Ovidius University Annals, Series Physical Education and Sport / SCIENCE, MOVEMENT AND HEALTH
Vol. XI, ISSUE 2 Supplement, 2011, Romania
The JOURNAL is nationally acknowledged by C.N.C.S.I.S., being included in the B+ category publications, 2008-2011.
The journal is indexed in: Ebsco, SPORTDiscus, INDEX COPERNICUS JOURNAL MASTER LIST, DOAJ DIRECTORY OF OPEN ACCES JOURNALS, Caby, Gale Cengace Learning

THE EFFECT OF ACUTE MAXIMAL AEROBIC EXERCISE ON BLOOD LIPID PARAMETERS ON HEALTHY MALES AND FEMALES

BAYDIL BİLGEHAN[1], MELEKOGLU TUBA[1], OCAL DEFNE[1]

Abstract
Purpose : The aim of the present study was to examine the effect of acute maximal aerobic exercise on blood lipid parameters on healthy males and females.
Methods : The heights, weights, resting hearth rates and blood samples of subjects were taken before the exercise. The subjects warmed up for ten minutes before they had 20 m shuttle run test protocole until exhaustion. The blood samples were taken before and immediately after the exercise for analizing triglyceride, high density lipoprotein (HDL), low density lipoprotein (LDL), total cholesterol. Statistical evaluation was conducted using SPSS 13 software program. The Wilcoxon Signed Rank Test was used for determine the differences within groups and Mann-Whitney U Test was used for beetwen groups results at a significance levels of $p<0.05$ and $p<0.01$.
Results : In conclusion, our study demonstrates that acute aerobic exercise has benefical effects on the blood lipid profile.
Keywords : Total Cholesterol, Triglyceride, HDL, LDL, Acute Aerobic Exercise

Introduction

The role of lifestyle change with regard to diet, weight control, and physical exercise is becoming more important in today's health care of chronic disease. These can be vastly important in management of abnormal blood lipids and lipoproteins. Indeed, with appropriate dietary discretion, weight control, and physical activity/exercise, standard drug therapies may be used at lesser dose levels and, in some instances, totally discontinued.

Major risk factors for cardiovascular diseases include hypertension, smoking and elevated levels of serum total or LDL-cholesterol, as well as low levels of HDL-cholesterol. Moreover, there is consistent, substantial and strong evidence that physical inactivity is a major health determinant for developing cardiovascular disease (C. Pitsavos, 2009).

Cardiovascular disease (CVD) is the leading cause of death worldwide. Low blood levels of high density lipoprotein cholesterol (HDL-C) are an independent risk factor for CVD. Cross-sectional data provide strong evidence that people who are more physically active have higher HDL-C levels. Thus, the value of regular aerobic exercise in increasing serum HDL-C level and in reducing the risk of CVD have received widespread acceptance (S. Kodama, 2007).

Comparisons between intensities of aerobic exercise programs resulted in favorable effects only for high intensity. The most frequently observed alteration was an increase in the high-density lipoprotein cholesterol, whereas reductions in triglycerides, total cholesterol, and low density lipoprotein cholesterol appeared less often (K. Tambalis, 2009).

To increase our understanding of the chronic effects of physical training on serum or plasma lipids, lipoproteins and apolipoproteins, it is important to study the acute effects of a single bout of exercise on these parameters.

The aim of the present study was to examine the effect of acute maximal aerobic exercise on blood lipid parameters on healthy males and females.

Materıal and method

Selection of Participants

The study included 8 male (mean age, 22.25 ± 1.49 years) and 7 female (mean age, 19.87 ± 1.45 years) subjects who did not actively exercise. It's determined that male's and female's with the mean age of 22.25 ± 1.49 years and 19.87 ± 1.45 years, average antropometric measurements are as follows (Table1) height of 177.62 ± 1.87 cm, 161.87 ± 3.18 cm, weight of 74.97 ± 3.32 kg, 57.91 ± 7.33 kg, respectively. All subjects were informed about the purpose and procedures of the study. For the standardize dietary, subjects were asked to obey dietitians advisement before exercise 3 days ago.

