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Serum Leptin, Plasma Glucose, and Lactate Changes following Aerobic Exhaustive Incremental Exercise in Trained 18-26 Years Old Men

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ABSTRACT

Aims This study aimed to examine the acute effects of exhaustive incremental exercise on serum leptin, glucose, and lactate in one session in trained 18-26 years old men.
Material & Methods The present study was conducted in 2021 on male physical education students available at the Faculty of Sports Sciences of the Shahid Chamran University of Ahvaz in Iran. Thirty students who had 18-26 years old, with body fat between 15-25% and VO2max between 35-45ml/kg/min, were simple randomly selected through 200 physical education students, and they were divided into two equal training and the control groups (each of them consists of 15 subjects). The exercise test included the Astrand test on a treadmill that performed exhaustive incremental exercise. Blood samples have been collected from two groups in pre and post-test and 9 hours after exhaustive incremental exercise. The statistical analyses used were the Independent T-test and one-way ANOVA tests by SPSS version 20.
Findings Results showed that serum leptin did not change between three measurement sets in the training group in comparison to the control group ($p>0.05$). Plasma glucose significantly changed between pre and post-test and pretest and 9 hours later ($p<0.001$). Plasma lactate significantly changed in post-test in comparison to pretest and 9 hours later to post-test ($p<0.001$).
Conclusion Incremental exhaustive exercise has no significant effect on serum leptin.

Keywords Exercise; Leptin; Lactic Acid; Glucose

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Introduction

Since the cloning of murine and human obese genes in 1994 [1], a lot of works have been devoted to elucidating the biology and physiological role of leptin. Leptin has an impact on several physiological systems, including neuroendocrine and immune functions, as well as being involved in growth and development [2, 3]. It is known that plasma leptin concentrations are associated with satiety and that leptin stimulates the oxidation of lipids, increasing energy expenditure [4-7]. These effects suggest that leptin plays an important role in energy homeostasis, providing hypothalamus information on the amount of body fat and limiting excessive energy storage in adipose tissue of mammals. Although the role of leptin in several physiological areas is only partially understood at best, even less is known about the effect of exercise on plasma leptin concentrations. According to the studies carried out on men [8, 9], some authors have shown that circulating leptin levels are lower in athletes than in sedentary subjects, because of the lower body fat content of the sportsmen and probably as a result of the complex neurohormonal adaptations on the long-term physical training [10]. Circulating leptin has been investigated, in man, after the different protocols of exercise that include short- and long-term exercise training [11] and following single sets of exercise (maximal, sub-maximal, short duration, and long duration) [12, 13]. There are many conflicting results in the leptin response to exercise [5, 13-15], but it appears that circulating leptin levels are only decreased by sets of the exercise with considerably high intensity [16] and long duration [6, 17-20]. Data from previous research suggest that altered plasma leptin concentrations are changed for energy intake and expenditure balance, as circulating leptin is influenced by exercise session which meets an energy expenditure threshold. In the study by Al-Hussaniy, regarding the effect of aerobic exercise on leptin secretion, it should be noted that researchers no change in leptin concentration was observed despite a reduction in blood insulin and blood glucose following 60 minutes of treadmill exercise at 50% of maximal oxygen consumption (VO_{2max}) in 6 healthy trained men [21]. On the other hand, In another study, a decrease in leptin concentration immediately, 24 and 48 hours after exercise, 60min running at 70% VO_{2max} with energy consumption of 882.7±14.4kCal was observed in 9 trained men and the leptin response was not associated with changes in blood glucose and lactate concentrations [22]. Resistance training reduces serum leptin levels by depleting glycogen, inhibiting glycolysis, and increasing glucose uptake in the presence of lactate, acidosis, and ketochlamines. However, different results have been obtained regarding the response of leptin to resistance training [23]. Elevated glucose increases leptin. Elevated lactic acid due to exercise may also play a role in increasing leptin. Lactate prevents the absorption of food and an increase in lactic acid increases leptin after exercise [23]. Also, according to studies conducted in various scientific databases and scientific texts, no similar research was observed in the field of trained men. Therefore, the authors considered it necessary to conduct this research.

