TÜBİTAK

Original Article

Turk J Med Sci
2010; 40 (3): 471-477
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E-mail: medsci@tubitak.gov.tr
doi:10.3906/sag-0905-27

Serum leptin, lipoprotein levels, and glucose homeostasis between national wrestlers and sedentary males

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Aim: Leptin is an important controller of the size of fat stores by inhibiting appetite. In wrestling, fat metabolism is important not only for aerobic energy system, but also for weight control and weight loss before competition. The aim of this study was to measure and compare the serum leptin levels, glucose homeostasis, and serum lipoproteins between Turkish national wrestlers and sedentary males.

Materials and methods: Forty-five Turkish national wrestlers at the end of Olympic training camp before Beijing 2008 Olympic Games and 43 sedentary students were selected as subjects. Post-exercise levels of serum leptin, HOMA (Homeostasis model assessment) values, triglycerides, total cholesterol, LDL-cholesterol, HDL-cholesterol, and VLDL-cholesterol were measured after overnight fasting. A Mann-Whitney U test was used to test the differences between 2 groups. Pearson Correlation was conducted between leptin and the other parameters.

Results: No significant difference was observed among the means of leptin and total cholesterol levels of the 2 groups. Wrestlers had significantly higher fasting insulin, HDL-cholesterol, triglyceride, and HOMA levels, but a lower LDL-cholesterol level compared to the sedentary males. The positive correlation was only found between leptin and fasting insulin levels ($r = 0.310$, $P = 0.043$).

Conclusion: This study indicated that wrestling training had no effect on resting leptin level after overnight fasting and wrestlers had also decreased insulin sensitivity with higher fasting insulin, HDL-cholesterol, triglyceride, and HOMA levels compared to sedentary males.

Key words: Wrestlers, leptin, HOMA, lipoproteins, insulin resistance

Türk milli güreşçilerin ve sedanterlerin serum leptin ve serum lipoprotein seviyeleri ve glukoz homeostazının karşılaştırılması

Amaç: Leptin açlığı bastırarak vücuttaki yağ depolarının miktarını kontrol etmektedir. Güreşte yağ metabolizması, sadece aerobik enerji sistemi için değil, müsabakalardan önce vücut ağırlığının kontrolü ve kilo düşme açısından da önemlidir. Bu çalışmanın amacı, Türk Milli Güreşçilerinin ve sedanterlerin serum leptin ve lipoprotein seviyeleri ve glukoz homeostazını ölçmek ve karşılaştırmaktı.

Yöntem ve gereç: Pekin 2008 Olimpiyat Oyunları öncesinde hazırlık kampı yapan 45 Türk Milli Takımı güreşçisi ve 43 üniversite öğrencisi sedanter denek olarak seçildi. Egzersiz sonrası serum leptin, HOMA değerleri, trigliseritler, total kolesterol, LDL-kolesterol, HDL-kolesterol and VLDL-kolesterol, bir gece açlıktan sonra ölçüldü. İki grup arasındaki farklılığın test edilmesinde A Mann-Whitney U testi kullanıldı. Leptin ve diğer parametreler arasında korelasyon katsayıları hesaplandı.

Bulgular: Bu çalışmanın sonuçları, iki grubun ortalama leptin ve total kolestrol değerleri arasında fark olmadığını gösterdi. Güreşçiler, sedanterlerden anlamlı şekilde daha yüksek açlık insulin, HDL-kolesterol, trigliserit seviyelerine ve

Received: 31.05.2009 – Accepted: 13.01.2010

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HOMA değerlerine sahipti. Fakat LDL-kolesterol seviyesi daha düşüktü. Sadece leptin ve açlık insülin seviyeleri arasında anlamlı korelasyon vardı (r = 0,310, P = 0,043).

Sonuç: Bu çalışma, güreş antrenmanının bir gece açlıktan sonra istirahat leptin seviyesine etki etmediğini ve güreşçilerin artan insulin düzeyi, HDL-kolesterol, trigliserit seviyeleri ve HOMA değerleri ile azalan insulin duyarlılığına sahip olduğunu ortaya koymaktadır.

