Iranian Journal of Health and Physical Activity (2013) 4 (1), (37-43)

Effect of Aerobic Training on Calorie Intake and Levels of Plasma Leptin and Insulin in Young Men

Rambod Khajei[1], Mahmood Hesar Koushki[2]*, Mohammad Reza Hamedinia[3], Azam Mollanovruzi[3], Marjan Kari[1]

[1] *Islamic Azad University, Neyshabur Branch, Neyshabur, Iran*
[2] *Department of Sport Physiology, Faculty of Physical Education and Sport Sciences, Mazandaran University, Babolsar, Iran*
[3] *Department of Sport Physiology, Faculty of Physical Education and Sport Sciences, Hakim Sabzevary University, Sabzevar, Iran*

Received 27 October 2012 Accepted 6 January 2013

Abstract

Purpose: Changes in the amount of leptin and its relation with the calorie intake after adaptation to aerobic exercise are unknown. The aim of this study was to investigate the effects of two months of aerobic training on calorie intake and the levels of plasma leptin and insulin in young men.

Material and Methods: Twenty three male students (age= 19.58 ± 2.12 yr; BMI= 21.63 ± 2.7 kg/m²; weight= 64.86 ± 6.46 kg) were randomly assigned into experimental and control groups. The experimental subjects performed aerobic trainings at 60-85% of their maximum heart rate, three times a week and for eight weeks. 72 hours prior to and after the eight-week aerobic training program, the subjects performed exhaustive exercise and their blood samples were taken in four stages in a non-fasted state before and after the exhaustive exercise.

Results: The findings of this study showed that aerobic training had no significant effect on plasma leptin (P=0.16), insulin concentration (P=0.06) and calorie intake (P=0.63) at the rest state after exhausting exercise while there were significant decreases in glucose (P=0.003) levels after exhaustive exercise.

Discussion and Conclusion: Lack of significant variations in weight and remarkable negative balance are possible reasons why no change occurred in leptin and calorie intake after aerobic training. It seems that the volume and intensity of training must be higher to induce changes in plasma leptin as this index is highly stable.

Key words: Leptin, Calorie intake, Aerobic training, Exhaustive exercise, Young men

Introduction

Obesity is an increasingly prevalent metabolic condition, which affects not only developed but also developing countries [1]. Indeed, obesity may be considered as the modern world syndrome incurring the most serious risks to health in the current era. It is currently increasing in all age groups [2] exposing people to a variety of diseases including heart attack, arthritis, diabetes type 2, stroke, hypertension and other diseases [3]. It is usually developed due to excess energy intake, insufficient energy consumption, low basal metabolic rate, genetic predisposition, reduced fat oxidation, reduced sympathetic activity and psychological stressors [4].

Several studies have been conducted on the genes contributing to body weight regulation. The first significant step in this regard was the discovery of leptin hormone secreted from adipose cells [5]. Leptin, a protein with a cytokine-like helical structure and molecular weight of 16 KDa, regulates the body weight and homeostasis of energy in the body [6]. There is a direct relationship between plasma levels of leptin and fat reservoir of the body [7].

Insulin is a key regulator of ob gene and leptin secretion [8]. The rapid reduction of serum leptin during fasting vis-a-vis lack of such reduction when insulin and glucose concentrations are maintained at the baseline suggests the important role of insulin in regulating leptin secretion [9]. In response to

* Corresponding author E-mail:
mh.koushki@yahoo.com

food intake, the levels of insulin increase resulting in increased leptin secretion [10] so that both food intake and insulin secretion (through Parasympathetic functions) reduce as well [3]. There is a close relationship between the plasma levels of leptin, fat percentage and insulin concentration. Leptin secretion increases with increased body fat; however, resistance to leptin activity grows gradually so that the fat mass does not decrease [11].

