Research Article

Effect of continuous aerobic training and high-intensity interval training on some anthropometric indicators of overweight and obese military personnel

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Abstract

Overweight and obesity are associated with an increased risk of cardiovascular disease, hypertension and type 2 diabetes. The purpose of this study was to determine the effect of two continuous aerobic training and high-intensity interval training on body weight, body mass index, waist to hip ratio, and body fat percentage in overweight and obese military people. In this quasi-experimental study, 30 overweight or obese military personnel stationed in a military center were divided into two equal groups of 15 subjects within continuous aerobic training group and high-intensity interval training group. The training protocol consisted of six weeks of continuous aerobic training and high intensity interval training performed every week for three sessions and each session for 60 minutes with equal intensity. The research variables included body weight, body mass index, waist to hip ratio and body fat percentage, which were measured in the same and standard conditions in two stages of pre-test and post-test. After 6 weeks of intervention, high-intensity interval training group showed a significant reduction in body mass index, waist-hip ratio and body fat percentage compared to the continuous aerobic training group($P<0.05$). However, there was no significant change in the body weight of the subjects ($P<0.05$). The results of this study showed that the high-intensity interval training protocol had a greater effect on the body composition parameters of the subjects compared to the continuing aerobic exercise protocol, so it could be included in the training program for overweight or obese military persons.

Key Words: **High-intensity interval training, Continuous aerobic training, Military personnel, Overweight, Obesity**

Introduction

In recent years, changes in lifestyle have caused different societies to face a new range of health problems, including overweight and obesity, so that obesity has been raised as a serious health problem (Tofighi, 2014). The prevalence of overweight and obesity has led to an increase in research on strategies to deal with obesity (Sobhani et al., 2019). Obesity is associated with many physical complications, including cardiovascular diseases, diabetes, high blood pressure, increased blood cholesterol and triglycerides, arthritis, asthma, and certain types of cancer. Overweight and obesity can increase blood pressure through several mechanisms. High blood pressure, like diabetes, is the underlying cause of heart, kidney, and other diseases. Blood lipid disorder with obesity, leads to increase risk of arteriosclerosis by reducing serum good cholesterol (HDL) and increasing serum bad cholesterol (LDL). Cholesterol deposition in the wall of the heart arteries causes a decrease in blood supply to the heart muscle and as a result, lack of oxygen received by the heart, which can ultimately lead to angina (chest pain) and heart attack (Bray et al., 2002). Obesity is the most preventable cause of cancer. Obese people are more susceptible to cancer such as breast, uterus, ovary and gall bladder cancer in women and colon, rectal and prostate cancer in men. Overweight and obesity, due to putting a lot of pressure on the weight-bearing joints of the body, especially the knees, thighs, and lower lumbar vertebrae, cause joint destruction, resulting in osteoarthritis and joint pain (Lau et al., 2010).

The World Health Organization has estimated that there are more than one billion obese or overweight adults in the world (Tofighi, 2014). The prevalence of obesity and overweight is increasing at an alarming rate in Iran, which has emerged due to the development of urbanization, changes in lifestyle and food consumption patterns, as well as a decrease in physical activity (Dehghanpouri et al., 2010). The military forces are not exempt from this, and the prevalence of overweight and obesity among military personnel has also increased in recent years.

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Imbalance between daily energy intake and consumption leads to obesity (Astorino et al., 2013). Many studies have been conducted on obesity treatment methods. Most of the studies agree on diet control along with appropriate and regular physical activity as the most basic and scientific way to lose weight (Gokee-LaRose et al., 2009). Exercises training with increasing energy consumption are one of the effective strategies in treating overweight and obesity (Zouhal et al., 2013). Since there are a variety of training programs for this purpose, knowing the methods that can affect energy metabolism and body composition in a more effective way is very important (Pourabdi et al., 2013). One of the training protocols that has recently attracted the attention of exercise physiology researchers is high intensity interval training (HIIT). HIIT includes periods of very high intensity physical activity and very low intensity active rest periods. Previous studies showed that HIIT compared to aerobic training in adults led to similar metabolic adaptations. Also, previous research has reported that performing HIIT increases fat oxidation capacity, mitochondrial enzyme activity, and as a result, maximal aerobic capacity (Hemmati et al., 2014). Recently, it has also been reported that continuous aerobic training (CAT) for 30 minutes and moderate intensity on most days of the week leads to no reduction or less reduction of fat compared to the implementation of HIIT, which shows the high capability of this type of training for increase in fat consumption (Nikroo & Barancheshme, 2014). Considering the positive effect of HIIT on body fat reduction, this study aimed to determine the effect of CAT and HIIT exercise on body weight, body mass index, waist to hip ratio, and body fat percentage of overweight military personnel. It seems that the results of such studies help expand the use of the best training methods to achieve the desired goals.

