

*Full Length Research Paper*

# Effect of endurance exercise training on blood lipids in young men

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The present study was conducted in order to investigate the effect of aerobic exercise (running) performed regularly for eight weeks without a special diet on blood lipid and lipoprotein levels. Twenty non-smoker, moderately active young volunteer men who were not on a special diet (Training Group = 10 and Control Group = 10) participated in the study. Training group performed aerobic exercise at target heart beat rate of 60 to 70% for 1 h/day for 4 days per week during 8 week-trial. Blood samples were taken at rest before and after the training period. Lipid and lipoprotein measurements were done with enzymatic method on auto-analyzer. Maximal oxygen uptake in the training group significantly increased after the experimental period, while body fat percentages did not change in both groups. The plasma levels of low density lipoprotein-cholesterol (LDL-C) increased in training group and decreased in control group, while levels of high density-cholesterol (HDL-C) decreased in both groups being statistically significant only in training group. Total cholesterol (TC) and triglyceride (TG) levels were not affected by the training program. In conclusion, a short term (8 weeks) aerobic exercise program performed without a special diet in moderately active young men may be considered as insufficient to make favorable effects on blood lipid profile.

**Key words:** Running exercise, total cholesterol, low density lipoprotein-cholesterol (LDL-C), high density-cholesterol (HDL-C), triglycerides.

## INTRODUCTION

A sedentary life style leads to an increase in all cause mortality risk (Berlin and Colditz, 1990; Powell et al., 1987). Exercise was found to have many benefits on health status, such as cardiovascular fitness, optimum body weight and muscle mass maintenance, decreasing abdominal fat, improving insulin sensitivity and blood lipid profile. A number of researchers believe that physical inactivity is the primary risk factor for coronary heart disease and stroke (Killoran et al., 1994; WHO, 1995; US Department of Health and human Services (PHS), 1996). These risks were found to decrease significantly in subjects who were successful to manage their physical fitness level from lower to higher levels (Blair et al., 1995), which suggests that all sedentary people with any body weight status should be encouraged to be physically active.

It is commonly proposed that regular exercise has impact to prevent coronary risk factors by positive effects

on lipid profiles (Kraus et al., 2002). Regular aerobic exercise is accepted to have a treating impact on blood lipid profile on a dose-dependent basis in either men or women (Durstine et al., 2001). Especially, levels of HDL-cholesterol which transports free cholesterol by esterifying with fatty acids from endothelium of vessels and peripheral tissues to liver (Reverse Cholesterol Transport) are very important and therefore named as "antiaterogenic factor" (Hill and McQueen, 1997). Plasma lipids, lipoproteins and metabolites of arachidonic acid have important roles on arteriosclerotic lesions (Herzberg, 2004). Lipid compounds are delivered by lipoproteins in the body which are separated into 3 groups as, very low density lipoprotein (VLDL), low density lipoprotein (LDL) and high density lipoprotein (HDL) (Vane et al., 1991).

Regularly performed aerobic exercises, such as walking, jogging, cycling and swimming have positive

impact on lipids, lipoprotein and prostaglandin profiles. Anaerobic exercise, however, does not influence at the same rate (Kipreos et al., 2010). Regular physical activity also prevents coronary heart disease and decreases the symptoms in subjects with cardiovascular disease. The effect of exercise on blood lipids, total cholesterol and cholesterol fractions has taken attention in many researches. In most of the trials, triglycerides were found to decrease while total cholesterol sometimes decreased and sometimes did not change besides cholesterol fraction with high density (HDL-C) and low density (LDL-C) increased and decreased, respectively (Durstine and Haskell, 1994; Leon and Sanchez, 2001). On the other hand, different results about the effect of regular exercise on blood lipid profile have been found in studies.

The frequency, duration and intensity of the exercise which might be efficient on blood lipid profile have not been clarified yet. Therefore, the present study was conducted to investigate the effect of endurance running exercise performed 1 h/day for 4 days in a week on lipids and lipoproteins in moderately active subjects who were not on a special diet.