Study Design

The heights, weights, resting hearth rates and 5 cc. venous blood samples of subjects were taken before the exercise.

[1] Department of Physical Education and Sport, Kastamonu University, TURKEY
Email: bilgehanbaydil@hotmail.com
Received 05.05.2011 / Accepted 18.07.2011

The subjects warmed up for ten minutes before they had 20 m shuttle run. The purpose of this test was to tire the subjects to the exhaustion. The heart beat rates were measured at the end of the test in order to determine the exhaustion levels of the participants.

The 5 cc. venous blood samples were taken again just after the exhaustion exercise.

Physical and Physiological Measurements

Measurement of height and weight

The height and weight variables were measured 1 hour before the exercise. The weight of subjects were meausered by an electronic scale in minimal clothing. The height measurements were determined with metric scale.

Measurement of resting hearth rate

The resting hearth rate of subjects were taken on sitting position with stethoscope and chronometer after 20 min. resting period before 1 hour exercise.

Collection of the blood samples

The blood samples of the subjects were taken preexercise and post exercise. The first blood sampless were drawn on resting and sitting position before 15 min. the start of exercise. The second blood sampless were drawn immediately after the fatiguing exercise on sitting position. 5 cc. Blood sampless were obtained from forearm antecubital vein into heparinazed tubes.

Statistics

Statistical evaluation was conducted using SPSS 13 software program. The Wilcoxon Signed Rank Test was used for determine the differences within groups and Mann-Whitney U Test was used for beetwen groups results at a significance level of $p<0.05$ and $p<0.01$.

Results

Table 1. Some of physical and physiological parameters of the participants

	Male		Female	
Parameters	**N**	**M±SD**	**N**	**M±SD**
Age (year)	8	22.25±1.49	7	19.87±1.45
Height (cm)	8	177.62 ±1.87	7	161.87±3.18
Body Weight (kg)	8	74.97 ±3.32	7	57.91±7.33
Resting Hearth Rate(beat/min.)	8	79.00±3.68	7	78.25±7.36
Max VO_2 (mL.kg/min)	8	48.24±1.52	7	33.67±4.26

M, average; SD, standard deviation, N, number of subjects

Table 2. The comparisons of the male participants average blood lipid parameters in pre and post exercise

Parameters	N	Pre exercise M±SD	Post exercise M±SD	%	Z
Total Cholesterol (mg/dl)	8	163.62 ± 21.30	141.12 ± 19.54	-13.75	**-2.521***
HDL (mg/dl)	8	56.87 ± 6.10	56.37 ± 5.55	-0.87	-0.423
LDL (mg/dl)	8	55.25 ± 36.40	45.37 ± 23.83	-17.88	-0.840
Triglyceride (mg/dl)	8	258.12 ± 119.37	197.00 ± 74.66	-23.67	**-2.521***

$P<0.05^{*}$ $P<0.01^{**}$

Table 3. The comparisons of the female participants average blood lipid parameters in pre and post exercise

Parameters	N	Pre exercise M±SD	Post exercise M±SD	%	Z
Total Cholesterol (mg/dl)	7	152.28 ± 26.29	143.14 ± 30.70	-6.00	-1.693
HDL (mg/dl)	7	72.00 ± 6.42	72.14 ± 6.96	+0.19	-0.316
LDL (mg/dl)	7	53.42 ± 14.60	49.28 ± 23.09	-7.74	-0.845
Triglyceride (mg/dl)	7	134.14 ± 82.29	108.28 ± 59.63	-19.27	-1.778

$P<0.05^{*}$ $P<0.01^{**}$

Table 4. The comparisons of the female and male participants average blood lipid parameters in pre exercise

Parameters	N	Males M±SD	Females M±SD	Z
Total Cholesterol (mg/dl)	15	163.62 ± 21.30	152.28 ± 26.29	-1.504
HDL (mg/dl)	15	56.87 ± 6.10	72.00 ± 6.42	**-3.014****
LDL (mg/dl)	15	55.25 ± 36.40	53.42 ± 14.60	0.000
Triglyceride (mg/dl)	15	258.12 ± 119.37	134.14 ± 82.29	**-1.967***

