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Investigation of serum leptin levels and VO_{2max} value in trained young male athletes and healthy males

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The present study aimed at investigating serum leptin levels of elite young male athletes who have been regularly exercising for a long period of time and males who do not exercise.

The study included 24 trained young male athletes and 22 healthy sedentary male subjects. Athletes who participated in the study were from different sports branches and have been regularly exercising for at least 2 years. Serum leptin levels were determined by RIA. VO_{2max} levels were identified during maximal exercise. Lactic acid levels were identified one minute before and one minute after exercise from the fingertip by Pro-lactate kit.

As a result of the tests, although BMI values of trained young male athletes and healthy males were close to each other, leptin levels were significantly lower ($p<0.01$), VO_{2max} values were significantly higher ($p<0.01$) and test periods were significantly longer ($p<0.001$) in the former.

In conclusion, regular exercise, by reducing body fat percentage, suppresses serum leptin levels.

Keywords: leptin, exercise, VO_{2max}, BMI, lactate

Leptin is a molecule originating from fat tissue and produced by ob gene. It was first defined by Zhang and co-worker in 1994 (32). Structure of the leptin hormone and leptin receptors resembles cytokines. Therefore, they are accepted as a member of the cytokine family. They are mainly found linked to soluble leptin receptors in circulation (31). Their effects can be both central and peripheral (3). The main secretion area for leptin is the white adipose tissue. It is also secreted from the brown adipose tissue in very small amounts. It informs the brain about the body's fat tissue. Its biological effects are suppression of food intake and increasing of energy consumption. Leptin is

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important in the body's weight control due to these effects. It is effective on the satiety center in the ventro-medial hypothalamus (5, 6, 8). It prevents putting on weight by increasing energy consumption.

It was demonstrated that leptin that was initially defined as a satiety factor (23, 26) not only played a role in energy regulation (7, 12), but it was also effective on the regulation of the functions of a number of systems ranging from gastrointestinal system (1), sympathetic system activation (5) and sexual development (17, 18), reproduction (4), hematopoiesis (9) and immune system (16). Therefore, its physiological role has not been clarified yet.

Leptin lessens fatty acid and triglyceride synthesis and increases lipid oxidation, thereby reducing storage of fat (8). As a hormone, leptin is directly related to body fat rate and BMI. Aerobic exercises increase the use of free fatty acids and thus they reduce body fat tissue.

In this study, in consideration of the effects of leptin and exercise on fat metabolism, leptin levels of young male athletes who have been making aerobic exercise for a long time and those of healthy sedentary males were compared and the effects of chronic exercises on serum leptin level were investigated.

Materials and methods

The study included 24 trained young male athletes whose mean age was 19.46 (2.9)/years, mean weight 69.08 (6.76) kg, mean height 174.00 (5.52) cm, BMI 22.77 (1.26) kg/m^2 and body fat percentage 7.8% and 22 healthy sedentary male subjects whose mean age was 21.63 (2.06)/years, mean weight 69.77 (6.76) kg mean height 175.27 (5.57) cm, BMI 22.78 (3.51) kg/m^2 and body fat percentage 13%. Athletes who took part in the study were from different branches of sports (football: 12, karate: 5, athletism: 5, swimming: 2) and have been exercising regularly for at least two years (1.5 hours/day, 5 days/week, 1 match/week in football). Healthy sedentary males who were included in the study as the control group were not engage in any sportive activity except for their daily routine activities. The study was carried out at the Istanbul University, Istanbul Faculty of Medicine, Department of Sports Medicine and Central Biochemistry Laboratory of Selcuk University, Meram School of Medicine. Experimental procedures were approved by the local ethic committee of University. Individuals in both groups were made to have a light breakfast at 8 o'clock in the morning. Five ml of venous blood was withdrawn from forearm veins at about 9.30 in the morning to establish serum leptin levels. Serum leptin levels were found by RIA method in the sera obtained from venous blood samples. VO_{2max} levels were identified during maximal exercise test carried out in accordance with Bruce protocol using breath by breath method in Sensor-Mediks 2900-C Metabolic Test System (19). Body fat percentages were calculated using Jackson and Pollack (2) method by measuring skin thickness in seven different areas of the body (triceps, axillar, subscapular, pectoral, abdominal, suprailiac and thigh areas) by skin-fold clipper (Holtain Caliper 0.2 mm, Made in UK).

Lactic acid levels were identified one minute before and one minute after exercise from the fingertip by Pro-lactate kit. The relations between groups in terms of leptin levels, VO_{2max} levels, blood lactic acid levels before and after exercise and maximal exercise periods were investigated.