## MATERIALS AND METHODS

Twenty moderately active university students volunteered to participate in this study. None of the students were involved in any regular exercise program within the previous 6 months. All of the participants were non-smokers and were divided into two equal groups (training and control) of similar age, body mass, percent body fat and  $VO_{2max}$ . Local Ethical Committee of Erciyes University School of Medicine Deanery gave ethical approval for the study. Written consent from the participants was taken after giving information about the study.

### Experimental design

Body height of the participants was measured with height measuring mechanical weighing scale to the nearest 1 mm on a standing position. Body weight was measured to the nearest 100 g with possibly lightest clothing. Body mass index (BMI) was calculated by dividing body weight (kg) to square of height ( $m^2$ ). Body fat percentage was determined by measuring biceps, triceps, subscapula and subrailiac skinfold thickness by using skinfold caliper (Holtain LTD. Crymych UK). Body fat percentage was determined by calculating body densities (Durnin and Womersley, 1974).

Body density =  $1.1631 - 0.0632 \times \text{Log} (\text{Biceps} + \text{Triceps} + \text{Subscapula} + \text{Subrailiac})$

Body fat (%) =  $(4.95/\text{Body density} - 4.50) \times 100$

To determine the maximal oxygen consumption ( $VO_{2max}$ ), the Bruce Treadmill Protocol was used. The criteria for ending the exhaustive exercise test were the achievement of the predicted maximum heart rate and the participant's request to stop running. The participants in the training groups participated in an endurance training, which consisted of running exercise for 1 h/day, for 4 days a week for eight weeks to 60 to 70% of intensity for target heart beat rate after one week adaptation training period. Training and control groups were not allowed to do regular exercise and were not given any

dietary recommendations during the study. The pre-study and post-study measurements and tests were performed with the same standard and under the same circumstances.

### Biochemical analysis

Blood samples of every participant were taken before and after the training program and plasma of the samples were obtained after centrifuging at  $+4^\circ\text{C}$  with 3000 turnovers for 15 min. Concentrations of total cholesterol (TC), high density-cholesterol (HDL-C), low density-cholesterol (LDL-C) and triglycerides (TG) were measured with enzymatic methods on an automated clinical chemistry analyzer (Dimension RxL Max, Siemens Healthcare Diagnostics) using original reagents from Siemens Healthcare Diagnostics.

### Statistical analysis

The effect of training program on physical characteristics and blood lipids were tested by 2 ( $2 \times 2$ ) factor variance analysis in repeated measures. In case of significant interaction between time  $\times$  group, independent t-test and paired t-test were performed in order to determine the differences. All results were expressed as mean ( $\pm$ ) and standard error of mean (SEM).  $P < 0.05$  was accepted as statistically significant.

## RESULTS

The physical characteristics of the control and training groups are presented in Table 1. All baseline variables in the pre-training stage were not different between the control and training groups. There was a significant interaction effect between time and group for body weight and BMI, but significant differences were not observed between the groups. No significant time and group main effects were observed for body weight and BMI. There was a significant time ( $F = 54.41$ ,  $P < 0.05$ ) and interaction effect ( $F = 28.72$ ,  $P < 0.05$ ) for  $VO_{2max}$  but no significant group effect ( $F = 0.73$ ,  $P > 0.05$ ). No variables in the control group were different between pre-training and post-training. The training group exhibited a significantly greater  $VO_{2max}$  in comparison to the control group after training ( $P < 0.05$ ).