Research has shown that exercise influences leptin cycle and function [12]. Most studies on the short-term effects of training on leptin response reported a reduction or no change in the levels of leptin [13, 14]. Studies have also been conducted on the adaptation of leptin to long-term training, which have yielded contradictory results [15, 16, 17, 18, 19]. Some studies reported that training may help reduce leptin levels if it entails reductions in the adipose tissue [17, 18, 19]. Ara and colleagues (2006) found no variation in serum leptin in a number of 12 male students following 6 weeks of strength exercises. However, both adipose mass and serum testosterone were found to significantly decrease in these subjects [15]. Researchers contended that variations in the levels of leptin maybe independent from variations in fat percentage or testosterone levels [20]. Kishali et al. (2011) found no significant variation in leptin levels in 31 male students following 8 weeks of aerobic training at 50-70% of maximum heart rate. Besides, the training did not induce any changes in the participants' weight and BMI [16]. On the contrary, Sari et al. (2007) reported a decrease in leptin levels in a number of 33 obese women following 4 weeks of aerobic training, 45 minutes per session at 60-85% of maximum heart rate [17]. Desgorces et al. (2004) reported a significant decrease in leptin levels in a number of 11 trained men following 36 weeks of heavy endurance training and 24 hours recovery [18]. Çelik et al. (2011) found a significant decrease in leptin levels in 16 female judo players following 6 weeks of training [19].

Moreover, exercise-induced reductions in serum glucose and insulin have been reported to lead to improvements in insulin resistance [21]. Thus, determination of plasma insulin and glucose can be used to assess the effectiveness of an exercise regimen. The association of insulin and leptin has been discussed recently, and it is well known that both regulate food intake [22] and that their levels are correlated with body weight [23]. Considering the adverse effects of obesity on health and the potential role of exercise in reducing the complications induced by obesity, the present study aims to investigate the effects of two months of aerobic training on calorie intake and the levels of plasma leptin and insulin in young male students.

Material and Methods

The participants of the study consisted of 23 male students (age= 19.58±2.12 yr; BMI= 21.63±2.7 Kg/m^2; weight=64.86±6.46 kg) who volunteered to participate in the study and were randomly assigned to a control group (N= 11) and an experimental group (N= 12). The subjects had no history of illness, smoking, medication and regular exercise at least during the last year.

Procedure

Consistent with the research design, anthropometric and physiological data including weight, BMI and maximum oxygen consumption were collected from the subjects one week before the exhaustive training session (see Table 1). Then the subjects were randomly assigned into the control or aerobic training group. Maximum oxygen consumption was measured in the participants using 12-minute Cooper's test of walking and running [24]. The subjects had the same breakfast and lunch on the day they performed the tests so that they received about 1163 kcal. Three days before and after the test, the subjects completed a 24-hour dietary recall questionnaire. To estimate their calorie intake, they recorded their daily meals including breakfast, morning snack, lunch, evening snack and dinner in the questionnaire. Then using food album guidebook, the ingredients and amount of foods were determined and analyzed using the software Food Processor 2. Both before and immediately after the exhaustive exercise, blood samples were taken from the subjects and were examined to measure plasma leptin, insulin and glucose levels. Variations in the plasma volume were determined and the amounts of hormones were corrected consistent with plasma volume variations to eliminate the pseudo effects of these indices due to reduced plasma volume.

Table 1: Mean and standard deviation of anthropometric and physiological indices in the subjects

Anthropometric & physiological indices	Experimental group (before aerobic training) N=11	Control group (before aerobic training) N=12	P	Experimental group (after aerobic training)	Control group (after aerobic training)	P (between-group variations)
Weight (kg)	6.32±63.76	6.73±66.76	0.34	5.94±63.40	6.65±66.98	0.24
BMI (Kg/m^2)	1.58 ±21.32	3.89 ±22.16	0.61	1.71±21.19	3.42 ±22.69	0.31
VO_{2max} (ml/kg/mni)	3.28±43.27	7.33 ±34.21	0.016	2.41±44.12	6.66±33.02	0.001

Exhaustive training

The subjects first ran at their 60-85% of maximum heart rate. At 85% of maximum heart rate, they continued running to exhaustion. The Borg Scale was used in this test while the exhaustive running protocol was researcher-made.

Aerobic training

The experimental subjects participated in 8 weeks of aerobic training, three sessions a week. The running intensity was 60% maximum heart rate in the first week, reaching to 85% in the sixth week. Then the intensity of 85% of maximum heart rate was maintained for the last three weeks. Polar pulsometer was used to record the heart rate and control the training intensity.

Blood sampling

Blood samples were taken in four stages before and immediately after the exhaustive training. The samples were then centrifuged and the plasma was extracted. ELISA method was applied to measure leptin concentrations using Mercodia kit made in Sweden with the sensitivity of 0.05 ng/ml and within-group variance of 4.7 percent. ELISA method was also applied to measure plasma insulin concentration using Uppsala Mercodia kit made in Sweden with the sensitivity of 1 mIU/L and within-group variance of 6.1 percent. Enzymatic colorimetric method was used to measure glucose levels in the samples using Tehran Pars Azmon kit with the sensitivity of 5 mg/dL and within-group variance of 3 percent.