$P<0.05^{*}$ $P<0.01^{**}$

Table 5. The comparisons of the female and male participants average blood lipid parameters in post exercise

Parameters	N	Males M±SD	Females M±SD	Z
Total Cholesterol (mg/dl)	15	141.12 ± 19.54	143.14 ± 30.70	-0.812
HDL (mg/dl)	15	56.37 ± 5.55	72.14 ± 6.96	**-3.249****
LDL (mg/dl)	15	45.37 ± 23.83	49.28 ± 23.09	0.347
Triglyceride (mg/dl)	15	197.00 ± 74.66	108.28 ± 59.63	**-2.083***

$P<0.05^{*}$ $P<0.01^{**}$

Discussion and conclusions

We examined the effect of acute maximal aerobic exercise on blood lipid parameters on healthy males and females.

We found reductions on total cholesterol (%13.75, P<0.05) and triglycerides (%23.67, P<0.05) values pre and post acute aerobic exercise on boy subjects. No significant reductions were noted for blood concentrations of HDL-C (%0.87) and LDL-C (%17.88) pre and post exercise.

When comparing the pre and post measurements of males and females, significant differences were observed in high-density lipoprotein cholesterol (P<0.01) and triglyceride (P<0.05) levels.

Endurance exercise may influence blood lipid profiles by altering intravascular enzyme activities. Increased lipoprotein lipase activity (LPLA) and decreased hepatic triglyceride (TG) lipase activity (HLA) have been noted after exercise training. In addition, increased lecithin-cholesterol acyltransferase (LCAT) activity (LCATA) and reductions in cholesterol ester transfer protein (CETP) concentrations have been reported. Elevations in LPLA or LCATA with endurance training may reduce TG and reciprocally increase HDL-C. Additionally, reduced HLA or CETP, allowing slowed catabolism of HDL particles with endurance training, may enhance the overall accumulation of cholesterol in HDL subfractions. These favorable effects of exercise may contribute to an improvement of the lipid profile (F.S. Lira, 2009).

Y.E. Tsekouras et al. examined the effect of high intensity intervals of aerobic training on very low density lipoprotein (VLDL) - TG secretion in sedentary young men (n : 7) and a nonexercising control group (n : 8). They observed that subjects who had trained by running on the treadmill for 8 weeks at 90% VO^{2}peak had a reduced rate of VLDL-TG secretion (by ~35%, $P \leq 0.05$), suggesting that a short period of high-intensity interval aerobic training lowers the rate of VLDL-TG secretion by the liver in previously sedentary men (Y.E. Tsekouras, 2008).

S.L. Fava et al. measured acute changes in lipid, lipoprotein, apolipoprotein and low-density lipoprotein particle size 6 to 12 hours before and immediately after an endurance triathlon in 34 male and 6 female. They reported that plasma triglyceride (TG) decreased significantly (%70 decrease) in both men and women. A significant increase in HDL cholestrol was observed in both men (%18 increase, P < .0001) and women (%5 increase, P < .01). LDL particle size increased in seven males, whereas in the remaining males and all females no change in LDL size was obserwed (S.L. Fava, 1989).

Lira et al. examined the effects of acute, high-intensity exercise and varying carbohydrate levels (control, low and high) on the blood lipid profile. Six male subjects were distributed randomly into exercise groups, based on the carbohydrate diets (control, low and high) to which the subjects were restricted before each exercise session. Total cholesterol and LDL cholesterol were reduced after the exhaustion and 1 h recovery periods when compared with rest periods only in the control carbohydrate intake group (P<0.05). They did not observe changes in TG and HDL-C concentrations (F.S. Lira, 2009).

S.F. Crouse et al. investigated that short term changes in blood lipid concentrations after high intensity and moderate intensity exercise in men with high cholesterol. Significant changes (P < 0.001) were as follows : total and low-density lipoprotein cholesterol fell by 4% immediately after exercise and then rose by 5-8% by 48 h. Triglycerides were 18% and 15% lower 24 and 48 h. respectively. HDL cholesterol rose 8-9% by 24 h and remained elevated (S.F. Crouse, 1995).