Plasma levels of TC, HDL-C, LDL-C and TG data pre-training and post-training are presented in Table 2. There were no significant interaction between time and group for TC, HDL-C and TG levels. There was a significant time effect for TC levels ( $F = 6.14$ ;  $P < 0.05$ ). TC levels decreased in both groups during experimental period. There was a significant time ( $F = 16.43$ ;  $P < 0.05$ ) and group ( $F = 5.80$ ;  $P < 0.05$ ) effect for HDL-C levels. HDL-C levels were significantly different between the control and training groups in training, and its levels decreased significantly in training group at training period. There was a significant interaction effect of time and group on LDL-C levels ( $F = 5.97$ ;  $P < 0.05$ ). During the experimental period, LDL-C levels decreased in control group, increased in training group, but no significant differences were observed between the groups. TG levels in control group were significantly higher than training group in the

**Table 1.** Changes in physical characteristics between pre-training and post-training.

	Group	Pre-training	Post-training	Time	Time x Group	Group
Age (year)	C	21.6 ± 0.3	-	-	-	-
	T	20.8 ± 0.2	-	-	-	-
Height (cm)	C	177.1 ± 0.7	-	-	-	-
	T	177.8 ± 0.9	-	-	-	-
Body weight (kg)	C	68.5 ± 1.0	67.9 ± 1.0	0.15	4.56*	0.75
	T	69.6 ± 1.8	70.4 ± 1.9			
BMI (kg/m <sup>2</sup> )	C	21.8 ± 0.4	21.5 ± 0.4	0.24	8.56*	0.31
	T	22.0 ± 0.6	22.1 ± 0.6			
Body fat (%)	C	12.5 ± 0.8	12.6 ± 0.6	1.74	0.61	1.63
	T	11.1 ± 0.7	11.5 ± 0.7			
VO <sub>2max</sub> (ml/kg/min)	C	49.3 ± 1.3	50.6 ± 1.1	52.41*	28.72*	0.73
	T	47.4 ± 1.2	55.9 ± 2.0 <sup>#†</sup>			

\*P < 0.05 significant main or interaction effect, <sup>#</sup>P < 0.05 significantly different from pre-training, <sup>†</sup>P < 0.05 significantly different between control and training groups. C = Control group; T = training group; BMI = body mass index; VO<sub>2max</sub> = maximal oxygen consumption, Values are shown as mean ± SEM.

**Table 2.** Changes in blood lipids after the exercise training.

	Group	Pre-training	Post-training	Time	Time x Group	Group
TC (mg/dl)	C	140.5 ± 8.8	121.9 ± 7.7	6.14*	0.27	0.00
	T	137.6 ± 7.4	125.4 ± 6.4			
HDL-C (mg/dl)	C	56.4 ± 2.6 <sup>‡</sup>	46.1 ± 3.7	16.43*	0.13	5.80*
	T	65.4 ± 2.1	53.0 ± 3.5 <sup>#</sup>			
LDL-C (mg/dl)	C	71.8 ± 5.5	55.2 ± 6.5	0.07	5.97*	0.16
	T	54.2 ± 6.5	67.5 ± 6.9			
TG (mg/dl)	C	61.3 ± 10.5 <sup>‡</sup>	53.0 ± 5.9 <sup>‡</sup>	0.00	0.40	14.19*
	T	98.5 ± 12.6	106.1 ± 17.3			

\*P < 0.05 significant main or interaction effect, <sup>#</sup>P < 0.05 significantly different from pre-training, <sup>‡</sup>P < 0.05 significantly different between control and training groups. C = Control group; T = training group. Values are shown as mean ± SEM.

pre-training and post-training. Also, changes in TG levels during experimental period were similar in both groups.

## DISCUSSION

The research shows that regular physical activity generally improves blood lipid profiles in subjects with different age and fitness levels (Aellen et al., 1993; Coutinho and Da Cunha, 1989; Revan et al., 2011). However, there are different study results about what

kind of lipid parameter is affected by exercise programs because of differences in exercise type, duration and intensity and baseline blood lipid profiles, dietary habits, physical characteristics and fitness level of participants.