Therefore, the aim of this study was to discuss the influence of exercise on leptin, in particular, to examine the acute effects of an aerobic exhaustive incremental exercise session on serum leptin, plasma glucose, and lactate in trained 18-26 years old men.

Material & Methods

The present study was conducted in 2021 by quasi-experimental method with a pre-test-post-test design on male physical education students available at the Faculty of Sports Sciences of the Shahid Chamran University of Ahvaz in Iran. The counting sampling method was used for choosing the 200 students, of which only 30 participants met the inclusion criteria. Participants allocated training and the control groups each consists of 15 subjects) using simple random sampling. Criteria for sample selection in the study included complete physical and mental health, trained students who exercised at least 3 times a week, age: 22.9±1.9 years, height: 174.4±6.7cm, weight: 71.2±7.5kg, and body mass index (BMI): 23.4±1.9kg/m^2, body fat between 15-25% and VO_{2max} between 35-45ml/kg/min. Exclusion criteria were non-observance of diet, participation in other sports activities, suffering from various diseases such as diabetes and hormonal disorders and heart, kidney, and liver disease, participating in other training programs before the test, and having an addiction.

Data was gathered by a Form containing personal information, medical certificate, amount of exercise during the week, and medication that was completed by these volunteers. The individual and physical characteristics of the participants were measured after a complete medical examination. The height and weight of the subjects were measured with a height meter ±0.5cm and a digital scale ±0.1kg (Ska, Germany), respectively. To calculate their BMI, the formula was used to divide the square of height by weight. Body fat percentage was determined using a body composition measuring device and bioelectrical impedance method (IN BODY 0.3, Korea). The maximum oxygen consumption was also measured using the Bruce test that it performed on a motorized treadmill (professional canine treadmill, Grillo, Modena, Italy). All these measurements were measured once before the test.

The study protocol was an incremental exhaustive exercise session performed by the training group. About two weeks before the start of exercise, participants in both study groups were asked to follow a simple, low-fat diet and did not take any herbal or chemical drugs during the study, and refrained from participating in other training programs. The subjects were also emphasized to eat their breakfast 2h before the test (the test was performed at 8 AM) because the exercise test was performed incrementally until exhaustion therefore morally subjects have to be fed at the onset of their test. An exercise test was the Astrand test which was performed on a treadmill; also it is used to estimate the VO2max of athletes. The purpose of this test is to measure a people's aerobic fitness (the ability of the body to use oxygen to produce energy while running). For this test subject starts walking on the treadmill and builds their speed up to 8.05km/h (5mph), with a grade (incline) of 0%. Once they were at this speed start the stopwatch and complete 3min. After 3min set the grade to 2.5% and complete another 2min. Increase the grade by 2.5% every 2min thereafter until the subject was unable to continue the test.

Blood samples were obtained before incremental exercise, immediately after incremental exercise, and 9h later [22]. Three stages of blood sampling were performed by laboratory science experts in Ahvaz to investigate the changes in biochemical parameters of the subjects. Before the start of the training session (pre-test stage), immediately after the training session (first post-test stage) and 9h after the training session (second post-test stage), about 8ml of blood was sampled from the brachial vein. Resistin, insulin resistance, and blood glucose levels were measured separately for each sample. Blood samples were poured into sterile tubes containing KEDTR. The EDTA and heparin tubes were placed on ice to prevent decomposition, and then the tubes were left at room temperature for several minutes. Finally, the blood sample was isolated by centrifugation at 3000rpm plasma for 10min. All blood samples were frozen at -20°C until laboratory operations were performed. Plasma leptin concentrations were determined by ELISA kits (Labor Diagnostika Nord GmbH, Germany). Also, plasma lactate and glucose concentrations were determined by using Shimanzym kits (Shimanzym Co, Iran).

Descriptive statistics were used to classify the raw data and to determine the standard deviation and the mean of the variables. The Shapiro-Wilk test was also used to determine the homogeneity and normality of information about the sample. Demographic information was statistically analyzed using Independent T-test and data related to research dependent variables were analyzed using the ANOVA test and Bonferroni post hoc test. These statistical analyses were performed by the SPSS software (version 20). Data are presented as means±SE with a value of $P < 0.05$ considered statistically significant.

