C and HDL-C levels. In addition, factors such as insulin resistance, dyslipidemia, lipid oxidation, inappropriate HDL/LDL concentration, inappropriate apolipoprotein M (APOM) concentrations, sedentary lifestyle, obesity, unhealthy diet, cigarette smoking, hypertension and psychological stress can further increase the risk of developing CVD(2). Numerous studies have investigated the effect of exercise on the risk factors of CVD. It has been suggested that exercise may have some beneficial effects in this regard by increasing endurance, recovery and muscle mass and reducing body fat. Therefore, we aimed to evaluate the effects of aerobic interval training on APOM levels in young men(3).

MATERIALS AND METHODS

Study population consisted of 20 healthy men (aged 20 to 24 years) who were selected via convenience sampling from undergraduate physical education and sport sciences students at Farhangian University, in the academic year 2016-17. The subjects were randomly and equally divided into a training group and a control group that were matched in terms of body mass index (BMI). After explaining the study objectives and training protocols, written consent was taken from all subjects. Exclusion criteria included a history of consuming dietary supplements, diabetes or cardiovascular, respiratory, metabolic and renal diseases.

Aerobic training was done according to a protocol described by Lunt et al. (4). The training group performed aerobic interval training by running on treadmill three sessions a week for 12 weeks. Each session started with 10 minutes of warm-up, followed by 35 minutes of training (5 combined cycles each including four minutes of running at intensity of 85-95% and an active resting period of treadmill running at 65-75% of maximum heart rate for 3 minutes), and 10 minutes of cool-down. A wrist-worn heart-rate-monitoring device was used to control the intensity of exercise.

The exercise intensity was gradually increased every two weeks by increasing the treadmill speed (Table 1).

Descriptive statistics (mean and standard deviation) were used to describe the data. Normal distribution of data was confirmed in the Kolmogorov-Smirnov test. Two-way ANOVA and Bonferroni's post hoc test were used to compare the groups. A P-value of less than 0.05 was considered statistically significant.

All statistical analyses were carried out in SPSS software (version 20).

Table1- Details of the training protocol performed by the subjects in the training group

Week	Active rest period			Main activity period		
	Duration (min)	Intervals (number)	Running intensity*	Duration (min)	Intervals (number)	Running intensity*
1-2	3	5	60-65	4	5	80-85
3-4	3	5	60-65	4	5	80-85
5-6	3	5	65-70	4	5	85-90
7-8	3	5	65-70	4	5	85-90
9-10	3	5	65-70	4	5	90-95
11-12	3	5	65-70	4	5	90-95

*Percent maximum heart rate (MHR)

RESULTS

Table 2 shows the level of APOM in plasma HDL of the subjects in the training and the control group.

Two-way ANOVA was used to evaluate the effect of aerobic interval training on plasma HDL-associated APOM levels in the study groups. Given the violation of the assumption of sphericity, the Greenhouse-Geisser method was used in the test. There was no significant difference between plasma levels of HDL-associated APOM in different time periods and groups (Table 4).

There was also no significant difference in plasma HDL-associated APOM levels between the two groups. Moreover, the Bonferroni's pairwise comparison of the means revealed no significant difference between different time periods.

Table 2- APOM level in plasma HDL of the subjects in the training and the control group

Variable		Training group	Control group
		Mean ± SD	Mean ± SD
APOM level in plasma HDL (µg/mL)	Baseline	9.39±15.77	2.13±11.08
	Week 4	11.68±15.85	2.37±12.03
	Week 8	12.17±17.07	3.31±12.90
	Week 12	9.47±14.96	8.43±16.13