Materials and Methods

Subjects

The present research was conducted in a quasi-experimental way and in the form of two groups with pre-test and post-test. The statistical population of the present study was made up of overweight and obese military personnel stationed in a military center with an age range of 20-45 years and a weight of 70-100 kg. The criteria for entering the study were perfect physical health, body mass index equal to or greater than 25, no sports history and the ability to perform the expected exercise program. The reasons for not entering the study included the use of supplements or drugs, disease and smoking, and the conditions for exiting the study were not participating regularly in training sessions. The statistical sample of this research was made up of 30 people who participated in this research with full knowledge of the objectives of the research who were randomly divided into two groups of 15 subjects: CAT and HIIT. It should be noted that a written consent was obtained from the participants and they took part in the study voluntarily.

Study Protocol

The pre test

After selecting the subjects, the researcher explained all the stages of research and testing to the subjects in details. Before the implementation of the main protocol, the individual characteristics and anthropometric indicators of the subjects, including height, weight, waist circumference, hip circumference, and body fat percentage were measured and recorded. Subjects' weight was measured using a Seka dial scale made in Japan with an accuracy of 0.1 kg, and their height was measured using a Seka Yagami model height meter with an accuracy of 0.1 cm. To measure the percentage of body fat, the In-Body device model 230 made in South Korea was used. For this purpose, the subjects were placed on the device without shoes and with the minimum possible covering and following the standard conditions. The numbers shown on the device screen were recorded. Then the subjects sat on a chair in a quiet environment and rested for five minutes, and then the heart rate was taken while lying down.

The post test

Then, the subjects were divided into two equal groups of 15 people, CAT and HIIT, based on the level of physical fitness, fat percentage and body weight by statistical homogenization. During the period, the subjects had the same food plan and daily activities, and they were asked not to change their usual diet and physical activity level.

CAT

In order to prepare the subjects, all of them attended a training course to improve aerobic fitness one week before starting the main protocol. The exercise protocol of the "CAT" group was implemented for six weeks, three sessions per week and each session lasted for 60 minutes from simple to difficult exercises with an intensity of 65-75% of the subject's maximum heart rate. Each training session included 5 minutes of stretching program, 10 minutes of dynamic warm-up program, 40 minutes of main exercises, including running, various periodic exercises and stationary exercises, and finally 5 minutes of cooling down program and returning to the initial state.

HIIT

The exercise protocol of the "HIIT" group was implemented for six weeks, three sessions per week and each session lasted 60 minutes as follows. At the beginning of the training protocol, the

Table 1. Individual characteristics of subjects in the two groups (mean ± standard deviation).

Variable	CAT	HIIT
Age (year)	33.53 ± 5.22	32.73 ± 4.87
Weight (Kg)	83.87 ± 7.56	88.70 ± 5.21
Height (cm)	1.75 ± 0.05	1.78 ± 0.05
BMI (Kg/m^2)	27.34 ± 2.58	27.65 ± 1.72
Body fat (percent)	25 ± 3.23	26.13 ± 2.13

subjects ran at maximum speed from the starting point (cone 1) towards cone 2 (path A), then turned and ran in the opposite direction 20 meters towards cone 3 at maximum speed (path B) and finally, they turned back and ran towards the starting point (cone 1) at maximum speed (path C) until the distance of 40 meters was completed. The subjects continued this process at maximum speed until the 30 seconds of the training protocol was completed and after 30 seconds of rest, they repeated the training protocol. How to progress training with the number of repetitions of 30 seconds from five times in the first week, and in the following weeks, one repetition was added to the next repetition every week. Before the start of the training protocol, in each session the subjects performed 5 minutes of stretching program, 10 minutes of dynamic warm-up program, 40 minutes of main exercises including running with 65-75% of the heart rate and then performing the HIIT protocol and finally, 5 minutes of cooling program and returning to the initial state were considered. In this research, in each stage of the training program, the intensity of the exercises was assessed through the preliminary determination of the maximum heart rate for the subjects, according to the Karvonen formula for each of the subjects, equal to 65-75% and the intensity of HIIT was determined from the heart rate. The maximum heart rate (HRmax = 220) was used, and in all stages of exercise, exercise intensity above 90% of the maximum heart rate was considered, which was calculated separately for each subject.