Statistical analysis

ANCOVA test with repeated measures was used to analyze the data in four stages including before and immediately after the first exhaustive training as well as before and immediately after the second exhaustive training in both control and experimental groups. Independent-samples t-test with added scores was also run to analyze the data. Statistical analysis was conducted using SPSS 18 software ($P<0.05$).

Results

The present findings showed that aerobic training induced no significant changes in physical and physiological characteristics of the participants, including weight; BMI and maximum oxygen consumption (see Table 1). However, it significantly increased exhaustion time and the mileage during exhaustive training in experimental subjects comparing with the control subjects ($P=0.001$) (see Figure 1&2). There was no significant difference in calorie intake between the experimental and control subjects three days before the first exhaustive training ($P=0.87$). As well, there was no significant difference in average calorie intake between the experimental and control subjects three days before the second exhaustive training ($P=0.63$) (see Table 2).

Table 3 illustrates the mean variations in plasma leptin, insulin and glucose. Following the correction of concentration indices in terms of plasma volume variations, aerobic training was found to have no significant effect on plasma leptin values at rest and after the exhaustive training

(P=0.71). Furthermore, aerobic training had no significant effect on plasma insulin concentrations at rest and after the exhaustive training (P=0.06). Although aerobic training had no significant effect on glucose concentrations at rest (P=0.23), it significantly decreased plasma glucose after the exhaustive training (P=0.003).

Discussion and Conclusion

The present findings showed no significant difference in calorie intake of the participants following eight weeks of aerobic training. Consistent with the present findings, Dodd et al. (2008) investigated energy intake in both slim and obese girls following exercise training (training on bicycle ergometer at 75% maximum oxygen

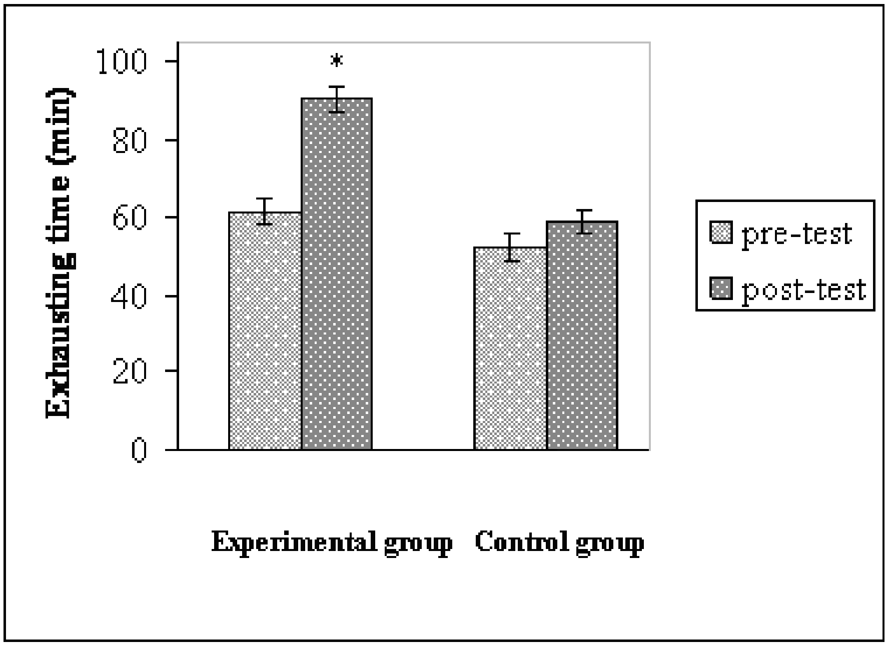

Figure 1: Exhaustion time during the exhaustive exercise in groups
*significant at the level p<0.05

