European Journal of Physical Education and Sport Science
ISSN: 2501 - 1235
ISSN-L: 2501 - 1235
Available on-line at: www.oapub.org/edu

10.5281/zenodo.56170 Volume 2 | Issue 1 | 2016

THE EFFECT OF FOUR WEEKS HIIT TRAINING WITH THE USE OF L-CARNITINE ON FAT PERCENTAGE OF TRAINED OVERWEIGHT WOMEN

Maryam Karimi*, Ebrahim Karimi, Sepideh Mizani

[1]Department of Sport Physiology, North Khorasan Science and Research Branch, Islamic Azad University, Bojnourd, Iran

[2]Department of Sport Management, Mashhad Branch, Islamic Azad University, Mashhad, Iran

[3]Department of Sport Physiology, Eslamshahr Branch, Islamic Azad University, Eslamshahr, Iran

Abstract:

The change in phenotype of adipose tissue as a result of practice is a new theory that has recently been proposed and its cell-molecular mechanism is under investigation. The aim of this study was to investigate the effect of high-intensity interval associated with consumption of L-Carnitine on body composition factors in the selective Orexin hormone. The population was trained overweight women, 25 to 35, and out of which, 40 persons voluntarily participated in the study and were divided randomly into 4 groups of 10 people of L-Carnitine, placebo, HIIT and placebo, HIIT L-carnitine. For the sports background and non-suffering of disease, a questionnaire was used. After explaining on implementing the protocol, measuring body composition and blood samples were conducted. Next, the subjects were participated in an intense training programme (with a maximum power) during 12 sessions. Each of the exercise includes a 10-minute warm-up and then a repeated 10 times for 30 seconds and, then, cool down was performed in 5 to 10 minutes. Forty-eight hours after the last training session, the necessary measurement of body composition and blood samples were conducted and data were analyzed using SPSS software and statistical methods. Four weeks of taking L-carnitine, HIIT training with placebo and with L-Carnitine has a significant effect on the percentage of body fat in overweight trained women. Four weeks of HIIT training with L-Carnitine had a significant effect on the percentage of body fat.

Keywords: HIIT, L-carnitine, fat percentage

Introduction

Feeling the joy is the most important indicators of life quality and can be an indicator of the level of success in life (Third, 2011). In today's society, there is too much socio-cultural emphasis on physical fitness and attractiveness. According to the researches, social pressures about weight loss and extensive ideas about the structure of the body has led to body dissatisfaction and negative body image among society and especially women. There are countless factors that affect the variation in body mass, including age, marital status, childbirth, physical activity rat (Zarshenas et al, 2010). There are various methods for the treatment of overweight and obesity, including medication, surgery types, types of exercise and diet which, due to being time consuming, expensive and side effects of other methods, nowadays, sport and physical activity is considered more as a therapy (Zarshenas et al., 2010). Training should be based on the characteristics of the physical, physiological features, scientific theories, and relevant needs. Factors should be considered such as energy devices involved, movement patterns and effective characteristics on the performance (Rodas et al., 2000). Muscle changes resulting from exercise, can be adjusted by the structure of the training program. Manipulation, intensity and duration of activity, and recovery time between bouts of activity, change the needs muscle-cells and metabolic pathways (Hossaini, 2008).

There are several exercises such as plyometric training, endurance training, weight training, stretching, exercises and High Intensity Interval Training (HIIT) and Fartlek training. In recent years, the use of training HIIT, which includes short-term activities with maximal and sub-maximal intensity of work has been increased, and are common in instead of continuous aerobic exercises and cardiovascular disease in athletes and improves Vo_2MAX (maximum oxygen intake), aerobic and anaerobic metabolism, reducing the reliance on carbohydrate and fat, improving insulin function, reduced blood pressure, heart disease, improving the performance of the two indices of sympathetic activity and Endothelia performance (Badri, 2014).