Statistical analysis

In the present research, Kolmogorov-Smirnov statistical tests were used to determine the normality of data, independent t-test was used to examine the effect of independent variables on dependent variables. All operations and statistical analyzes were performed at a significant level (α>0.05) using SPSS version 22 statistical software.

Results

The individual characteristics of the subjects are presented in Table 1.

The results of the independent t-test showed that the body composition indices of the two groups were not significantly different in the pre-test stage, i.e. before the exercise intervention, but the mean and range of changes in the post-test stage, i.e. after six weeks of training, showed a significant change in these indices. Fat percentage, body mass index and ratio of waist circumference to hip circumference showed a significant difference, but no significant change in body weight was observed (Table 2). These changes was higher in the HIIT group than in the CAT group. (P>0.05).

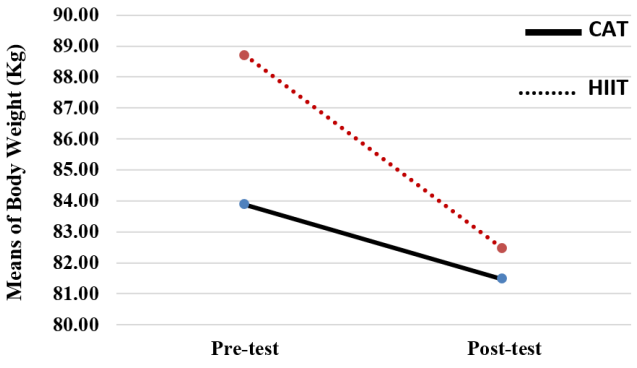
Table 2. Independent T test results of study variables in two groups.

Variable	Measurements	t	df	Sig
Weight	Pre-test	2.034	28	0.052
	Post-test	0.432	28	0.676
	Difference pre-post	0.369	28	0.715
Body fat	Pre-test	0.970	28	0.340
	Post-test	2.987	28	0.006
	Difference pre-post	7.482	28	0.001
Waist/hip ratio	Pre-test	0.201	28	0.842
	Post-test	1.286	28	0.209
	Difference pre-post	6.163	28	0.001
BMI	Pre-test	0.394	28	0.697
	Post-test	0.830	28	0.414
	Difference pre-post	3.432	28	0.002

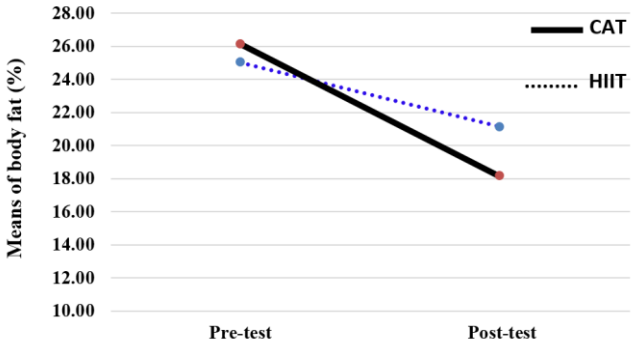
In the comparison between two training methods, it should be noted that both CAT and HIIT methods caused changes in anthropometric indices and body fat percentage of overweight and obese military personnel. These changes in the HIIT group compared to the CAT was more significant (Fig. 1, 2 and 3).

Discussion

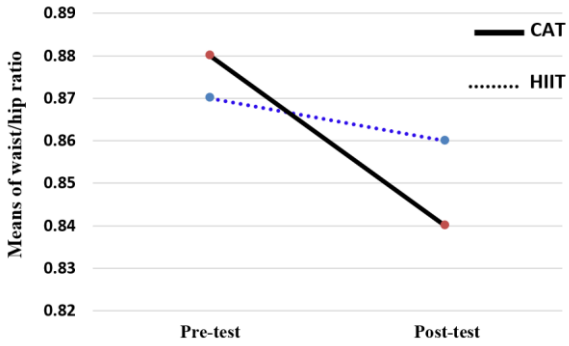
The results of the present study showed that six weeks of HIIT compared to CAT caused a significant decrease in body fat percentage, waist to hip ratio and body mass index in overweight and obese military personnel. In line with the results of the present research, Nikroo and Barancheshme (2014) compared the effect of an HIIT with CAT on maximum oxygen consumption, body mass index, and fat percentage of male students of Naja Officer College, and concluded that an interval training session has a significant effect on maximum oxygen consumption and fat percentage.