Statistical analyses

Statistical analyses were carried out by Independent Samples-t test using SPSS-10 software. Data were presented as arithmetic mean ± standard deviation and values for which $p<0.05$ were accepted significant.

Results

Anthropometric measurements values of the two groups are presented in Table I. There was no statistical difference between height, body weight and BMI between groups ($p>0.05$), but there were significant differences between age and body fat percentage ($p<0.05$).

Table I

Anthropometric measurements

	Age (year)	Height (cm)	Weight (kg)	BMI (kg/m^2)	Body fat percentage (%)
Healthy sedentary males (n=22)	21.63±2.06	175.27±5.57	69.77±6.76	22.78±3.51	13±3.2
Athletes (n=24)	19.46±1.9	174.00±5.52	69.08±6.76	22.77±1.26	7.8±2.6
P value	p<0.05	NS	NS	NS	p<0.05

NS: Non significant.

Serum leptin levels, maximal oxygen use value, exercise period and lactic acid values were presented in Table II. It was seen that levels of serum leptin hormone were higher in sedentary healthy males (6.66±3.72 ng/ml) than in athletes (2.43±1.78 ng/ml) ($p<0.001$). Maximal oxygen use of subjects during exercise were significantly lower in healthy males (50.05±3.40 ml/kg/min) than those of athletes (62.51±5.09 ml/kg/min) ($p<0.001$). The comparison of the periods for which each group could continue exercising revealed that the results were higher in favor of athletes ($p<0.001$) (test period for athletes: 14.52±1.62 min; for healthy males: 11.63±0.74 min). There was no significant difference between groups in terms of lactic acid levels before exercise (healthy males: 1.76±0.34 nmol/l; athletes: 1.70±0.17 nmol/l), while lactic acid levels following maximal exercise were found higher in athletes ($p<0.05$) (healthy males: 8.06±3.06 nmol/l; athletes: 10.65±1.25 nmol/l).

Table II

Results of maximal exercise test and serum leptin levels in trained male athletes and healthy sedentary males

	Healthy sedentary males (n=22)	Athletes (n=24)	P value
Leptin (ng/ml)	6.66±3.72	2.43±1.78	<0.001
Max VO_2 (ml/kg/min)	50.05±3.40	62.51±5.09	<0.001
Test period (min)	11.63±0.74	14.52±1.64	<0.001
Lactic acide before exercise (mmol/l)	1.76±0.34	1.70±0.17	NS
Lactic acide after exercise (mmol/l)	8.06±3.06	10.65±1.25	<0.05

NS: Non significant.

Discussion

It is known that exercise enhances free fatty acid and glucose metabolism. In consideration of such physiological effects of leptin as reducing food intake and increasing energy consumption, a number of researchers studied the relation between leptin and exercise (15, 21, 25). Since the lower body fat weight is, the higher VO_{2max} is used, leptin is believed to increase performance especially in resistance sports. There is a negative correlation between body fat weight and use of VO_{2max} (28) whereas there is a positive correlation between BMI value and serum leptin level. In their studies on morbid obese people, Meier et al. (20) demonstrated that serum leptin levels were directly related to BMI (BMI=22 kg/m^2, serum leptin=7 ng/ml, BMI=45 kg/m^2, serum leptin=52 ng/ml).

Although BMI of trained young male athletes were similar to those of healthy sedentary males in this study, leptin levels were significantly lower in the former. The reason why young male athletes had lower serum leptin levels than sedentary males despite having the same BMI is that body fat rates is lower in athletes than in sedentary males. VO_{2max} values were found significantly higher and test periods were found significantly longer in the group comprising young male athletes ($p<0.001$). This finding shows that regular exercise increases oxygen use of an individual and decreases body fat rate. The fact that exercise period was longer in athletes also supports this finding. Lactic acid levels after exercise were found higher in athletes due to their exercise periods' being longer ($p<0.05$). The relation between leptin and exercise has attracted the attention of many researchers, although the results of preliminary studies were contradictory. It had been seen that these contradictions stem from the failure to form study standards. Intensity of exercise, amount of energy spent during exercise, duration of exercise and the time when blood is collected after exercise all have an impact on serum leptin level. Serum leptin studies conducted without giving due consideration to these parameters generally found that there was no relation between exercise and serum leptin levels. Hickey et al. (11) examined serum leptin levels in long distance runners after a run and stated that there was no change in serum leptin levels. Kraemer et al. (14) reported that serum leptin levels did not change just after acute exercise in women who are in menopause and who do not receive hormone replacement. Torjman et al. (25) could find a change in serum leptin levels neither after short-term maximal exercise nor 4 hours after long-term aerobic exercise performed at 50% of VO_{2max}. However, Leal-Cerro et al. (15) demonstrated that serum leptin levels decreased just after a marathon run.