L-Carnitine

L-carnitine is a nutrient as vitamins, which in small amounts in animals' body, is synthesized from two essential amino acids lysine and methionine and causes the release of energy from fat cells. On average, there is 20-25 grams of L-carnitine in the body. It causes the transferring of fatty acids into the mitochondria. Carnitine is formed

in muscle tissue and liver, and existed in some foods such as red meat, poultry, fish and some dairy products (Shaker Hosseini et al, 2005). The main function of carnitine in the body is help to metabolism and convert food into energy. It does this by transferring long chain fatty acids into the mitochondria for beta-oxidation. On the other hand, the use of fat as an energy source saves the consumption of muscle glycogen. And by maintaining glycogen, stores lead to a delay in the onset of fatigue. Mitochondrial can be considered the engine room of body cells. In fact, the energy needed is produced in this part of the cells. Some evidence suggests that the dose of L-Carnitine increases in childhood and pregnancy and breastfeeding as the body needs more energy. The increased demand led to increased production of Carnitine by the body (Deragan et al, 1987). It also appears that L-Carnitine is needed to improve heart function. For example, a study has shown that the abnormal function and abnormal heart pounding is greatly reduced after 45 weeks of 4 gr L-carnitine per day in diabetic patients - In addition to high blood pressure, they suffer heart problems. Another study has shown that daily consumption of L-Carnitine in up to 25% Athletes can even enhance the ability and physical capacity. People who use L-carnitine supplements after exercise to a lesser extent are experiencing fatigue. The studies have shown that the use of L-carnitine two hours before and after running a distance of 20 km, causes less fatigue and faster recovery of physical force. L-Carnitine intake of 100 mg per kg of body weight by children with thalassemia major for 3 months reduced body needs to refine their blood (Akbari et al., 2009).

Generally, body's cells for the synthesis of L-carnitine need the vitamins B6, C, B3 (niacin) but the plant foods are not a good source of it. Other studies have shown the anti-oxidative and anti-inflammatory effects of L-carnitine and its positive effects in improving some health problems, including irregular heartbeat, inflammation of the heart muscle and angina, as well as the use of high doses of immune responses in patients with AIDS (Ashtiyani et al, 2009).

According to the findings of researchers, taking this supplement in a large number of athletes aims to free fatty acids in the membrane of mitochondria and ultimately to increase performance (Paul et al, 2000).

In general, L-carnitine increases ATP production through facilitating the transport of fatty acids into the mitochondrial matrix and stimulating the beta-oxidation. Also, it has an antioxidant (Ashtiyani et al., 2009). Carnitine, as a biological agent, facilitate long-chain fatty acid oxidation of the energy needed to produce heart cells and others tissues. Adjusting the ratio between the COA-SH and Acetyl-COA and acyl groups to trap and stabilize the cell membrane is among its important effects. It has been introduced as a protective agent against free radicals and possibly transcriptional

control it. L-carnitine, in fact, is a drug to treat patients that their bodies do not produce enough carnitine.

Carnitine deficiency in patients with fatigue syndrome improves the function of red blood cells in patients on dialysis, and dialysis treatment in their subsequent syndrome, increase exercise tolerance in patients with angina, improve cardiac function in congestive heart failure and cardiomyopathy, muscle weakness reform, slow growth, and impaired motor skills in children and premature infants, corrected for body weight reduction, treatment of poisoning and sodium valproate, preserve muscle glycogen stores and... (Farlong et al, 1996). Now, its use as a way to prevent injuries are being considered as enters the tissue as an effect of chemotherapy (Martidal, 2002). Carnitine deficiency in fitness program (muscle strengthening) is to prevent muscle cramps during hemodialysis and to help improve heart function that taking carnitine isomer D is very limited and only under the supervision of Genetics (Najafi et al, 2003).

Lipid Metabolism

Fat, a major source for working muscles during exercise, is the consequence of long chain fatty acids from adipose tissue into muscle. The degradation of fatty acids from adipose tissue triacylglycerol and fatty acid release and removal of fat tissue is called the setup process. There is some evidence that intramuscular triacylglycerol in providing the enabling environment for energy during exercise is useful but not convincing. But the importance of exercise intensity and different time remains somewhat ambiguous. The first happen in the regulation of fat breakdown muscle is activation of the lipase triacylglycerol including fatty lipase triacylglycerol (newly discovered) and hormone-sensitive lipase. For oxidation, all of the fatty acids binding protein in the cytoplasm, should be transferred to mitochondrial outer membrane, the cell either outside or inside the muscle cell and, then, be activated with coenzyme A, which if not activated, would convert to fatty acyl carnitine fatty acyl. This combination is transferred by a transferee across the mitochondrial membrane, while carnitine is moving in the opposite direction of this action. Recent evidence also suggests that the transfer of fatty acyl-carnitine complex protein transport across the membrane in some unknown status fat are the same fatty acids transmitters. Within the mitochondria, carnitine is removed. Coenzyme A turns to carnitine palmitoyl-transferase II by the enzymes of fatty acid rebound in long chains. Acyl coenzyme A fat molecule is then metabolized in the oxidation of acetyl coenzyme A and B, with production declining balance, are reducing Flavin adenine dinucleotide. Reducing balance is used directly in the electron transport chain, while the acetyl coenzyme A which is metabolized on track

to more carboxylic acid with excess production loss of balance. Electron transport chain allows the loss of balance to produce a proton motive force recognizes that converts non-organic chemical energy into adenosine triphosphate synthesis of adenosine diphosphate. While in the process of oxidative phosphorylation, it consumes oxygen (Holly He et al, 2009). Potential locations metabolism in skeletal muscle and fat oxidation during prolonged exercise control include:

1. Analysis of adipose tissue, the release of free fatty acids from adipose tissue, and receive free fatty acids to your muscles.
2. Free fatty acids movements across the membrane of the muscle.
3. Transfer control of free fatty acids in the cytoplasm.
4. Analysis of intramuscular triacylglycerol.
5. Transferring of free fatty acids in the mitochondrial membrane.
6. Presumably, regulating the oxidation process B.

Finally, a pervasive aspect of metabolism and oxidation of fat is skeletal muscle mitochondrial volume which determines the overall capacity to oxidize fat (Sahlin, 2009). Shakiba et al (2013) investigated the effect of orexin B-17 gel aromatase and estradiol concentrations in the nucleus of the ventromedial hypothalamus of 40 adult male rats, and found that there are ventromedial hypothalamic neurons secreting estradiol in the area and hypothalamic area trawl.

Baghaei et al (2012), in a study titled "the relationship between total antioxidant and the enzyme creatine phosphate kinase as hydrogen peroxide in female athletes, affected by intensive training found that the immune system in response to intense physical exercise prevent the injury by increasing the antioxidant levels in tissues from damage caused by H2O2 and CPK. In this study, 25 female athletes, 21 to 24, in three phases: before exercise (GXT103) and three hours later, were taken blood samples from the brachial vein. Shekarzadeh et al (2012) inspected the effects of diazinon on liver glutathione levels in rats and the protective effect of selenium and L-carnitine and concluded that selenium and L-carnitine improves antioxidant status in front of diazinon pesticide.

Khaza'ali et al (2012) investigated the effect of stress induced by intravenous injection of epinephrine and cortisol on the secretion of orexin in rats fed with different energy levels. They concluded that Ark Syn injection inhibited the epinephrine secretion induced by starvation in mice that were fed a diet of 100% and 50%. Suri et al (2012) studied the impact of high intensity intermittent exercise on changes in cell adhesion molecules (Sicam-1) plasma lipid profile and body composition in obese sedentary men and concluded that the intensity interval exercise resulted in a significant reduction in intercellular adhesion molecules and improved the lipid profile.

In this study, obese sedentary subjects with a mean age 55 ± 1.34 were divided into two groups. Syahkoyan et al (2012) studied the effect of intense interval training and MCT program on indicators of aerobic and anaerobic athlete at the boys and found that intensive interval training method compared to the MCT program causes similar adaptation in heart fitness - endurance. Training sessions were performed three times a week for 8 consecutive weeks.

Hemmati Nafar et al (2012) studied the impact of high-intensity interval training (HIIT) on plasma levels of adiponectin and insulin sensitivity young men passive resistance in 2012. They found that performing HIIT in terms of time is an effective agent for increasing adiponectin levels and decreasing body fat percentage. Also, the intensity of exercise can be noted as a crucial factor in the increase in adiponectin levels. In this study, 18 students were randomly assigned to two experimental and control groups. Blood samples were collected fasting one day before and then after the exercise protocol. Also, Hemmati Nafar et al (2012) studied the effect of 6 weeks of high-intensity interval (HIIT) on fibrinolytic agents (t-PA and PAI-1 and PAI-1 complex and t-PA) inactive young men and concluded that effective implementation of the 6 weeks of HIIT, in addition to reducing body fat and increasing aerobic fitness, improves fibrinolysis process in sedentary young men. The study subjects were 18 inactive young men who were divided into two experimental and control groups. Each session consisted of 4 to 6 reps running with maximum speed and 30 seconds recovery at intervals of rest. Parra et al (2000) studied HIT training varies with the frequency. Both programs significantly increased glycolytic enzymes phospholipase Fructo kinase and aldolase enzyme acyl-coenzyme A dehydrogenase oxidative citrate synthase and 3-hydroxy. The findings show that 14 sessions of HIT improve glycolytic and oxidative enzyme activity and the changes will be affected by periods of rest between strength training sessions.

