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COMPARISON OF LIPID AND LIPOPROTEIN VALUES IN MEN AND WOMEN DIFFERING IN TRAINING STATUS

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Abstract. The aim of this study was to compare plasma triglyceride and lipoprotein concentrations of male and female subjects of different training levels and to examine the risks of cardiovascular diseases. For this purpose, 20 male athletes from the National Turkish Wrestling Team (age 23.5±1.25 years) and 44 male and 51 female students (ages 21.7±1.72 and 20.20±1.68 years, respectively) from physical education and sports department and 40 sedentary females (age 21.14±1.72 years) participated this study. Trigliceride (TG), total cholesterol (TC), HDL-C and LDL-C levels were determined by Hitachi 717 autoanalyser. Apo A-1, Apo B and Lp(a) levels were determined by Behringer Nephelometer 100. Maximum oxygen consumption (VO_2max) values were predicted from the results of 12 min run test and the maximalanaerobic power values were measured by Jump Meter Instrument. There were no significant differences in plasma TC, TG and small lipoprotein a (Lp (a)) values between four groups ($p>0.05$). No significant differences were found in HDL-C, LDL-C, apolipoprotein A1 (Apo-A1) and apolipoprotein B100 (Apo-B) values between wrestlers and male students; and between female students and sedentary females ($p>0.05$). HDL-C values of female students and sedentary females were significantly higher when compared with wrestlers and male students (41.52 and 40.93 mg/dl versus 51.92 and 50.10mg/dl). However, LDL-C values were found to be lower in females than in males (121.83 and 101.10 mg/dl as oppose to 97.7 and 98.4mg/dl). Significant ($p<0.05$) of differences were found between wrestlers and both female groups. Although the wrestlers' training levels were higher than that of male students, their TG and lipoprotein values were not different. These variables were not different between female groups either. These results showed that in young subjects medium and high level of exercises did not cause significant differences in TG and lipoprotein levels, but the gender differences were very pronounced. Neither in

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wrestlers nor in the remaining groups of subjects the lipid and lipoprotein profiles indicate risk of coronary heart disease.

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Key words: Plasma lipoproteins - Training – Wrestlers - Gender

Introduction

Cross-sectional studies demonstrated significant effect of exercise on blood lipids and lipoproteins in both men and women [5].Observational data provide stronger evidence for lower plasma TG and higher HDL-C levels in physically active individuals [5,10]. The thresholds established form cross-sectional studies occur at training volumes of 24 to 32 km per week of brisk walking or jogging that elicit energy expenditure between 1200 to 2200 kcal/wk. This range of weekly energy expenditure is associated with by 2 to 3 mg/dl increases in HDL-C and TG reduction by 8 to 20 mg/dl [5]. It has been suggested that exercise equivalent to jogging 16 to 24 km/wk is necessary to significantly alter blood lipids [7]. Estimates form a meta-analysis of randomized case-control studies suggest that exercise training may only be expected to lower TC and LDL-C levels by approximately 4 mg/dl [5]. It has been found that the HDL-C levels were higher by 15% in male and by 5% in female weight lifters than in untrained persons. The data suggest that the training-induced the increases of the HDL-C levels are more pronounced in males than in females [10,11].

Meta-analysis of 66 studies on the effects of physical activity on lipid and lipoprotein metabolism demonstrated that TC, LDL-C, TG and TC/HDL-C ratio significantly decrease after training [17]. It has been reported that the increases in HDL-C levels induced by exercise training were inversely related to baseline HDL-C levels. These findings suggested that individuals with the lowest HDL-C levels would exhibit the greatest increases in HDL-C with exercise [5]. The magnitude of the observed changes in these values depend on age, sex, body weight, body fat content, duration and intensity of exercise [17]. The effect of exercise on fat metabolism shows differences between sexes. Meta analysis revealed that HDL-C and LDL-C levels in females didn't significantly change during training, because the HDL-C levels were high in females irrespectively of training status [13]. Plasma LDL-C levels were repeated to be higher in body builders than in cyclists and long distance runners, while HDL-C levels were found to be the highest in runners and the lowest in body builders. In the body builders who use anabolic

steroids and got livers damage the HDL-C levels were found to be low and LDL-C levels to be high [18].

Many researches show that the plasma cholesterol is related to coronary heart disease (CHD). The LDL-/HDL-C ratio is associated with the risk of arteriosclerosis. There is substantial, consistent and strong evidence that physical activity is a deterrent for developing many forms of cardiovascular disease [8,15,18]. In general blood lipids and lipoprotein profiles of physically active groups reflect a reduced risk for the development of cardiovascular diseases in comparison with their inactive counterparts [5,8]. In many studies it has been proved that the endurance athletes have lower plasma TG concentration and higher HDL-C levels than the sedentary subject. However the various exercise interventions, experimental designs and participant sample characteristics in longitudinal investigations have hindered the efforts to quantify the exercise dose needed to change lipids and lipoprotein levels in various subgroups of the general population [8].