Findings

Thirty students participated in this study and remained until the end of the study (Figure 1).

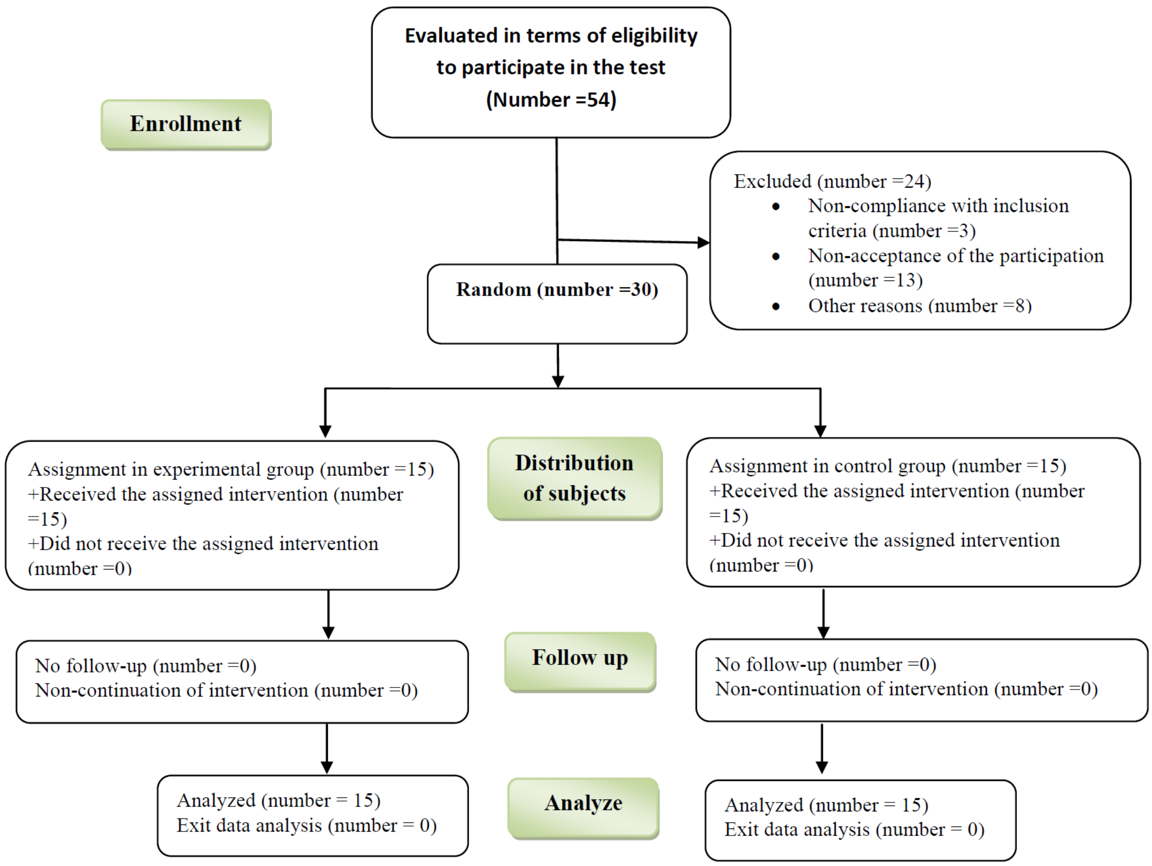

Figure 1) CONSORT process flow diagram

Table 1) Results of mean±SD of subjects' characteristics

Parameters	Training group	Control group	p-value
VO_{2max} (ml/kg/min)	41.26±8.12	42.14±6.27	0.13
Body Fat Percent (%)	20.03±4.22	19.57±2.95	0.23
Weight (kg)	71.33±6.54	71.07±8.09	0.18
Height (cm)	173.57±8.06	175.23±5.83	0.09
Age (year)	23.64±1.48	21.36±2.70	0.11
BMI (kg/m2)	23.01±2.32	23.79±1.74	0.31
Waist to Hip Ratio	0.82±0.10	0.78±0.07	0.08