Anahtar sözcükler: Güreşçi, leptin, HOMA, lipoproteinler, insulin direnci

Introduction

Wrestling success depends on power, power endurance, maximum strength, muscular endurance of short duration, flexibility as well as technique and tactical skills. Wrestling is an intermittent sport characterized by short duration, high intensity bursts of activity. It requires significant anaerobic fitness, and operates within a moderato-level of aerobic system. Percent contribution of energy systems in wrestling is estimated to be 30% alactic anaerobic, 30% lactic anaerobic, and 40% aerobic. While both alactic and lactic anaerobic energy production systems use only carbohydrate as substrate, aerobic system uses fat in low intensity workloads with long duration and carbohydrate in high intensity workload with moderate duration. The primary aim of conditioning for wrestling is to delay the onset of fatigue by increasing tolerance of lactic acid build-up, increasing the ATP and creatine phosphate to improve efficiency of oxygen use, and to improve recovery between intense bursts of activity (1). Weight control and weight loss are also very important issues in the view of wrestling success. Despite cautions from the medical community (2), adolescent and senior wrestlers continue to reduce their body weight through a combination of dietary restriction and exercise to prepare for athletic competitions (3). Athletes also train to maintain and lose their body weight by burning body fat with a low intensity and long duration exercises. Therefore, fat metabolism becomes more dominant when the wrestlers lose body weight. It is well established that plasma leptin is associated with satiety and leptin stimulates lipid metabolism, and increases energy expenditure. These effects implicate leptin as a major regulator of energy homeostasis, which may serve to limit excess energy storage. As plasma leptin concentrations are tightly coupled with fat mass in humans, decreases in adipose mass with weight loss coincide with decreased concentrations of circulating leptin (4).

Exercise changes the energy balance by increasing energy expenditure and causes to decrease the body fat mass (5), and it is a major therapeutic modality in the treatment of diabetes mellitus (6). Regular physical exercise has been reported to be effective in the prevention, and delay the onset of type 2 diabetes, increase insulin sensitivity, and ameliorate glucose metabolism (7). Since the leptin hormone is directly associated with food intake and energy use, it was studied by many researchers. Therefore, 'leptin efficiency in top level athletes' and control of body fat weight have come into question. It is well known that wrestlers who are able to participate in the Olympic Games have nutrition and weight management problems during their sport career. Intensity of exercise and the amount of energy spent during exercise are very important factors affecting the serum leptin level (8-9). However, the number of studies and the general knowledge concerning these topics in wrestlers are insufficient.

In this study, it was aimed to measure and compare the metabolic characteristics including glucose homeostasis, serum leptin, and lipoprotein levels in wrestlers and healthy sedentary males.

Materials and methods

Selection of the subjects

This study was carried out using a quasi-experimental design. The subjects of this study were 45 Turkish National free and Greco-Roman style team wrestlers during Olympic training camp before Beijing 2008 Olympic Games with an age range of 18-21 while the sedentary group was composed of 43 sedentary and healthy male volunteers with an age range of 18-22. The control group was gender-, age-, and BMI-matched. During the study, the wrestlers were training at least 5 days a week 2 h a day. The sedentary group was selected from among Zonguldak Karaelmas University students. All the subjects were asked not to eat, drink alcohol, and use antioxidant

drugs 8 h before providing blood samples. Subjects' medical history and athletic experiences were investigated and they also went through a medical examination before the study. Subjects who smoked, consumed alcohol, have chronicle illness, and/or exercise induced asthma were eliminated from this study.

All the details of the study were explained to the subjects and the study was approved by the ethics commission.

Body height and weight measurements

Data about the anthropometric characteristics including age, body weight, height, and body mass index (BMI) were obtained. The body height of the subjects was measured by a metal scale with a 0.1 cm sensitivity, and the body weight measurement was taken by a digital weight with a 0.1 kg sensitivity.

Blood analysis

All data were collected at the Medical Faculty laboratory at Zonguldak Karaelmas University. Blood samples were withdrawn into heparinised tubes from a cubital vein after overnight fasting and immediately stored in ice. Plasma was separated from cells by centrifugation at 3000 rpm for 10 min and the plasma samples were stored at -80 °C until analysis.

Analyses of serum lipoproteins, triglycerides, total cholesterol, LDL-cholesterol, HDL-cholesterol, and VLDL-cholesterol were determined by an automated chemistry analyzer (Spectrophotometric enzymatic method, Roche Integra 800) using commercial kits. Moreover, as an indicator of insulin sensitivity, the HOMA value was calculated. Leptin levels were assessed by the ELISA method.

Statistical analysis

All statistical analyses were performed by SPSS version 13.0. Results of descriptive statistics in this study are presented as mean, standard deviation, and minimum and maximum values. Mann-Whitney U test was used to test the differences between wrestlers and sedentary males at 0.05 confidence level. Pearson Correlation was conducted between leptin and the other parameters.

Results

The characteristics of the wrestlers and the healthy sedentary males are presented in Table 1. There were no significant differences in the mean age, height, body weight, and body mass index (BMI) between the 2 groups ($P < 0.05$). Groups were matched according to gender, age, and BMI.

Table 1. Physical characteristics of the wrestlers and the healthy sedentary males.