The reason why different studies give different results is related to the intensity of exercise. Intensity of the exercise and the amount of energy spent are important in the change in serum leptin levels (10). Leal-Cerro et al. (15) stated that serum leptin level decreased after a marathon in which 2800 kcal of energy was spent, whereas Gainsford et al. (9) showed that there was a decrease in serum leptin levels 24 hours after exercises where 800–1500 kcal energy was spent. In a study on professional football players, Unal et al. (29) found that elite athletes who consume 1200–1300 kcal of energy in one exercise had serum leptin levels lower than the control group after 24 hours following the exercise.

Exercise period and the time when blood is collected after exercise is as important as the intensity of exercise in establishing serum leptin levels. Tuominen et al. (27) showed that following a 2-hour treadmill run there was a 34% decrease in serum leptin levels which were measured 24 hours after the run. Weltman et al. (30) stated that serum leptin levels did not change 3.5 hours after aerobic exercises that lasted 30 minutes. Essig et al. (8) found a 30% decrease in plasma leptin level 48 hours after an aerobic exercise performed at 70% of VO_{2max}. In a study, including 10 healthy males, Nindl et al. (21) could not find a significant change in serum leptin levels until the 9th hour after acute resistive exercise, but found a 33% decrease beginning from the 9th hour (26% at the 9th hour, 33% at the 13th hour). Kraemer et al. (13) reported that serum leptin levels did not change after short-term acute exercises lasting less than 60 minutes, that the levels decreased 1–3 hours after running or bicycling exercises that lasted more than 60 minutes and this inhibition continued for more than 24 hours. Studies about the relation between leptin and exercise have generally focused on acute exercise and changes in serum leptin levels. However, chronic exercises should be the focus of attention in order to study the permanent effects of leptin hormone on the body. There is a positive correlation between leptin level and body fat weight. Regular aerobic exercising for a long time decreases body fat percentages (chronic adaptation to exercise) and thus decreases serum leptin levels. In order to understand the chronic effect of exercise, our study included young male athletes who have been exercising for at least two years, 5 days a week. Resting leptin levels of the athletes were found 2.5-folds lower than those of the control group ($p<0.001$). In addition, a negative correlation was established between serum leptin level and VO_{2max} use.

In a study including 10 young, professional footballers who have exercised 5 days a week and played a match once a week for at least 5 seasons and 17 sedentary healthy males (BMI in athletes: 23.1 kg/m^2, BMI in controls: 21.4 kg/m^2), Unal et al. (29) found that resting serum leptin levels were 2.5 times lower in athletes than in the control group (Elite athletes: 2.56 ng/ml, control group: 6.32 ng/ml).

Ozcelik et al. (22) in their study including 14 obese, female patients (age: 42 years, BMI: 40.8 kg/m^2) applied an aerobic exercise program (60 min/day, 3 days/week) and a 1200–1400 kcal/day low-calorie diet for 12 weeks. They demonstrated that serum leptin levels did not change in acute exercise after exercise (before acute exercise: 23.6 ng/ml; after exercise 22.6 ($p>0.05$)). It was also reported that there was no difference between serum leptin levels before and after the last exercise. When the effects of 12-weeks exercise are examined, it was seen that serum leptin levels fell down significantly before the last exercise after 12-weeks exercise program in comparison to the levels before the first exercise.

Gomez-Merino et al. (10) made a study in France with 26 male soldiers and reported that there was a 3-fold decrease in serum leptin levels after 4-weeks exercise when compared to the levels at the beginning.

In a study including 38 obese women and 16 obese men (BMI: 41.8 kg/m^2, age: 30 years), Sartorio et al. (24) used aerobic exercise + low-calorie diet + stretching exercise in the subjects and found that at the end of 3 weeks there was a 4% decrease in BMI and 7% decrease in fat weight, while serum leptin levels fell from 19.4 ng/ml to 11.6 ng/ml in men and from 41.1 ng/ml to 29.9 ng/ml in women.

Aerobic exercises made regularly for long periods of time reduce body fat percentages (chronic adaptation to exercise) and inhibit serum leptin levels. Intensity of exercise, exercise period, frequency of exercise and the time of blood drawn could be affect serum leptin levels.

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