Fgure 1. Body weight changes of subjects in pre-test and post-test in two groups. CAT: Continuous Aerobic Training, HIIT: High-Intensity Interval Training.



Fgure 2. Changes in body fat percentage of subjects in pre-test and post-test in two groups. CAT: Continuous Aerobic Training, HIIT: High-Intensity Interval Training.



Fgure 3. Changes in the ratio of waist circumference to hip circumference of subjects in pre-test and post-test in two groups. CAT: Continuous Aerobic Training, HIIT: High-Intensity Interval Training.

Also, Behrad et al.'s showed that selected aerobic exercise along with a controlled diet caused a significant decrease in the weight and body fat percentage of subjects in different groups (Behrad et al., 2016). Bahrami and Saremi showed that caloric restriction with aerobic exercise causes a significant decrease in body weight, abdominal fat, insulin resistance, blood lipid profile and C-reactive protein (Bahrami & Saremi, 2011). In addition, Ghanbarzadeh et al. found that six weeks of intense interval training brings about a significant decrease in weight, body mass index, fat percentage, ratio of waist circumference to hip circumference and a significant increase in maximum oxygen consumption, strength and agility (Ghanbarzadeh et al., 2017). Gholizadeh et al. also reported that two weeks of intense interval training increases fat oxidation by 43%, as well as oxygen, and decreases body fat percentage and weight (Gholizadeh et al., 2016). Physical activity alone or in combination with a proper diet leads to the best long-term result of weight loss and fat percentage (Reyes-Guzman et al., 2015). In the present study, in line with these researches, following HIIT, the percentage of fat, the ratio of waist circumference to hip circumference, and body mass index decreased. However, the observed decrease in body weight was not statistically significant, which is probably due to the short intervention period.

One of the most important effects of obesity and overweight is attributed to an increase in body fat mass and an increase in leptin concentration. Regular exercise training by increasing cellular metabolism has a significant effect on the prevention and treatment of diseases related to obesity and overweight and its complications. There is a lot of evidence showing that increased leptin sensitivity produces a lean and obesity-resistant phenotype. These observations show that leptin prevents weight gain and increasing leptin sensitivity is effective in dealing with obesity. In this context, one of the mechanisms cited is the increase in the function of the glucose transporter (GLUT4) in HIIT, which causes glucose to enter fat cells through GLUT4; Glucose then acts as an intracellular signal, stimulating the relea-se of leptin from fat cells. Leptin prevents weight gain and increasing leptin sensitivity is effective in dealing with obesity (Bahrami & Saremi, 2011). Exercise as a stimulus can create a negative energy balance and then activate the mechanisms involved in energy regulation and balance and cause weight loss (Haghravan et al., 2016).

The research conducted in this field shows that the increase in fat oxidation after intense interval training can be due to the need for energy to return H+ and resynthesis of glycogen increases epinephrine, growth hormone and energy consumption. Some studies have shown that intense interval training increases the content of several mitochondrial proteins by 18-29%, such as citrate synthetase, beta-hydroxyacyl coenzyme A dehydrogenase and pyruvate dehydrogenase, and also increases fatty acid transporters (FABPpm, CD36). Therefore, this type of training increases mitochondrial enzymes and fatty acid transporters in the short term and increases fat oxidation. Research suggests that intensity of exercise is the main factor in increasing mitochondrial biogenesis, which is the adaptation mechanism of skeletal muscle to HIIT (Perry et al., 2008). The increase of mitochondria is associated with the increase of oxidative enzymes and the use of fat as fuel increases. Another possible mechanism in the increase of fat oxidation is due to the increase of hormones. The response of increased catecholamine's to HIIT is an important feature of this type of exercise, especially epinephrine, which causes lipolysis and is the main responsible for the release of free fatty acids from fat tissue. The response of growth hormone to HIIT is due to the 10-fold increase in the concentration of this hormone compared to the resting state, which increases lipolysis. Despite the increase in blood lactate during HIIT, the transfer of free fatty acids also increases and the amount of glycerol released from fat, which causes more transfer of fatty acid and its oxidation (Gibala et al., 2012). Di Araujo et al. reported that performing HIIT increases the activity of aerobic and anaerobic enzymes (De Araujo et al., 2016). Research shows that if the recovery time between intense