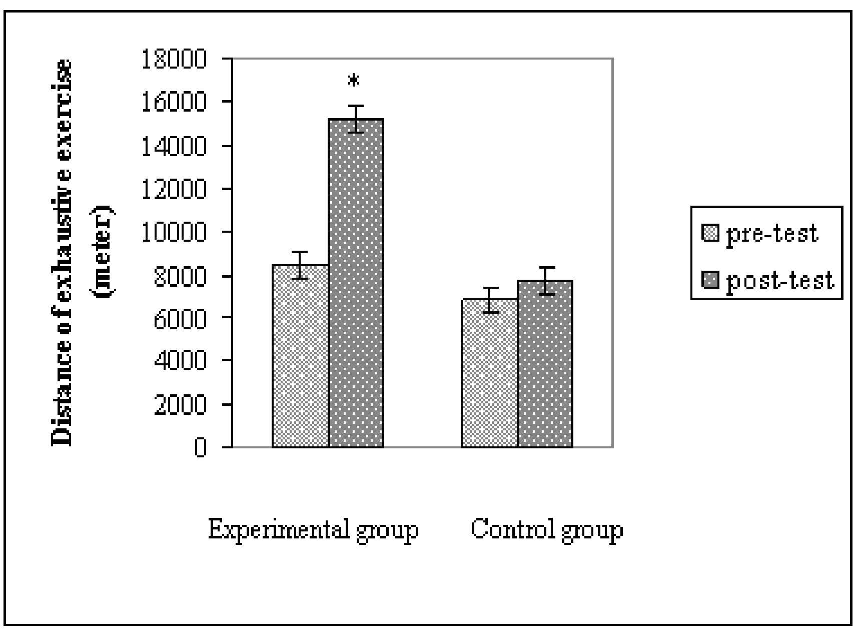

Figure 2: The mileage in the exhaustive exercise (in meters) in groups
*significant at the level p<0.05

Table 2: Mean and standard deviation of calorie intake in both groups

Variable	Time	Three days before the first exhaustive exercise	Three days before the second exhaustive exercise
Calorie intake (kcal)	**Control group**	1455.90±514.98	1682.62±725.70
	Experimental group	1556.50±358.76	1604.31±482.42
	P (between-group variations)	0.87	0.63

Table 3: Mean variations in dependent variables

Variables / Time	Groups	Before the exhaustive exercise 1	After the exhaustive exercise 1	Before the exhaustive exercise 2	After the exhaustive exercise 2
Leptin (ng/ml)	**Control**	†6.26±5.07	5.15±3.90	5.59±4.27	6.06±4.11
	Experimental	3.46±2.12	3.56±2.13	3.49±2.46	4.09±3.25
Insulin (mIU/L)	**Control**	11.91±5.71	*9.04±3.72	6.87±3.78	*5.76±3.11
	Experimental	11.64±6.81	*7.85±4.27	7.04±3.18	*3.80±1.62
Glucose (mg/dL)	**Control**	85.57±6.6	*81.49±6.03	79±9.78	*74.05±3.81
	Experimental	95.75±12.31	*88.55±8.10	80.75±9.97	**70.62±9.56

†Data are represented as Mean±SD; * significant difference comparing with the rest condition P<0.05; ** significant difference comparing with the control condition P<0.05

consumption). In their cross-sectional study, three children trained while three other stayed inactive. The participants were inactive on the first, fourth and fifth days but did the training protocol on the second and third days. The researchers found no significant difference in energy intake between the active and inactive conditions [25]. On the other hand, Long et al. (2002) investigated the effect of exercise on food intake in response to high- and low-energy preloads in men. The subjects were assigned into control, moderate or heavy training groups. A training session consisted of 40 minutes of moderate or heavy exercise. They found no significant differences in energy intake in the control subjects following high (2513 kJ) or low (1008 kJ) energy loading. However, the experimental subjects decreased their energy intake following high energy preload comparing with low energy preload. Moderate training subjects decreased their energy intake following high energy preload comparing with low energy preload; however, the difference was not significant in heavy training subjects [26]. These findings suggest that moderate exercise may precisely compensate for energy preload in the short run. In sum, a comparison of calorie intake in the present subjects before and after the training protocol revealed no significant difference in the calorie intake. To account for this, energy balance might have been maintained during the training protocol so that no significant negative energy balance occurred in the experimental subjects. The participants' weights did not reduce, which may probably account for lack of variation in calorie intake following the aerobic training.

Consistent with the present findings [16, 27], Lowndes et al. (2008) and Kishali et al. (2011) found no significant change in the levels of leptin at rest and after exhaustive training [16, 27]. Lowndes et al. (2008) found no significant difference in the levels of leptin in a number of 38 men and women following 6 months of aerobic training. Besides, they observed no changes in the subjects' weights, to which they attributed the lack of leptin changes [27]. Kishali et al. (2011) reported no significant variation in the levels of leptin following 8 weeks of aerobic training at 50-70% of maximum heart rate. The training did not induce any changes in the subjects' weight and BMI. They contended that other factors may contribute to leptin variations rather than BMI [16]. However, inconsistent with the present findings, Sari et al. (2007), Desgorces et al. (2004) and Çelik and Iri (2011) reported significant decreases in the levels of leptin following exercise training [17,18,19].