The aim of this study was to compare lipid and lipoprotein values of subjects differing in training status and to examine their risk of cardiovascular diseases.

Materials and Methods

Subjects: Twenty male wrestlers who were training for 10 years (heavy activities), 44 male students and 51 female students who were engaged in various sports activities for at least 6 years (moderate activity), and 40 sedentary females that constitute the control group, participated this study. The wrestlers were chosen from the Preparation Camp for University World Championship (year 2000); the students were recruited from to Department of Physical Education and Sport, Ondokuz Mayıs University; the control group females were students at various faculties of Ondokuz Mayıs University.

Plasma lipid and lipoprotein measurement: Fasting blood samples were taken in the morning. TG, TC, HDL-C, LDL-C levels were determined by Hitachi 717 Autoanalyser. Apo A1, Apo B and Lp(a) levels were determined by Behringer Nephelometer 100.

Body fat percentage estimation: Triceps and subscapula skin thickness were measured by Holtain caliper from the right side of the body. The following formulas were used for calculation of body fat percentage: For Females: 0.55 x triceps + 0.31 x subscapula + 6.13. For males: 0. 43 x triceps + 0.58 x subscapula + 1.47 [20].

Maximal oxygen uptake was predicted from the results of 12 min run test according to the formula: VO_2 max (ml/kg/min) = Speed (m/min) x 0.2 + 3.5 ml/kg/dk [16].

Anaerobic power (P) was calculated according to the formula: Anaerobic Power (P) = √4.9 x Body Weight x √Jump Distance [16]. Jump distance was measured using jump meter.

Daily energy expenditure: Basal metabolic rates of 1.0 kcal/kg/h and 0.9 kcal/ kg/h) were assumed for males and females, respectively. For calculating the extra energy expenditure, the activity coefficients were taken; for wrestler's (heavy activity) 90%, for student's (moderate activity) 70% and for sedentary subjects 50% of basal metabolism. For wrestlers 2 h, for students 1 h extra activity was calculated [17]. The students were engaged in various sports activities in 5 days a week for 2-3 h at about 70 percent of maximum heart rate.

For total energy expenditure estimation on Basal metabolism + Additional Activity Metabolism was taken [19].

Analysis of variance and Scheffe tests were used for comparison between group of subjects. Values are expressed as means ±Standard Error.

Results

Table 1
Characteristics of subjects

Parameters	Wrestlers	Male Students	Female Students	Control Group
Age (year)	23.5±1.25	21.7±1.72	20.20±1.68	21.14±1.72
Height (cm)	172.3±4.7	174.40±5.3	165.53±5.2	163.21±4.6
Body Weight (kg)	70.2±6.3	72.5±5.9	64.62±5.8	65.15±4.2
BMI (kg/m^2)	23.72±0.12	23.95±0.13	22.63±0.10	22.46±0.6
Body Fat %	9.5±2.1	12.9±2.2	13.8±2.4	16.6±3.7
VO_2 max (ml/kg/min)	52.4±5.2	48.5±5.3	42.2±4.2	40.1±3.4
Anaerobic power (kg/m/s)	127.89±9.4	118.3±8.1	97.8±7.5	80.5±7.6
Systolic blood pressure (mmHg)	114.95±1.92	113.6±2.8	110.5±2.7	113.5±2.6
Diastolic blood pressure (mmHg)	76.62±1.39	75.7±2.5	73.02±2.9	73.01±2.8
Age of training (year)	10±2.3	6.9±3.8	5.4±3.6	0
Energy expenditure (kcal/day)	4720±160	2958±170	2372±135	2210±127