Larsen et al (2002) studied the effect of 4 weeks of HIT (12 repetitions of 30 seconds at 175% of maximum aerobic power and 4.5-minute recovery between repetitions, 2 times a week) and regular exercise and low intensity in ten trained cyclists. Stokes et al (2004) investigated the effect of 6-week sprint training (including training, cycling Speed 2 sessions per week endurance and sprint training 1 session per week) on the response to growth hormone (HGH) and some of the physiological and metabolic variables. After exercise, maximum and mean increased 6 and 5%, respectively. The maximum concentration of blood lactate increased and blood lactate recovery period and plasma concentration decreased after exercise. The study showed that 6 weeks of combination of speed and speed - endurance decreased the human

growth hormone response to exercise reduces despite the improvement in speed enforcement.

Material and Methods

The research method is the field one. The population included all women who were overweight and already practiced in different sports clubs. But after giving birth and abandoning the exercise, are overweight and trying to lose weight and fat percentage was in vain. And now are regularly busy with three times a week for at least an hour per session. Of the population, 60 samples available announced their readiness as subjects.

Tools and Measuring devices

- A treadmill for exercise protocol of subjects (Mark techno Jim Made in Italy).
- 0.1 g precision digital scales for determining the weight and BMI of subjects (Seca Germany).
- Height gauge with accuracy of ***0***.5 cm to determine the height and then determine BMI subjects (Seca Germany).
- Wind devices to determine body composition and fat percentage, BMI and body composition of subjects (Omeron).
- Kate orexin, Eastbiopharm.
- Demographic questionnaire, medical records and nutrition.
- Consent form in the practice sessions.

SPSS21 software was used for data analysis and descriptive statistical methods for calculating the mean, median and standard deviation and inferential statistics (Shapiro-Wilk) for normal, one-way ANOVA test for homogeneity of the samples and the Mann-Whitney U test to compare changes between groups and Wilcoxon to compare changes within the group and t-test to test the hypotheses.

Findings

First Hypothesis

According to the non-parametric data, using the Mann-Whitney U test, body fat percentage changes between the consumption of L-carnitine and placebo groups were determined during pre-test and post-test and Wilcoxon test intra-group changes origin in each Which of the groups (Table 1).

Table 1: Mann-Whitney U test and Wilcoxon percent of body fat L-carnitine consumer groups and placebo pre-test and post-test

Mann-Whitney U		Wilcoxon		stages		group	variable
Significance level	Z	Significance level	Z	Post-test mean ± SD	Pre-test mean ± SD		
*0.001	-3.197	*0.005	-2.803	35.94±3.25	39.50±3.12	L-Carnitine	Body Fat Percentage
		0.161	-1.403	39.85±2.83	40.18±2.75	placebo	

* Significant level is P<0.05.

Based on the results in Table 1, changes in body fat percentage was significant between the groups (P<0.05). Also, Wilcoxon test's results showed that mean changes in body fat percentage was significant in the group of L-carnitine (P<0.05); In other words, the percentage of body fat in the group of L-carnitine significantly decreased from 39.50 percent in the pre-test to 35.94 percent in the post-test.

Second Hypothesis

According to the non-parametric data, using the Mann-Whitney U test, body fat percentage changes between the consumption of L-carnitine and placebo groups were determined during pre-test and post-test and Wilcoxon test intra-group changes origin in each Which of the groups (Table 2).

Table 2: Mann-Whitney U test and Wilcoxon percent of body fat HIIT workout and placebo groups during pre-test and post-test

Mann-Whitney U		Wilcoxon		stages		group	variable
Pre-test mean ± SD	Z	Significance level	Z	Post-test mean ± SD	Pre-test mean ± SD		
*0.022	-2.25	*0.008	-2.65	37.94±3.95	40.18±2.97	HIIT training	Body Fat Percentage
		0.161	-1.403	39.85±2.83	40.18±2.75	placebo	

* Significant level is P<0.05.

Based on the results presented in Table 2, the changes between the percentage of body fat was significant (P<0.05). Also, Wilcoxon test results showed that the change in the mean percentage of body fat HIIT training group was significant (P<0.05); in other words, the percentage of body fat of HIIT training group significantly decreased from 40.18 percent in the pre-test to 37.94 in the post-test.

Third Hypothesis

According to the non-parametric data, using the Mann-Whitney U test, body fat percentage changes between the consumption of L-carnitine and placebo groups were determined during pre-test and post-test and Wilcoxon test intra-group changes origin in each Which of the groups (Table 3).