In the study conducted by M.A. Ferguson and his friends, it was found that 11 active male subjects, LDL cholesterol and total cholesterol concentrations decreased immediately after treadmil exercise at %70 of maximal fitness. There were also exercise induced increases in HDL cholesterol concentrations immediately after exercise (M.A. Ferguson, 2003).

D. H. Park and J.W. Ransone investigated acute high-density lipoprotein-cholesterol (HDL) changes in 18 healthy college aged-men completing two-counterbalanced running trials at different exercise intensities: trial 1 at 70 % lactate threshold (LT) (372.5 ± 28.9 kcal); trial 2 at LT intensity (365.9 ± 75.9 kcal). For each trial, blood samples were collected at pre-exercise (baseline), 15 min post-exercise (15 m PE) and 24 hours post-exercise (24 h). In assessing the lipid variables, the significant increase in HDL (p < 0.05) at the 24 h was due to the increase in both HDL_2 and HDL_3. The increase in 15 m PE TC at the LT intensity occurred while the decreases in 24 h TG and VLDL concentrations at the LT intensity occurred at different time periods, respectively. These decreases in the concentrations of TG and VLDL were significantly different, contributing to change in 24 h HDL concentration. Consequently, the LT intensity might appear to be the threshold intensity of acute aerobic exercise (expending 350 kcal) necessary to promote a significant increase in HDL (D.H. Park, 2003).

Ferguson et al. determined the threshold of exercise energy expenditure necessary blood lipid and lipoprotein concentrations and lipoprotein lipase activity in healty trained 11 men. They reported a reduction in triglycerides (TG) and LDL-C concentrations and an increase in HDL-C concentrations 24 h after exercise sessions at 70% VO2max and with energy expenditures higher than 1.100 kcal (M.A. Ferguson, 1998).

Lennon et al. studied 28 subjects (14 males and 14 females) during bicycle exercise for 14 min at a work intensity of 55% of their maximal oxygen consumption. Total and HDL-cholesterol levels were measured (and LDL-cholesterol calculated) at rest, 10, 20, 30, and 40 min of exercise, and 15 min postexercise. There was a significant ($p < 0.001$) increase in HDL-cholesterol levels at 10 min of exercise (58.8 ± 13.9 mg/dl, mean ± SD) above rest (53.1 ± 13.4 mg/dl) for all subjects. This increase persisted ($p < 0.001$) at all time points throughout the exercise session, but declined by 15 min postexercise. There was a small, insignificant decline in LDL-cholesterol (D.L.F. Lennon, 1983).

Ozhan et al. investigated levels of HDL-C, LDL-C, VLDL-C, total cholesterol and triglyceride following an exercise in 20 volunteer males participated in their study, age ranged from 19 to 20 years. For blood analyses, 3ml blood sample was obtained from antecubital vena before the test and the test was begun with a 600 kpm overload. The exercise was loaded at 300 kpm in every 3 minutes, and bicycle pedal freguency was 60 rpm. The test was ended when the subjects came to the point of exhaustion; blood samples were obtained and heart impulses were recorded. Following 5 minutes rest, the same measurements were repeated. According to the data obtained from the analysis of blood samples soon after the exercise, the level of serum HDL-C was significantly increased ($p<0.05$). A decrease in the level of LDL-C was observed but it was not statistically significant ($p>0.05$). There was no significant difference in serum: cholesterol and triglicerid levels ($p>0.05$) (E. Ozhan, 2000).

P.D. Thompson et al. examined acute effect of a single prolonged exercise on serum lipids in 12 trained male runners. Serum TG levels unchanged up to 4 h after the race, but 18, 42 and 66 hr mean reductions of 65%, 39% 32% were observed. Total cholesterol concentration didn't change immediately after exercise, but unexpected significant reductions of 6%-10% were found at 4-66 hr. Only small and transient increases in HDL cholesterol levels were noted after exercise. As a result they suggest that prolonged exercise acutely lowers TG and total cholestrol, but has little effect on HDL mass (P.D. Thompson, 1980).