Variables		Wrestlers (n = 45)	Controls (n = 43)	P
Age (year)	mean ± SD	19.1 ± 0.9	19.4 ± 1.1	0.075
	min-max.	18-21	18-22	
Body Weight (kg)	mean ± SD	71.5 ± 13.6	74.4 ± 8.8	0.195
	min-max.	50-115	65-85	
Body Height (cm)	mean ± SD	1.68 ± 0.07	1.69 ± 0.08	0.675
	min-max.	1.54-1.84	1.53-1.86	
Body Mass Index (kg/m^2)	mean ± SD	25.3 ± 4.8	26.3 ± 3.2	0.281
	min-max.	18.5-40.7	20.5-33.7	

The serum lipoprotein, leptin, glucose, and insulin levels as well as the calculated HOMA values for both groups are presented in Table 2. No significant difference was observed among the means of leptin and total cholesterol levels of the 2 groups ($P > 0.05$). However, the mean glucose and LDL-cholesterol levels in wrestlers were lower compared to the sedentary group ($P < 0.05$). The wrestlers had also higher mean values of serum HDL-cholesterol, triglycerides, fasting insulin levels, and HOMA values, which are calculated using fasting insulin and glucose ($P < 0.05$). The leptin levels of the wrestlers were positively correlated with fasting insulin levels ($r = 0.310$, $P = 0.043$). No significant correlation was observed between leptin and the other parameters.

Discussion

It was observed in studies conducted in Turkey that the leptin/body mass index (BMI) value in the exercised male group was 4 times greater compared to their female counterparts, whereas the same value for the sedentary male group was 5 times greater compared to the female counterparts (10-11). It has been shown that the level of blood leptin with respect to gender may change depending on the location of body fat stores in addition to body fat ratio (10-12). In the "Training Level Comparison Trial" program, which investigates whether intensive exercise has more positive effect on lipoprotein levels compared to a less intensive exercise program (13), it was found that the frequency of exercise may have a more effective role than the exercise intensity. Unal et al. investigated the relations between 10 males who were professional football players and 17 healthy sedentary males in terms of leptin levels before and after exercise. They found that although BMI of professional male athletes was higher than that of the healthy sedentary males, leptin levels of the former were significantly lower ($P < 0.01$) (14).

In this study, no significant differences were found in leptin levels between the wrestlers and the healthy-sedentary males. In this study, the wrestlers had a lower plasma leptin mean value of 2.3 ± 4.0 ng/mL than the sedentary groups' mean value of 3.0 ± 27.6 ng/mL. These results were in accordance with the study carried out by Gippini et al., who reported that the intense exercise had no effect on leptin concentrations, whereas endurance exercise decreased plasma leptin after 48 h. Generally serum leptin levels decrease in highly-trained endurance athletes in comparison with nonsporting individuals (15). Exercise training-induced reductions in leptin levels have been attributed to alterations in energy balance, and glucoregulatory factors including improvements in insulin sensitivity, lipid metabolism, and unknown factors (16). Conversely, training level induced by resistance and/or endurance exercises did not influence leptin production when considering body composition variations (15). Besides Petibois et al. stated that leptin was an indicator of tissue overload in highly-trained endurance athletes, even though it was not sensitive to an increase in training volume and was not accurate with female athletes (17). Similar to wrestling, the effect of training judo on the plasma

Table 2. A comparison of lipid parameters and glucose homeostasis between wrestlers and healthy sedentary males.

Parameters	Wrestlers	Sedentary Group	p
Leptin (ng/mL)	2.3 ± 4.0	3.0 ± 27.6	0.860
Total cholesterol (mg/dL)	169.8 ± 20.5	160.2 ± 26.8	0.079
HDL-cholesterol (mg/dL)	51.2 ± 11.5	43.5 ± 9.9	0.001
LDL-cholesterol (mg/dL)	79.5 ± 22.0	93.6 ± 24.7	0.009
Triglycerides (mg/dL)	142.4 ± 39.9	113.1 ± 43.7	0.007
Glucose (mg/dL)	83.1 ± 7.1	87.8 ± 6.2	0.032
Insulin (mU/L)	9.2 ± 7.4	3.5 ± 4.1	0.001
HOMA values	3.7 ± 1.4	0.8 ± 0.9	0.001

"Homeostasis model assessment, HOMA = (fasting insulin mU/L) / 22,5 * e-ln (fasting blood glucose mmol/L)"

leptin levels 60 h after training was investigated by Oliveira et al. in the competition period in high-performance male athletes. They found that the trained group had a lower concentration of leptin, both as absolute values as well as relative to the percentage of fat in relation to the nontrained group (18). Additionally, Bouassida et al. examined the leptin response and related hormones during and after 2 sub-maximal exercise protocols in trained and untrained subjects. They concluded that leptin is not sensitive to acute short or prolonged sub-maximal exercises in volleyball. The volleyball athletes showed significantly lower resting and exercise leptin response with respect to untrained subjects. It appears that in these anaerobically trained athletes' leptin response to exercise is more sensitive to the level of energy expenditure than hormonal or metabolic modifications induced by acute exercise (19).