Table 2
Comparison of serum lipid values between the groups of subjects

Mg/dl	Groups	n	Mean	SE	Min.	Max.	F	Scheffe
TC	Wrestlers (1)	20	179.75	11.53	135.00	364.00	1.67	NS
	Male students (2)	44	162.64	5.11	104.00	291.00		
	Female students (3)	51	165.94	4.13	104.00	232.00		
	Control group (4)	40	160.2	4.14	103.10	234.00		
TG	Wrestlers (1)	20	80.75	6.41	47.00	129.00	0.96	NS
	Male students (2)	44	95.52	6.43	34.00	268.00		
	Female students (3)	51	90.45	6.20	28.00	221.00		
	Control group (4)	40	96.15	6.5	29	219		
HDL-C	Wrestlers (1)	20	41.52	1.86	30.00	59.00	20.13**	1<3.4** 2<3.4**
	Male students (2)	44	40.93	1.36	24.00	61.00		
	Female students (3)	51	51.92	1.38	34.00	78.00		
	Control group (4)	40	50.10	1.29	35.00	79.00		
LDL-C	Wrestlers (1)	17	121.83	11.26	74.00	305.60	4.32*	1>3.4*
	Male students (2)	44	101.10	5.12	51.00	236.00		
	Female students (3)	51	97.70	4.29	40.00	159.00		
	Control group (4)	40	98.4	4.12	39.00	148.00		
Apo-A_1	Wrestlers (1)	20	144.15	3.11	97	199	-3.9*	1.2<3.4*
	Male students (2)	44	143.20	3.15	98	202		
	Female students (3)	51	158.93	4.13	104	221		
	Control group (4)	40	149.5	4.09	102	218		
Apo-B	Wrestlers (1)	20	101.3	31.10	41	219	2.36*	1.2>3.4*
	Male students (2)	44	100.2	30.92	40	218		
	Female students (3)	51	87.59	31.6	36	165		
	Control group (4)	40	91.3	31.4	35	168		
	Wrestlers (1)	17	21.80	20.19	10.6	99		NS

Lp (a)	Male students (2)	44	21.78	20.21	10.6	99	0.007
	Female students (3)	51	21.76	20.76	10.6	91	
	Control group (4)	40	20.52	20.12	10.6	94	

*p<0.05; **p<0.01; NS - no significant differences

Table 3
Cardiovascular risk indices of athletes and sedentary subjects (ANOVA and Scheffe)

Mg/dl	Groups	n	Mean	SE	Min.	Max.	F	Scheffe
TC/ HDL-C	Wrestlers (1)	20	4.53	0.38	2.59	10.40	9.70**	1>3.4** 2>3.4*
	Male students (2)	44	4.14	0.18	2.31	7.66		
	Female students (3)	51	3.32	0.13	1.88	6.44		
	Control group (4)	40	3.33	0.14	1.87	6.42		
LDL-C/ HDL-C	Wrestlers (1)	20	3.11	0.36	1.42	8.73	9.41**	1>3.4** 2>3.4*
	Male students (2)	44	2.57	0.15	1.12	6.21		
	Female students (3)	51	1.99	0.12	0.71	4.68		
	Control group (4)	40	2.17	0.11	0.70	4.69		
Apo-B/ Apo-A_1	Wrestlers (1)	20	0.72	0.26	0.21	1.06	3.14*	1.2>3.4* 3<4
	Male students (2)	44	0.71	0.25	0.22	1.03		
	Female students (3)	51	0.57	0.15	0.15	0.89		
	Control group (4)	40	0.67	0.14	0.13	0.87		

*p<0.05; **p<0.01

Physical anthropometric and motoric characteristics were given in Table 1. Daily energy expenditure and VO_2 max values were 4720±160 kcal/day and 52.4±5.2 ml/kg/min in wrestlers. 2958±170 kcal/day and 48.5±5.3 ml/kg/min in male students, 2372±135 kcal/day and 42.2±4.2 ml/kg/min in female students and 2210±127 kcal/day and 40.1±3.7 ml/kg/min in control group. Comparisons of serum lipid values between groups were given in Table 2. There were no significant differences in plasma TC, TG and small lipoprotein a (Lp (a)) values between four groups (p>0.05). No significant differences were found in HDL-C, LDL-C, apolipoprotein A1 (Apo-A1) and apolipoprotein B100 (Apo-B) values

between wrestlers and male students; and between female students and sedentary females ($p>0.05$). HDL-C values of female students and sedentary females were significantly higher when compared with the same values of wrestlers and male students. However, LDL-C values were found to be lower in females than in males but the significant differences were found only between female groups and wrestlers ($p<0.05$). Apo-A1 value in female students and sedentary females were found significantly higher than in wrestlers and male students ($p<0.05$) while their Apo-B values were lower than in males ($p<0.05$). Cardiovascular risks indices of groups were given in Table 3.

Discussion

Body Mass Index (BMI) lower than 25 kg/m^2 and VO_2 max values higher than 40 ml/kg/min are recommended in middle-aged person for health [3]. In our study the BMI and VO_2 max values were found in normal ranges in all subjects.

In the study of Friedman and Kindermann [9], 42 healthy and active subjects were divided in to two groups. Subjects from one group were submitted to endurance training while those from the other group didn't exercise regularly. At the end of the training TG and TC levels didn't differ between these two groups. In our study TG and TC levels also did not differ between groups. Most cross-sectional studies indicate only small, insignificant differences in TC and LDL-C levels between exercise-trained and sedentary individuals [21]. Friedmann and Kindermann [9], found HDL-C, Apo-A1 and Apo-A2 levels higher in endurance trained male group than in the inactive group. In our study these values did not differ significantly between male groups. Because male wrestlers perform mostly anaerobic exercise and strength training it is suggested that such exercise does not increase the HDL-C levels. Some studies showed that aerobic exercise increases the HDL-C levels [5,9,20]. It is, therefore, emphasized that aerobic exercise is important for the athletes who were submitted to the strength training [12].