Table 2) Serum leptin, glucose, and lactate values in three measurement sets

Humeral markers	Intervention			Within groups p.	Between groups p.
	Before	Immediately after	9h later		
Serum leptin (ng/ml)					
Training	4.28±1.54	4.71±1.43	3.98±1.71	0.45	0.21
Control	5.04±2.38	4.15±2.27	4.84±2.14	0.37	
Plasma lactate (mmol/l)					
Training	1.49±0/31	4.79±0.36	1.65±0.26	0.00	0.01
Control	1.36±0.27	1.39±0.24	1.62±0.60	0.36	
Plasma glucose (mg/dl)					
Training	90.07±8.98	103.54±9.70	91.29±9.84	0.00	0.01
Control	89.26±10.72	88.69±10.12	87.61±9.97	0.51	

The mean of their age was 22.50±1.90 years. Their BMI and VO_{2max} were 23.40±1.90kg/m^2 and 41.70±7.05ml/kg/min, respectively, which showed that subjects were trained and at normal weight. Independent T-test showed that there was no significantly different between the two groups in basic characteristics such as age, BMI, and VO_{2max} (Table 1).
The results showed that lactate and glucose levels in the training group compared to the control group the immediate after training compared before training showed a significant increase and in 9h after training compared to immediately after training experienced a significant decrease and return to pre-workout levels (Table 2).

Discussion

The purpose of this study was to investigate the acute effects of exhaustive incremental exercise on serum leptin, glucose, and lactate in one session in trained 18-26 years old men. This study was new because it was performed on subjects who exercised regularly. Results showed that plasma glucose and lactate was increased in training group to control group immediately after incremental exercise but plasma leptin had not any changes between three measurement sets in training group to control group. Studies which have investigated the effects of exercise on serum leptin in man range from designs that employed short duration exercise at varying degrees of intensity to very long duration sets of considerably high volume. Some of investigations suggest that serum leptin concentrations are unchanged by short duration exercise (41min or less) in contrast, other studies, which employed exercise sets of considerably high volume have resulted in decreased leptin [6, 8, 17, 18]. These studies suggested that an exercise-induced energy expenditure threshold must be achieved in order to have influential effects on circulating leptin concentrations. The delayed response of decreased leptin to physical activity (24-48 h) [24-27] led to the hypothesis that exercise-induced reductions in leptin are probably associated to alterations in nutrient availability at the level of adipocytes, the primary site of leptin production and secretion [28, 30]. Catecholamines play a role in the regulation of leptin synthesis. These hormones decrease leptin production through their production of intracellular cAMP [14]. Researchers administered a standardized meal to subjects and observed increases in leptin during 41 min of cycling at 50% of the cycling intensity of VO_{2max}. This was followed by a reduction in serum leptin during recovery that increased to control values after 2 hrs. Cortisol and epinephrine concentrations rose immediately during exercise, and epinephrine decreased quickly after the exercise. Cortisol stimulates leptin production, whereas epinephrine and norepinephrine inhibit leptin production [2, 31]. Probably reciprocal effects of catecholamines and cortisol hormones which secrete during incremental exercise do not have significant effects on serum leptin.
Also, in this study, plasma lactate was increased in a training group to the control group immediately after the incremental exercise test and it was decreased during recovery after the exercise test (9h later the test). These findings are consistent with the results of some studies. [4, 6, 12, 17, 24, 28]. For example, it was reported in a study on short-term (<60 min) exercises can that leptin production is not acutely affected by short-term exercise, regardless of exercise intensity, in healthy males and females [28]. It was shown in another study that reported reductions or increases can be attributed to circadian rhythms or hemoconcentration. It remains to be determined how hormones and metabolites that appear to stimulate (e.g., cortisol, insulin, and glucose) or inhibit (e.g., epinephrine and norepinephrine) leptin work

together to prevent decline under some conditions but not in other conditions [6]. Ultimately increasing anaerobic glycolytic activity, increasing glucose consumption during incremental exercise, and increasing catecholamines and glucagon hormones result in increased plasma glucose during incremental exercise [4, 24]. Based on the above, it can be said that due to the increase in training intensity to the point of exhaustion, the anaerobic energy production system was activated and increased blood lactate levels [12, 17].