Datas of males were consistent with most of study results.

Results of exercise training studies in women are inconsistent, with some of these reporting beneficial effects on lipids and with others reporting the opposite or simply no change at all.

The female subjects average total cholesterol (%6), triglycerides (%19.27) and low density cholesterol (%7.74) concentrations decreased immediately after the exercise, insignificantly. There was a small, insignificant increase in high-density lipoprotein cholesterol (%0.19).

Grandjean et al. investigated the influence of a worksite aerobic training program on serum lipid and lipoproteins and cardiovascular fltness in female employees. Thirty-seven healthy but previously untrained, female employees volunteered for the study. Subjects were randomly assigned to either an exercise group (Ex) (n = 20) or control group (C) (n = 17). Following PRE testing, the Ex group aerobically trained by walking, jogging and/or cycling, at least 3 days per wk for 24 wks. Their study's results demonstrate that aerobic training by females in a worksite fitness program significantly improves cardiovascular fitness without altering lipids or lipoproteins (P.W. Grandjean, 1996).

In the study conducted by Ready et al. examined the effect of walking volume on aerobic fitness, serum lipids, and body composition in women post-menopause, a population at risk for coronary artery disease. 56 women participants walked at an intensity of 60% peak oxygen uptake ($\dot{}VO_{2peak}$) for 60 min, 3 $d \cdot wk^{-1}$ ($N = 19$) or 5 $d \cdot wk^{-1}$ ($N = 17$), or remained sedentary($N = 20$). They obserwed no changes in serum lipids in response to either program (A.E. Ready 1996).

Pronk et al. evaluated the acute effects of walking performed of fairly light (50% VO_{2max}) and moderate (70% Vo_{2max}) intensities on serum lipids and lipoproteins in a group of premenopausal (n=11) and a group of postmenopausal (n=10) women. All subjects walked on a motor-driven treadmill at each respective intensity of exercise for a total duration sufficient to expend 350 kcal of energy. Blood samples were obtained at baseline (pre-exercise), immediately post-exercise (IPE), and at 24 hours and 48 hours post-exercise. They found that a single bout of walking has the potential to acutely affect the blood lipid profile of premenopausal as well as postmenopausal women. Immediately following a walk performed at 70% VO_{2max}, reduction in TC and LDL-C was noted for both groups of women. Furthermore, an IPE increase in TG ($p<0.05$) was observed (N.P. Pronk, 1995).

Goodyear et al. examined the immediate and delayed effects of prolonged strenuous exercise on plasma lipid and lipoprotein concentrations in female runners. Venous blood samples were collected from 12 female runners 24 h before, 10 min after, and 1, 3, and 5 d after running a 42 km marathon. Total cholesterol concentrations were significantly reduced 1 d following the exercise and were still lower 3 and 5 d post-marathon. LDL-C was lower immediately and 1 d after the marathon. HDL-C concentrations, corrected for changes in plasma volume, were elevated 24 h post-exercise. Triglyceride concentrations were elevated immediately following the marathon but returned to baseline levels by 24 h post-exercise (L.J. Goodyear, 1990).

Ginsburg et al. determined the effects of a single bout of ultraendurance exercise on blood lipids in highly trained athletes. Thirty-nine volunteer subjects (26 men, 13 women; mean age, 38±10 years) who competed in and completed competiton triathlon. Subjects had blood samples obtained 2 days prior to and within 15 minutes of completion of the triathlon. With exercise, plasma volume corrected levels of triglycerides decreased 39% from 1.58±0.83 to 0.97±0.68 mmol/L (139.6±73.6 to 85.8±60.5 mg/dL) (*P*<.001). Levels of total cholesterol decreased 9% from 4.94±0.88 to 4.50±0.79 mmol/L (190.8±33.8 to 173.8±30.6 mg/dL) (*P*<.001), low-density lipoprotein cholesterol decreased 11% from 2.59±0.77 to 2.30±0.86 mmol/L (100.1±29.9 to 88.7±33.3 mg/dL) (*P*=.02). High-density lipoprotein cholesterol increased with exercise but not significantly (G.S. Ginsburg, 1996).