The present study investigated the effect of 8-week aerobic running exercise program on blood lipid levels of young men who were healthy and moderately active. VO<sub>2max</sub> capacity of participants in training group significantly increased while no significant change was observed in body fat percentages of training and control group participants. Similarly, aerobic exercises were

shown to increase  $VO_{2max}$  levels (Kelley and Kelley, 2008; Revan et al., 2011). The most important result of the present study is finding no favorable changes of 8-week aerobic training program on blood lipid profile on the contrary to other previous reports. Moreover, LDL-C level was found to increase in training group while decreased in control group against expectations. HDL-C level decreased in both groups being statistically significant only in training group. In two studies, after 8-week (Martin et al., 2003) and 6-week (Branth et al., 2006) endurance training performed in similar duration with the present study, HDL-C levels of the participants were reported to significantly increase and LDL-C levels did not change. Discrepancies between previous studies and this study may be due to the differences in frequency, duration and intensity of exercises in training programs performed. The training group participants in this study performed running 1 h/day for 4 days in a week with an intensity of 60 to 70%. In terms of intensity, exercises above anaerobic threshold were found to have no effect or even have negative effect on blood lipoprotein profiles.

It was emphasized that physical activity should be below anaerobic threshold in order to improve blood lipoprotein profiles (Aellen et al., 1993). Additionally, total serum cholesterol, triglycerides, HDL-C and LDL-C were not determined as significantly different in sedentary people and athletes who performed anaerobic physical activity mainly. Researchers have stated that lipoprotein profiles of healthy normolipidemic people did not change with anaerobic sportive activities (Giada et al., 1988). In a study conducted with young male athletes, HDL-C concentration was found to be significantly high. Hypercholesterolemia, hypertriglyceridemia and low concentration of HDL-C were found in male athletes as compared to sedentary controls. According to these results, low plasma TG levels and high HDL-C concentrations are characteristics of aerobic exercising subjects. Long term training leads to low plasma LDL-C levels in male athletes (Cardoso Saldan et al., 1995). Studies have also shown that duration and intensity of exercises, dietary treatments, lipid profiles and weight status (such as obese or normal) of the subjects caused differences in lipid levels (Archer et al., 2003; Sharman et al., 2004; Devoe et al., 2009; Togashi et al., 2010). HDL-C and coronary heart disease have strong, independent and converse correlation. Increasing HDL-C levels after aerobic training may partially explain protection from coronary heart disease (Kokkinos and Fernhall, 1999). In the present study, however, HDL-C levels significantly decreased as compared to baseline in training young men. Decreased HDL-C levels also in control group were thought to be affected by different factors, such as diet. Revan et al. (2011) have reported that HDL-C levels failed to reach expected levels and exercise, alone, was not enough to increase low HDL-C concentration although aerobic exercise programs without a dietary intervention significantly increased HDL-C levels in subjects with low baseline levels.

Lipid profile was negatively influenced despite aerobic exercise program in the present study. Previous studies demonstrated that anaerobic exercises affected blood lipid profile unfavorably even in athletes and especially decreased HDL-C levels (Witek, 2009; Kipreos et al., 2010). Kishali et al. (2005) found that plasma TC, TG, HDL-C and LDL-C levels were not different between athletes, moderately active and sedentary individuals and thereby moderate and intense training did not contribute significantly to lipid and lipoprotein levels. There were no significant differences in experienced wrestlers as compared to sedentary people (Imamoglu et al., 2005). Athletes in another study were found to have low TC, TG and VLDL-C levels as compared to sedentary subjects. Athletes had more appropriate levels of lipid/lipoprotein levels although athletes and sedentary groups did not show differences in LDL-C and HDL-C levels (Coutinho and Da Cunha, 1989).

The present study has some limitations. The participants were not on a special diet during the study and daily energy intake could not be determined and monitored which may have an effect on the results of the study. Also, this study was limited in that it lasted for eight weeks. Longer exercise programs may lead to different findings.

## Conclusion

Conclusively, a short term aerobic exercise program performed without a special diet may be considered as insufficient to make favorable effects on blood lipid profile in moderately active young men.

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