One of the limitations of this study is that not all subjects had the same amount of daily calories, were not in the same mental condition and the amount of sleep and rest during the day was not equal. Positive points of this study were that they had the same amount of daily activity and exercise, they were motivated in all training sessions and the training program was performed regularly. we suggest that future researches focus on investigating the effects of exercise which have energy expenditure higher than 800 kcal and last more than 60 minutes, on serum leptin to maybe can observe changes in serum leptin levels. The data provided evidence for the regulatory role of leptin in energy absorption and consumption in humans, suggesting that any acute or long-term change in energy consumption, including exercise, may affect leptin levels. The short-term effect of exercise on leptin secretion is contradictory due to differences in the study population (male, female, trained, and untrained), exercise programs (duration, intensity, and type), and nutritional status (fasting or non-fasting).

Conclusion

In general, we can conclude that incremental exhaustive exercise has no significant effect on serum leptin.

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References

1- Bouassida A, Zalleg D, Bouassida S, Zaouali M, Feki Y, Zbidi A, Tabka Z. Leptin, its implication in physical exercise and training: a short review. J Sports Sci Med. 2006;5(2):172-81.
2- Baile CA, Della-Fera MA, Martin RJ. Regulation of metabolism and body fat mass by leptin. Annu Rev Nutr. 2000;20:105-27.
3- Bryson JM, Phuyal JL, Swan V, Caterson ID. Leptin has acute effects on glucose and lipid metabolism in both lean and gold thioglucose-obese mice. Am J Physiol. 1999;277(3):E417-22.
4- Chwalbinska-Moneta J, Krysztofiak F, Ziemba A, Nazar K, Kaciuba-Uściłko H. Threshold increases in plasma growth hormone in relation to plasma catecholamine and blood lactate concentrations during progressive exercise in endurance-trained athletes. Eur J Appl Physiol Occupational Physiol. 1996;73(1-2):117-20.
5- Dirlewanger M, Di Vetta V, Giusti V, Schneiter P, Jéquier E, Tappy L. Effect of moderate physical activity on plasma leptin concentration in humans. Eur J Appl Physiol Occupat Physiol. 1999;79(4):331-5.
6- Duclos M, Corcuff JB, Ruffie A, Roger P, Manier G. Rapid leptin decrease in immediate post-exercise recovery. Clin Endocrinol. 1999;50(3):337-42.
7- Sajedi D, Shabani R, Elmieh A. Changes in leptin, serotonin, and cortisol after eight weeks of aerobic exercise with probiotic intake in a cuprizone-induced demyelination mouse model of multiple sclerosis. Cytokine. 2021;144:155590.
8- Kharaeva Z, Hokonova T, Elmurzaeva J, Dzamihova I, Mayer W, De Luca C, et al. Effects of heavy isotopes ($^{2}H_{1}$ and $^{18}O_{16}$) depleted water con-sumption on physical recovery and metabolic and immunological parameters of healthy volunteers under regular fitness load Sports. 2021;9(8):110.
9- De Groote E, Deldicque L. Is physical exercise in hypoxia an interesting strategy to prevent the development of type 2 diabetes? a narrative review. Diabetes Metab Syndr Obes. 2021;14:3603-16.
10- Kim DS, Wheeler MT, Ashley EA. The genetics of human performance. Nat Rev Genet. 2022;23(1):40-54.
11- Houmard JA, Cox JH, MacLean PS, Barakat HA. Effect of short-term exercise training on leptin and insulin action. Metabolism. 2000;49(7):858-61.
12- Fisher JS, Van Pelt RE, Zinder O, Landt M, Kohrt WM. Acute exercise effect on postabsorptive serum leptin. J Appl Physiol. 2001;91(2):680-6.
13- Nindl BC, Kraemer WJ, Arciero PJ, Samatallee N, Leone CD, Mayo MF, et al. Leptin concentrations experience a delayed reduction after resistance exercise in men. Med Sci Sports Exerc. 2002;34(4):608-13.
14- Hilton LK, Loucks AB. Low energy availability, not exercise stress, suppresses the diurnal rhythm of leptin in healthy young women. Am J Physiol Endocrinol Metab. 2000;278(1):E43-9.
15- Pérusse L, Collier G, Gagnon J, Leon AS, Rao DC, Skinner JS, et al. Acute and chronic effects of exercise on leptin levels in humans. J Appl Physiol. 1997;83(1):5-10.
16- Elias AN, Pandian MR, Wang L, Suarez E, James N, Wilson AF. Leptin and IGF-I levels in unconditioned male volunteers after short-term exercise. Psychoneuroendocrinology. 2000;25(5):453-61.
17- Landt M, Lawson GM, Helgeson JM, Davila-Roman VG, Ladenson JH, Jaffe AS, et al. Prolonged exercise decreases serum leptin concentrations. Metabolism. 1997;46(10):1109-12.
18- Leal-Cerro A, Garcia-Luna PP, Astorga R, Parejo J, Peino R, Dieguez C, et al. Serum leptin levels in male marathon athletes before and after the marathon run. J Clin