Subası et al. examined influences of acute resistance and aerobic exercises on plasma homocysteine level and lipid profiles. Fifty one healthy subjects, aged 21.76 ± 2.73 years old, were included the study. The subjects were divided into three groups as aerobic exercise(AE) group (10 female, 8 male), resistance exercise (RE) group (11 female, 9 male) and control (CT) group (8 female, 5 male). They found that TG level decreased after acute aerobic exercise. They also found that levels of Total-c and LDLc, HDL-c did not change immediately after both acute resistance and acute aerobic exercise (S.S. Subası, 2009). These values are similar to our study results.

Weise et al. investigated effects of cholesterol status on blood lipid, lipoprotein lipid, and lipid regulatory enzyme responses to a single session of aerobic exercise in physically active, postmenopausal women. In this study, blood samples were obtained from 12 women with high cholesterol (HC; _200 mg/dl) and 13 women with normal cholesterol (NC; _200 mg/dl), 24 h before (Pre), immediately after (IPE), and 24 and 48 h after an exercise session (treadmill walking at 70% peak oxygen consumption, 400 kcal). They found that blood lipid and lipoprotein lipid concentrations at the IPE, 24 HR, and 48 HR time points did not depend on preexercise cholesterol status of the women. For both groups, triglyceride was significantly reduced (-8.5%) after exercise. The average HDL-C concentration was lower at the IPE time point, but it rose 5% by 24 HR to return to the preexercise value. No significant changes over time from preexercise values were noted for blood concentrations of TC, LDL-C (S.D. Weise, 2005).

In the study conducted by H. Imamura and his friends, examined the effects of moderate exercise on serum lipids, lipoproteins and apolipoproteins in seven sedentary young women under controlled conditions. The subjects exercised on separate days for 30 or 60 min at an intensity of 60% of maximal oxygen uptake on a cycle ergometer. Total cholesterol, triglycerides, high-density lipoprotein–cholesterol (HDL-C), HDL_2-C, HDL_3-C, low-density lipoprotein–cholesterol, apolipoproteins A-I, A-II and B were measured in the serum at the end of the 60 min rest period before each exercise, immediately after the performance of each exercise and at 30 min and 1, 2 and 24 h after each exercise. The results showed that there were no significant differences between the pre- and postexercise samples for any of the parameters tested (H. Imamura, 2000).

In conclusion, these results indicate that acute aerobic exercise can induce acute beneficial modifications on blood lipid profiles in males. But when investigated the females results insignificant values were observed. There were a lot of inconsistent study results in women. According to our data, gender may influence the acute lipid response to exercise.

References

CROUSE, S.F., O'BRİEN, B.C., ROHACK, J.J., et al, 1995, *Changes in serum lipids and apolipoproteins after exercise in men with high cholesterol: influence of intensity*, Journal of Applied Physiology, 79(1) : 279-286.

FAVA, S.L., MCNAMARA, J.R., FARBER, H.W. et al, 1989, *Acute changes in lipid, lipoprotein, apolipoprotein, and low-density lipoprotein particle size after an endurance triathlon,* Metabolism, 38(9):921-925

FERGUSON, M. A., ALDERSON N. L., TROST S. G., et al, 2003, *Plasma lipid and lipoprotein responses during exercise,* Scandinavian Journal of Clinical and Laboratory Investigation, 63(1): 73-80.

FERGUSON, M.A., ALDERSON N.L., TROST S.G., et al, 1998, *Effects of four different single exercise sessions on lipids, lipoproteins, and lipoprotein lipase,* J Appl Physiol, 85:1169–1174.

GİNSBURG, G.S., AGİL, A., O'TOOLE, M. et al 1996, *Effects of a Single Bout of Ultraendurance Exercise on Lipid Levels and Susceptibility of Lipids to Peroxidation in Triathletes*, JAMA,276(3):221-225.