In the study of Friedman and Kindermann [9], the effect of regular endurance training on lipoprotein and apolipoprotein concentration in plasma differed between males and females [9]. In our study no significant differences were found in HDL-C levels between active and sedentary female subjects ($p>0.05$) but HDL-C levels were significantly higher in women than in men ($p<0.01$). Comparison of the regression slopes of training-induced increase HDL-C and TG in men and women imply that women may be more resistant to exercise-induced changes than men [6]. It has been found that increase in Apo-A1, HDL-C levels after an endurance training were greater in males than in females [9]. In another study, no

relation could found between lipid profiles and training status in females [4]. In females HDL-C levels were higher than in males between 10-50 year probably due to the effect of estrogen. So HDL-C levels can not increase by the continuoun physical activities in females [11]. Gender differences in young distance runners showed that TC and LDL-C are generally greater in male runners than in female runners. HDL-C was similar in boys and girls until age of 13 years, after which values remained greater in girls. No clear pattern of gender differences emerged for TG [7]. It has been found that in females, the exercise-induced differences in HDL-C and LDL-C levels were smaller than in males. The HDL-C levels were found to be higher and the ratio of LDL-C/HDL-C lower in sedentary females than in sedentary males [9]. In our study both in the female athletes and sedentary females' HDL-C levels were higher than in males. All the lipid parameters were not significantly different between male wrestlers and male physical education students. Because both of them did not perform endurance training Effects of exercise on lipid and lipoprotein levels can be initiated at low training volumes [5] but the wrestlers mostly perform strength training and anaerobic training so their lipid profiles could be worse than the other groups.

Aellen *et al.* [1] studied with 45 healthy sedentary males, 16 subjects exercised above anaerobic threshold level (blood lactate >4 mmol/lt), and 17 subjects exercised below anaerobic threshold on the bicycle ergometer for 9 weeks four times in a week. The other 12 subjects were the control group. Energy needs were similar in both training group. The training changed the plasma concentrations of HDL-C, HDL-C_2, LDL/HDL-C, HDL-C_2/HDL-C_3 and TC/HDL-C. The beneficial change in the lipid and lipoprotein profiles were found only after training below anaerobic threshold. Moreover, training above anaerobic threshold increased the ratio of LDL-C/HDL-C. The ratio correlated positively with blood lactate concentration during exercise. According to these results, the training above the anaerobic threshold may negatively affect the lipoprotein profiles. So it's concluded that the training under the below threshold level have to be performed to induce favorable changes in lipid profile [1].

In the present study LDL-C levels and LDL-C/HDL-C ratio were higher in wrestlers than female groups. Our result supports the study of Aellen *et al.* [1]. The reason of this could be the training (anaerobic and isometric) modality of the wrestlers. Bedir *et al.* [2] compared athletes and sedentary control groups and found significant differences in HDL-C and Apo-A1 levels but they couldn't found significant differences in LDL-C, Lp(a) and Apo-B levels between groups [2]. Yalaz *et al.* [22] found HDL-C levels in male athletes higher than in sedentary subjects (49.8 mg/100cc and 42.2 mg/100cc respectively). In our study the HDL-C

values of wrestlers were lower than in athletes but similar to those in the sedentary group in Yalaz *et al.* [22] study. In the present study while Apo-A and Apo-B levels in males were found higher in females ($p<0.05$), Lp(a) levels did not differ among groups ($p>0.05$).

The people who have HDL-C cholesterol levels under 40 mg/dl have more than three times higher risk of cardiovascular diseases than people who have high HDL-C levels. Although it's true that death rates from coronary heart disease are substantially higher the men than in premenopausal women, after age 65 of years the rates become similar in the two sexes [21]. The risk of coronary heart disease can be estimated by dividing TC levels to HDL-C levels. The risk factor is high if TC/HDL-C ratio is higher than 5; the risk factor is low if the ratio is lower than 3.5 [6,14,19]. In our study the cardiovascular risk ratios were 4.53 in wrestlers, 4.14 in male students, 3.32 in female students and 3.33 in sedentaries. The cardiovascular risk ratios of wrestlers are higher than other groups.

Conclusion

Although the wrestlers' training level was higher than that of male students, triglyceride and lipoprotein values didn't differ between the groups. These variables were not different between active and sedentary female groups either. But the plasma LDL-C and Apo-B levels while HDL-C and Apo-A1 values were higher in female subjects than in men were lower. This result shows that medium and high level of exercises did not cause significant differences in lipid and lipoprotein levels.

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