Table 3: Mann-Whitney U test and Wilcoxon percent of body fat HIIT workout with the use of L-carnitine and placebo groups during pre-test and post-test

Mann-Whitney U		Wilcoxon		stages		group	variable
Pre-test mean ± SD	Z	Significance level	Z	Post-test mean ± SD	Pre-test mean ± SD		
*0.001	-3.690	*0.005	-2.810	34.40≠3.54	39.76≠3.36	HIIT training & L-carnitine	Body Fat Percentage
		0.16=1	-1.403	39.85≠2.83	40.18≠2.75	placebo	

* Significant level is P<0.05.

Based on the results presented in Table 3, the changes of the percentage of body fat between groups was significant (P<0.05). Also, Wilcoxon test results showed that the average percentage of body fat changes associated with the consumption of L-Carnitine HIIT training group was significant (P<0.05); in other words, the percentage of body fat of HIIT training group significantly decreased associated with the consumption of L-Carnitine from 39.76 percent in the pre-test to 34.4 in the post-test.

Discussion and Conclusion

Improvement of percentage of body fat

This research shows that HIIT training for four weeks with L-Carnitine intake had a significant impact on the percentage of body fat that are in parallel with the research findings of Tremblay (1994), Moriri (1997), Haghighi (2010), Whelan (2000) and Alex (2004). HIIT training program with the use of L-carnitine, is not removing or completely eliminating fat from the body, but help to achieve an appropriate level of body fat. Although the percentage of body fat and blood lipids are two separate issues, but they are in common in some cases including a high percentage of body fat (overweight and obesity), as well as blood lipids (triglycerides, cholesterol and LDL) are somehow associated with cardiovascular disease. The results of academic research show that to

reduce the percentage of body fat (obesity) and blood lipid regulation, regular physical activity plays a critical role. In this regard, Tremblay et al (1994) studied the effects of HIIT with continuous moderate-intensity exercise for 30 minutes five times a week, reduce the percentage of fat in young men and women. The results showed that the HIIT group was significantly reduced compared to moderate intensity for more fat percentage. Moriri et al (1997) reported a decrease of 48% in visceral fat and 18 percent fat loss under the skin after eight weeks (Two sessions per week of physical activity a steady state and a session HIIT) in men and women with type 2 diabetes (Moriri et al 1997).

The researchers showed that aerobic training alone reduces fat percentage and weight loss, if practiced for more than a year with large volume (800 minutes per week) or at 80 percent of maximum heart rate (Wilani, 2000). Interval training is one of the optional protocol that plays a role in controlling body composition by reducing appetite (by facilitating the release of Corticotropin factor) and by increasing fat oxidation (Butcher, 2010). L-Carnitine supplementation and six weeks' aerobic exercises causes a significant decrease in body fat percentage, but there is no effect on body mass index and weight (Haghighi et al, 2010). Research shows that supplementation with L-carnitine accelerates fat oxidation in overweight subjects and reduces body fat percentage (Alexi et al, 2004).

HIIT exercise and consumption of L-Carnitine had an impact on improving body fat percentage, body mass index and overweight trained women, while these changes are not in parallel with orexin changes. On the other hand, non-significant changes reported in levels of orexin may be related to the type, length, volume and training intensity, duration and hours of sleep, mood and nutrition.

References

1. Akbari Hamzeh, Amir Samani Ramin. (2009). L- Carnitine supplementation effect on IL6 and CRP during a swimming training in male swimmer, Olympic quarterly, 4.
2. Alesci s. De martimo ma, kino T. IIias I. (2004). L- Carnitine is a modulator of the glucocotioid receptor alpha. Ann Acad ser. 102: 147-152
3. Baghaie (2012). The relationship between total antioxidant enzyme creatine phosphokinase and hydrogen peroxide in female sports athletes under the influence of intense workouts. Razi Journal of Medical Sciences. 95.
4. Boutcher S H. (2011). High – Intensity Intermittent Exercise and Fat Loss. Journal of Obesity. 10.