GOODYEAR, L.J., VAN HOUTEN D.R., FRONSOE M.S. et al, 1990, *Immediate and delayed effects of marathon running on lipids and* *lipoproteins in women,* Med Sci Sports Exerc., 22(5):588-92.

GRANDJEAN, P.W., ODEN, G.L., CROUSE, S.F., et al, 1996, *Lipid and lipoprotein changes in women following 6 months of exercise training in a worksite fitness program.* J Sports Med Phys Fitness., 36(1):54-9.

IMAMURA, H., KATAGİRİ, S., UCHİDA, K., et al, 2000, *Acute Effects Of Moderate Exercise On Serum Lipids, Lipoproteins And Apolipoproteins In Sedentary Young Women,* Clinical and Experimental Pharmacology and Physiology, 27(12): 975–979.

KODAMA, S., TANAKA, S., SAİTO, K., et al, 2007, *Effect of Aerobic Exercise Training on Serum Levels of High-Density Lipoprotein Cholesterol,* Arch Intern Med., 167:999-1008

LENNON, D. L. F., STRATMAN, F. W., SHRAGO, E. et al, 1983, Total *cholesterol and HDL-cholesterol changes during acute, moderate-intensity exercise in men and women,* Metabolism**,** 32**(**3**) :** 244-249.

LİRA, F.S., ZANCHİ, N.E., LİMA-SİLVA A.E. et al, 2009, *Acute high-intensity exercise with low energy expenditure reduced LDL-c and total cholesterol in men,* Eur J Appl Physiol.,107(2):203-10.

ÖZHAN, E., HİZMETLİ, S., ÖZHAN, F., et al, 2000, *Erkek Sporcularda Egzersizin Kan Lipoproteinlerine Etkisi,* C. Ü. Tıp Fakültesi Dergisi, 22(2): 88 – 92.

PARK, D.H., RANSONE, J.W., 2003, *Effects of submaximal exercise on high-density lipoprotein-cholesterol subfractions,* Int J Sports Med., 24:245–251.

PITSAVOS, C., PANAGIOTAKOS, D.B., TAMBALIS, K.D., et al, 2009, *Resistance exercise plus to aerobic activities is associated with better lipids' profile among healthy individuals: the ATTICA study,* Q J Med, 102:609–616

PRONK, N.P., CROUSE, S.F., O'BRİEN, B.C. et al, 1995, *Acute effects of walking on serum lipids and lipoproteins in women,* Journal of sports medicine and physical fitness, 35(1) : 50-58.

READY, A.E., NAIMARK, B., DUCAS, J. et al, 1996, *Influence of walking volume on health benefits in women post-menopause,* Medicine & Science in Sports & Exercise, 28(9) : 1097-1105.

SUBASI, S.S., GELECEK, N., OZDEMİR, N., et al, 2009, *Influences of acute resistance and aerobic exercises on Plasma homocysteine level and lipid profiles,* Türk Biyokimya Dergisi [Turkish Journal of Biochemistry–Turk J Biochem], 34(1): 9–14.

TAMBALİS, K., PANAGİOTAKOS, D.B., KAVOURAS S. A., et al, 2009, *Responses of Blood Lipids to Aerobic, Resistance, and Combined Aerobic With Resistance Exercise Training: A Systematic Review of Current Evidence,* Angiology, 60(5): 614-632

THOMPSON, P.D., CULLİNANE, E., HENDERSON, L.O. et al, 1980, *Acute effects of prolonged exercise on serum lipids,* Metabolism, 29(7):662-665.

TSEKOURA,S Y.E., MAGKOS, F., KELLAS, Y. et al, 2008, *High-intensity interval aerobic training reduces hepatic very low-density lipoprotein-triglyceride secretion rate in men,* Am J Physiol Endocrinol Metab., 295(4): E851–E858.

WEİSE, S. D., GRANDJEAN, P. W., ROHACK, J.J. et al, 2005, *Acute changes in blood lipids and enzymes in postmenopausal women after exercise,* Journal of Applied Physiology, 99(2) : 609-615.