Endocrinol Metab. 1998;83(7):2376-9.
19- Olive JL, Miller GD. Differential effects of maximal-and moderate-intensity runs on plasma leptin in healthy trained subjects. Nutrition. 2001;17(5):365-9.
20- Zaccaria M, Ermolao A, Roi G, Englaro P, Tegon G, Varnier M. Leptin reduction after endurance races differing in duration and energy expenditure. Eur J Appl Physiol. 2002;87(2):108-11.
21- Al-Hussaniy HA, Alburghaif AH, Naji MA. Leptin hormone and its effectiveness in reproduction, metabolism, immunity, diabetes, hopes and ambitions. J Med Life. 2021;14(5):600-5.
22- Picó C, Palou M. Leptin and metabolic programming. Nutrients. 2022;14(1):114.
23- Suzuki Y, Takagishi K, Kurose Y. Circadian rhythm in hypothalamic leptin receptor (Ob-Rb) mRNA expressions and cerebrospinal fluid and circulating glucose and leptin levels in lactating rats. Biochem Biophys Rep. 2021;28:101129.
24- Hickey MS, Calsbeek DJ. Plasma leptin and exercise. Sports Med. 2001;31(8):583-9.
25- Goral M. Effects of leptin, diet and various exercises on the obesity. Res J Biol Sci. 2008;3(11):1356-64.
26- Racette SB, Coppack SW, Landt M, Klein S. Leptin production during moderate-intensity aerobic exercise. J Clin Endocrinol Metab. 1997;82(7):2275-7.
27- Ramírez-Vélez R, García-Hermoso A, Correa-Rodríguez M, Fernández-Irigoyen J, Palomino-Echeverría S, Santamaría E, et al. Effects of different doses of exercise on inflammation markers among adolescents with overweight/obese: HEPAFIT study. J Clin Endocrinol Metab. 2022:dgac021.
28- Reseland JE, Anderssen SA, Solvoll K, Hjermann I, Urdal P, Holme I, et al. Effect of long-term changes in diet and exercise on plasma leptin concentrations. Am J Clin Nutr. 2001;73(2):240-5.
29- Thong FS, Hudson R, Ross R, Janssen IA, Graham TE. Plasma leptin in moderately obese men: independent effects of weight loss and aerobic exercise. Am J Physiol Endocrinol Metabo. 2000;279(2):E307-13.
30- Weltman A, Pritzlaff CJ, Wideman L, Considine RV, Fryburg DA, Gutgesell ME, et al. Intensity of acute exercise does not affect serum leptin concentrations in young men. Med Sci Sports Exercise. 2000;32(9):1556-61.
31- Trayhurn P, Hoggard N, Mercer JG, Rayner DV. Hormonal and neuroendocrine regulation of energy balance-the role of leptin. Archiv für Tierernaehrung. 1998;51(2-3):177-85.