Miyatake et al. (2004) reported decreased levels of leptin in obese men following one year of aerobic training at 65% of maximum oxygen consumption. This decrease occurred in addition to decreases in fat percentage, body weight and BMI in the participants. The researchers suggested that insulin might have caused the decreases in the level of leptin [28]. The inconsistency between this and the present findings may be related to differences in the subjects and training duration. Çelik and Iri (2011) observed a significant decrease in the levels of leptin in 16 female judo players following 6 weeks of judo training. They attributed the leptin decrease to increased metabolism and decreased fat percentage [19]. As the study on leptin biology requires a precise attention to energy balance [29] and it is not only the energy intake or exercise energy expenditure but also their balance that stimulate leptin responses [30], lack of variation in leptin concentration at rest following the training protocol maybe related to the energy balance and lack of changes in weight.

The results showed that aerobic training did not significantly affect plasma insulin. However, exhaustive exercise significantly decreased insulin levels both before and after the training protocol in the control and experimental subjects. Similarly, Martins et al. (2010) reported no changes in insulin levels following 8 weeks of aerobic training [31] while Martins (2007) found decreases in insulin levels after one training session [32]. lack of variation in insulin levels following the training protocol in this research maybe due to lack of negative energy balance and no variation in calorie intake in the participants because insulin is a hormone associated with energy abundance [33].

It is well known that both insulin and leptin regulate food intake [22]. There is a relationship between the levels of insulin and leptin with body weight [23]. Lack of variation in calorie intake and insulin concentrations following the aerobic training protocol, may be the result of increased food uptake (more efficient absorption). Participants may also have reduced some of their activities so that their energy balance was not disturbed.

The results of the present study showed that a session of exhaustive exercise both before and after the aerobic training protocol significantly reduced plasma glucose in both groups. The subjects performed the exhaustive exercise to their exhaustion. Thus, glucose concentrations reduced as a result of high energy expenditure and consumption of energy reservoir.

In sum, it may be concluded that lack of variation in body weight and negative energy balance maybe relate to lack of variations in leptin and calorie intake following aerobic training. For the leptin levels to change there may be a need for high intensity and volume of training, as leptin is a highly stable index.

References

1-Ren J (2004). Leptin and hyperleptinemia-from friend to foe for cardiovascular function. Journal of Endocrinology 181: 1-10.

2-Nammi S, Koka S. Chinnala, K. M. Boini, K. M (2004). Obesity: an overview on its current perspectives and treatment options. Nutrition Journal 3: 3-10.

3-Crampes F, Marion-Datard F (2003). Effects of a longitudinal 3. Training program on response to exercise in over weight men. Obesity Research 11:247-256.

4-Blaak EE, Van B (2000). Impaired oxidation of plasma - derived fatty acid in type 2 diabetic during moderate - intensity exercise. Diabetes 49:2102-2107.

5-Yanovski JA, Yanovski SZ (1999). Recent advances in basic obesity research. Journal of the American Medical Association 282:1504-1506.

6-Hamedinia MR, Sardar MA, Haghighi AH, Porjahed J (2009). Comparison of Adiponectin and Leptin Levels in Obese Children and Adolescents. Iranian Journal of Endocrinology & Metabolism 11(2): 169-175. [Persian]

7-Hong S, Frieman J, Alt S (2003). Modifiable risk factors for the primary prevention of heart disease in women. J Am Womens Assoc 58: 275-84.

8-Kolaczynski JW, Nyce MR, Concidine RV, Boden G, Nolan JJ, Henry R, et al (1996). Acute and chronic effects of insulin on leptin production in humans: studies in vivo and in vitro. American Diabet Assocation 45(5): 699- 701.

9-Boden G, Chen X, Mozzoli M, Ryan I (1996). Effect of fasting on serum leptin in normal human subjects. Journal of Clinical Endocrinology Metabolism 81(9): 3419- 3423.

10-Pellymounter MA, Cullen MJ, Baker MB, Hecht R, Winters D, Boone T, Collins F (1995). Effects of the obese gene product on body weight regulation in ob/ob mice. Science 269:540-543.