Table 3- APOM level in plasma HDL3 and HDL2 of the subjects in the study groups

Variable		Control group	Training group
		Mean ± SD	Mean ± SD
APOM level in plasma HDL3 (µg/mL)	Baseline	0.12±1.43	0.29±1.92
	Week 4	0.17±1.44	0.19±1.68
	Week 8	0.16±1.41	0.29±1.36
	Week 12	0.27±1.62	0.4±1.73
APOM level in plasma HDL2 (µg/mL)	Baseline	9.47±14.34	2.06±9.16
	Week 4	11.69±14.41	2.44±10.33
	Week 8	12.19±13.56	3.3±9.21
	Week 12	9.59±13.34	8.58±14.41

Two-way ANOVA was used to evaluate the effect of aerobic interval training on plasma HDL-associated APOM levels in the study groups. Given the violation of the assumption of sphericity, the Greenhouse-Geisser method was used in the test. There was no significant difference between plasma levels of HDL-associated APOM in different time periods and groups (Table 4). There was also no significant difference in plasma HDL-associated APOM levels between the two groups. Moreover, the Bonferroni's pairwise comparison of the means revealed no significant difference between different time periods.

DISCUSSION

The amount of APOM in healthy individuals is 0.94 µmol or 23 µg/L (5). Diet is one of the primary factors for cholesterol synthesis. It seems that the amount of APOM in plasma is dependent on the level of cholesterol or the enzymes involved in its metabolic pathway, such as 7-alpha hydroxylase and lecithin-cholesterol acyltransferase (LCAT). Since LDL particles are much larger than HDL particles, APOM makes up about 5% of the HDL structure and 2% of the LDL structure (6). Considering that APOM is an exchangeable apolipoprotein, plasma concentration of HDL-associated APOM may be related to APOM exchange between HDL2 and HDL3. In the present study, at week 12, APOM levels increased in the HDL3 particle and decreased in the HDL2 particle. This finding is in line with findings of some previous studies (7, 8).

This difference could be attributed to the difference in the subjects and training protocol or intensity used in each study (9). In a study on 19-21 years old healthy men, plasma APOM levels decreased after 8 weeks of endurance training at 60-80% of MHR, three days a week. However, the exact mechanism through which aerobic interval training can affect HDL-associated APOM level is not clear. The decrease in HDL-associated APOM level could also be due to a decrease in sphingosine level since APOM is a known carrier of sphingosine-1-phosphate (S1P), and the protective effects of sphingosine are mediated through its binding with HDL-associated APOM (10, 11). Acute inflammation could also contribute to the decrease in HDL-associated APOM level. In this condition, both S1P and APOM levels decrease, which negatively influences the

protective activity of HDL on the cardiovascular system (12). Although we did not measure plasma S1P levels, Baranowski et al. demonstrated that plasma S1P levels decrease significantly after a period of exhaustive exercise and does not return to the baseline levels within 48 hours of initial recovery (13). However, another study claimed that a period of exhaustive exercise only slightly decreases plasma S1P levels compared to baseline (14). Another reason for the decreased plasma APOM level could be down-expression of APOM in the liver and kidneys, the main producers of this lipoprotein. It has been shown that APOM belongs to the lipocalin protein family (15, 16). Current evidence suggests that the plasma levels of APOM are mainly dependent on α-HDL, which is involved in conversion of pre-α-HDL to pre-β-HDL.

In addition, the two-fold increase in APOM levels slows down the progression of atherosclerosis. Furthermore, APOM-containing HDL particles have higher antioxidant activity compared to HDL particles alone (17). Results of studies on the in vitro and in vivo effects of leptin on plasma levels of APOM have been contradictory. According to the in vitro studies, at concentrations higher than the physiologic level (>100 ng/mL), leptin can inhibit the expression of APOM in a hepatocyte-containing medium, while at the physiologic concentrations, it can downregulate APOM expression (18). Nevertheless, more studies are required to gain a better understanding of the exact mechanism through which a period of aerobic exercise can reduce plasma APOM levels.

CONCLUSION

This study demonstrated that a period of aerobic interval training does not significantly affect HDL-associated APOM levels. However, it is recommended to monitor subjects' diet throughout the study period to reach a more comprehensive conclusion.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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