5. Farlong H.(1996). Acetyl-L carnitine metabolism and application inchnical practice alternative medium Review, 1: 85-93.
6. Haghighi, Amir Hossein, Foroughian, Mehdi, Hamedinia, Mohammad Reza, Chami, Maryam. (2011). The effect of six weeks of aerobic training and L - carnitine supplementation on body fat percentage and serum lipid profiles active men, life sciences and sports. 7: 58-61.
7. Hallal PC, Victoria CG, Azevedo MR, Wells JC. (2006). Adolescents physical activity and health: a systematic review. Sport Med. 36:1019-1030.
8. Hemmati Far (2003). The impact of high-intensity interval training (HIIT) on plasma levels of adiponectin resistance and insulin sensitivity young men disabled, the Journal of Zanjan University of Medical Sciences. 84: 12-1.
9. Hemmati Far (2013). The effect of 6 weeks of intense intermittent exercise (HIIT) on fibrinolytic agents (t-PA, PAI-1 and PAI-1 coordination complex and t-PA) sedentary young men, life sciences, sports, fall, Vol. 5, Issue 3: 89 -77.
10. Khaza'ali, Homayoun; Motamedi Juibari Muhammad. (2012). The effects of fear induced by intravenous injection of epinephrine and cortisone secretion in male rats fed with different levels of energy, medical library. 13.
11. Laursen PB, Jaks INS DG. (2002). The Sclenrific basis for high intensity interval training, optimizing trainging Drogrammes and marsimizing performancein high.
12. Martimdal. (2002). The Extra pharmacopoera, carnitin pharmaceutical press. London & Chicago.1356.
13. Mourier A, GautierJ – F, De Kerviler E & et al. (1997). "Mobilization of visceral adipose tissue related to the improvement in insulin sensitivity in response to physical training in NIDDM: effects of branched – chain amino acid supplements, " Diabetes Care.3:385 – 391.
14. Najafi, Moslem, Ghaffari, Saba; Shaseb, alpha, Eteraf Oskoei, T. (2007). The protective effect of L-carnitine and acetyl L-carnitine compared to the size Anfar coat Aysmkymyk heart, Journal of Physiology, Pharmacology. 14.
15. Najafi, Moslem, Gorjestani, Ali Reza (2003). The effect of **L-carnitine** on reperfusion in rat heart arrhythmia caused by the phenomenon. Tabriz University of Medical Sciences.
16. Najafi, Moslem, Gorjestani, Ali Reza (2005). Effect of L-carnitine on Arthemi from Eskimi phenomenon caused by reperfusion in rat heart; Journal of Basic Medical Sciences. 14.

17. Parra J, Cadefau JA Rodas G, Amigo N, Cusso R. (2000). The distribution of rest periods affects performance and adaptations of energy metabolism induced by high-intensity training in human muscle. Acta Physiol Scand.169:157-165.
18. Poortvlit E, Yngve A, Ekelund U, Hurtig-Wennlof A, Nilsson A, Hagstromer M, sjostrom M. (2003). The European Youth Heart Survey (EYHS): an international study that addresses the multi-dimensional issues of CVD risk factors. Forum Nutr. 56:254-256.
19. Roads G, Ventura J L, Cadefau J A, Cusso R & Parra J. (2000). A short training programme for the rapid improvement of both aerobic metabolism. Eur. J. Appi. Physiol. 82:480-486.
20. Sellayah D, Bharas p, sikder D. (2011). Orexin is requrred for brown adipose tissue development defferentation, and function. Cell metabolism. 14: 478-490
21. Shaker Hosseini Rahbar; Rahbar Ali Reza; Saadat Navid, Taleban Farooq Azam. (1984). The study of carnitine in improving glycosylated parameters in patients with type 2 diabetes. Journal of Endocrinology Metabolism. 2.
22. Shakiba Elham; Homayun Khaz'ali (2013). The impact of stress induced by intravenous injection of epinephrine and cortisol secretion in rats fed Arcsine with different levels of energy, Journal of Endocrinology and Metabolism. 3.
23. Sharkey Brian. Exercise Physiology (Coach's Manual). Translated by Rahmania Forad, second edition, Tehran: Office of Research and Development of Physical Education and Health Department of the Ministry of Education Publication.
24. Siyahkohyan. (2013). The effect of intense interval training and MCT program on indicators of aerobic and anaerobic athlete in boys. Exercise Physiology, 18: 22-36.
25. Suri (2012). Lipton periodic exercises and some hormones that affect the metabolism of fat in overweight young men. Journal of Endocrinology and Metabolism, 3: 248-256.
26. Suri (2013). The impact of severe periodic changes of cellular adhesion molecules (sICAM- 1) plasma lipid profile and body composition in obese sedentary men. Sports Biological Sciences, 3: 91: 102.
27. Tremblay A, Simoneau J-A & Bouchard C. (1994). "Impact of exercise intensity on body fatness and skeletal muscle metabolism, "Metabolism. 7:814-818.