11-Brannian JD, Schmidt SM (2001). Baseline non-fasting serum leptin concentration to body mass index ratio is predictive of IVF outcomes. Hum Report 16:1819-1826.

12-Gomese-Merino D, Chennaoui M (2004). Leptin and exercise, Science and sport 19, 8-18.

13-Elias AN, Pandian MR, Wang L, Suarez E, James N, Wilson AF (2000). Leptin and IGF-I levels in unconditioned male volunteers after short-term exercise. Psychoneuroendocrinology 25:453-461.

14-Olive JL, Miller GD (2001). Differential effects of maximal-and moderate-intensity runs on plasma leptin in healthy trained subjects. Nutrition 17:365-369.

15-Ara I, Perez-Gomez J, Vicente-Rodriguez G, et al (2006). Serum free testosterone, leptin and soluble leptin receptor changes in a 6-week strength-training programme. Br J Nutr 96:1053–9.

16-Kishali NF (2011). Serum leptin level in healthy sedentary young men after a short-term exercise. African Journal of Pharmacy and Pharmacology 5(40): 522-526.

17-Sari R, Balci MK, Balci N, et al (2007). Acute effect of exercise on plasma leptin level and insulin resistance in obese women with stable caloric intake. Endocr Res 32:9–17.

18-Desgorces FD, Chennaoui M, Gomez-Merino D, et al (2004). Leptin, catecholamines and free fatty acids related to reduced recovery delays after training. Eur J Appl Physiol 93:153–8.

19-Çelik Mm.n, Iri R (2011). Effects of competition term trainings on leptin values of female judokas. African Journal of Pharmacy and Pharmacology 5(6): 683-687.

20-Ishigaki T, Koyama K, Tsujita J, et al (2005). Plasma leptin levels of elite endurance runners after heavy endurance training. J Physiol Anthropol Appl Human Sci 24:573–8.

21-Schenk S, Horowitz JF (2007). Acute exercise increases triglyceride synthesis in skeletal muscle and prevents fatty acid-induced insulin resistance. J Clin Invest 117(6):1690–1698.

22-Xu J, Kirigiti MA, Grove KL, Smith MS (2009). Regulation of food intake and GnRH/LH during lactation: role of insulin and leptin. Endocrinology 150(9):4231–4240.

23-Aas AM, Hanssen KF, Berg JP, Thorsby PM, Birkeland KI (2009). Insulin-stimulated increase in serum leptin levels precedes and correlates with weight gain during insulin therapy in type 2 diabetes. J Clin Endocrinol Metabol 94(8):2900–2906.

24-Cooper K.H. A means of assessing maximal oxygen: correlation between field and treadmill testing. JAMA. 1968; 203:201-204.

25-Dodd CJ, Welsman JR, Armstrong N (2008). Energy intake and appetite following exercise in lean and overweight girls. Appetite 51: 482–488.

26-Long SJ, Hart K, Morgan LM (2002). The ability of habitual exercise to influence appetite and food intake in response to high- and low-energy preloads in men. British Journal of Nutrition 87: 517-523.

27-Lowndes J, Zoeller RF, Caplan JD, Kyriazis GA, Moyna NM, Seip RL, et al (2008). Leptin responses to long-term cardiorespiratory exercise training without concomitant weight loss: A prospective study. J Sports Med Phys Fitness 48:391-7.

28-Miyatake N, Takahashi K, Wada J, Nishikawa H, Morishita A, Suzuki H, et al (2004). Changes in serum leptin concentrations in overweight Japanese men after exercise. Diabetes Obes Metab 6(5):332-7.

29-Hilton LK. Loucks AB (2000). Low energy availability, not exercise stress, suppresses the durenal rhythm of leptin in healthy young women. American Journal of Physiology and Endocrinology and Metabolism 278:43-49.

30-Hojjati Z, Rahmani Niya F, Rahnama N, Soltani B (2008). Heart disease and exercise. Sport Sci 6(11):65-77. [Persian]

31-Martins C, Kulseng B, King NA, Holst JJ, Blundell JE (2010). The effects of exercise-Induced weight loss on appetite-related peptides and motivation to eat. J Clin Endocrinol Metab 95(4): 1609-1616.

32-Martins C, Morgan LM, Bloom SR, Robertson MD (2007). Effects of exercise on gut peptides energy intake and appetite. Journal of Endocrinology 193: 251–258.

33-Wynne K, Stanley S, McGowan B, Bloom S (2005). Appetite control. J Endocrinoly 184: 291–318.