The subjects of this research, wrestlers preparing for competitions that will take place in Olympic games, were equally trained according to their anaerobic and aerobic energy systems. So, they had lower serum leptin levels compared to the sedentary individuals. In this study there was only a positive correlation between leptin levels and fasting insulin levels in wrestlers. Doucet et al. stated that variability in insulin levels contributes to variations in leptin levels independently from the influence of adiposity in both men and women. They confirm that in individuals of an identical adiposity level, high fasting insulin is associated with elevated fasting leptin levels. In addition, they emphasize that variations in leptinemia are correlated with the changes in insulin levels during weight loss, independent of changes in adiposity. Thus, fasting leptin levels are influenced by insulin both before and during weight loss in men and women. (20).

Exercise in children could, as in adults, stimulate proinflammatory cytokines known to inhibit directly anabolic activity of the growth hormon-insulin like growth factor-1 axis [namely, interleukin (IL)-6, IL-1, and tumor necrosis factor-α (TNF- α)], each of which has been shown previously in adults to be increased with exercise (21-25). During intensive exercise programs, there are significant changes in the body composition and metabolic markers including plasma lipoproteins. However, the literature and the knowledge about these topics are insufficient for the wrestlers.

Insulin and exercise have been shown to activate glucose transport at least in part via different signaling pathways. However, it is unknown whether insulin resistance is associated with a defect in the ability of an acute bout of exercise to enhance muscle glucose uptake in vivo (26). In this study, fasting insulin and HOMA values among wrestlers were significantly higher than sedentary healthy males. Although they had intensive training programs, the wrestlers had characteristics of insulin resistance. Furthermore, the serum triglycerides levels were also found significantly higher in the study. However, as expected, HDL-cholesterol level was found higher among wrestlers compared to the sedentary group. Increased HDL-cholesterol is one of the positive effects of regular training on lipoproteins in the atherosclerosis. In addition, there were significant decreases in fasting blood glucose, total cholesterol, and LDL- cholesterol levels among wrestlers.

Glucose was obtained from liver by glycogenolysis and gluconeogenesis. Therefore, increasing energy demand of muscles results in the release of glucose into blood. During the exercise, the more the muscles use the glucose from blood the more glucose release from liver and the blood glucose level is maintained at a given level (27-28). In this study, the wrestlers' fasting insulin in glucose homeostasis and HOMA values with respect the insulin resistance were increased. Changes in the nutritional habits, such as high carbohydrates and fat, in wrestlers might be responsible for these results.

In the study conducted by Kishali et al. on Turkish wrestlers, no significant differences were found in HDL-cholesterol, LDL-cholesterol, apolipoprotein Al (Apo-Al), and apolipoprotein B100 (Apo-B) values between wrestlers and male students, and between female students and sedentary females (29). In the present study, serum triglyceride and HDL-cholesterol levels of the wrestlers were higher, whereas total cholesterol and LDL-cholesterol levels were lower compared to the healthy sedentary males.

Stannard and Johnson reported that elevated intramyocellular triglyceride (IMTG) was strongly associated with insulin resistance, though a cause and effect relationship had not been fully described.

Insulin sensitivity and IMTG content are both dynamic and can alter rapidly in response to dietary variation, physical activity, and thermoregulatory response. Physically active humans (athletes) display elevated IMTG content, but in contrast to obese persons, they are insulin-sensitive (30). On the other hand, James et al. found that there was a strong association between obesity and both metabolic syndrome and insulin resistance in Division 1 collegiate football players. Linemen are at significant risk for metabolic syndrome and insulin resistance compared with other positions. This may be predictive of future health problems in collegiate football players, especially linemen (31).

In conclusion, this study indicated that wrestling training had no effect on resting leptin level after overnight fasting. In addition to resistance and/or endurance training, intensive wrestling training, including aerobic and anaerobic activities, did not influence leptin production of athletes with respect to the healthy-sedentary males whose age, gender and BMI-matched for comparison. In wrestling, changes in functional aerobic, anaerobic, and neuromuscular structure cause significant changes in metabolism and lipoprotein levels. In the present study, higher results were observed in fasting insulin, HOMA values, and triglycerides levels, which may lead to atherosclerosis process and metabolic syndrome especially in the wrestling group. On the other hand, wrestlers had a higher value of HDL-cholesterol and lower value of LDL-cholesterol, which may reflects the effects of exercises on lipoproteins, compared to sedentary males. Wrestlers had a decreased insulin sensitivity with higher levels of triglycerides and HOMA values. This means that the increasing fat metabolism during exercise saves carbohydrates as a substrate for high intensity muscle contractions in order to prevent early exhaustion.

Therefore, the results of this study will encourage prospective studies that will investigate the cardiovascular mortality and morbidity in wrestlers.

Acknowledgments

This work was supported by Zonguldak Karaelmas University (Project number: 0001/2008).

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