bouts is reduced, the contribution of glycolysis to provide energy is also reduced, and as a result, aerobic metabolism increases to compensate for this energy deficit. In this regard, Eigendorf et al suggested that aerobic metabolism plays an important role during the recovery periods of intense exercises for creatine phosphate regeneration and lactic acid oxidation (lactate removal) (Eigendorf et al., 2018). Based on these studies, glycogen and creatine phosphate consumption decreases after intense interval training exercises and fat oxidation increases. Therefore, the main reasons for the significant reduction in fat percentage, body mass index, waist circumference to hip circumference ratio and body weight reduction in the present study can be due to the above changes in fat oxidation in the subjects. One of the reasons for the possible increase in these adaptations is the length of the training period, which is shown in the results of past research indicating that the role of the duration of the physical activity is important in sports programs and is effective in body composition and weight loss.

Conclusion

As a result, it can be concluded that the length of the training period (six weeks) along with the increase of oxidative enzymes and the changes created lead to the improvement in the body composition, especially the reduction of weight, body fat, the ratio of waist circumference to hip circumference and the improvement of body mass profile.

What is already known on this subject?

Overweight and obesity are associated with an increased risk of cardiovascular disease, hypertension and type 2 diabetes.

What this study adds?

HIIT protocol had a greater effect on the body composition parameters of the subjects compared to the CAT protocol, so it could be included in the training program for overweight or obese military persons.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The study protocol conformed to the declaration of Helsinki and was approved by the Committee of Baqiyatallah University.

Informed consent It was obtained from the subjects.

Author contributions

Conceptualization: SH.R.M, F.R, M.S; Methodology: SH.R.M, M.R.F; Software: SH.R.M, F.R, M.S; Validation: SH.R.M, M.R.F; Formal analysis: SH.R.M, F.R; Investigation: SH.R.M, M.S; Resources: M.R.F, M.S; Data curation: M.S; Writing - original draft: SH.R.M, F.R; Writing - review & editing: M.S, M.R.F; Visualization: M.S; Supervision: F.R; Project administration: SH.R.M, M.R.F; Funding acquisition: F.R.

References

Astorino, T. A., Schubert, M. M., Palumbo, E., Stirling, D., & McMillan, D. W. (2013). Effect of two doses of interval training on maximal fat oxidation in sedentary women. Med Sci Sports Exerc, 45(10), 1878-1886. doi: https://doi.org/10.1249/MSS.0b013e3182936261

Bahrami, A., & Saremi, A. (2011). Effect of caloric restriction with or without aerobic training on body composition, blood lipid profile, insulin resistance, and inflammatory marker in middle-age obese/overweight men. Arak Medical University Journal, 14(3), 11-19. URL: file:///C:/Users/HP/Downloads/65113905602%20(1).pdf

Behrad, A., Askari, R., & Hamedinia, M. R. (2016). The effect of high intensity interval training and circuit resistance training on respiratory function and body composition in overweight females. Journal of Practical Studies of Biosciences in Sport, 4(7), 89-101. doi: https://doi.org/10.22077/JPSBS.2016.386

Bray, G. A., Lovejoy, J. C., Smith, S. R., DeLany, J. P., Lefevre, M., Hwang, D., . . . York, D. A. (2002). The influence of different fats and fatty acids on obesity, insulin resistance and inflammation. The Journal of Nutrition, 132(9), 2488-2491. doi: https://doi.org/10.1093/jn/132.9.2488

De Araujo, G. G., Papoti, M., Dos Reis, I. G. M., De Mello, M. A., & Gobatto, C. A. (2016). Short and long term effects of high-intensity interval training on hormones, metabolites, antioxidant system, glycogen concentration, and aerobic performance adaptations in rats. Frontiers in Physiology, 7, 505. doi: https://doi.org/10.3389/fphys.2016.00505

Dehghanpouri, M., Rahimi, A. R., & Sokhanguei, Y. (2010). The effects of isotonic exercising Method on under-skin fat rate in non-athlete boy students of Islamic azad university of Shabestar.

Eigendorf, J., May, M., Friedrich, J., Engeli, S., Maassen, N., Gros, G., & Meissner, J. D. (2018). High intensity high volume interval training improves endurance performance and induces a nearly complete slow-to-fast fiber transformation on the mRNA level. Frontiers in Physiology, 9, 601. doi: https://doi.org/10.3389/fphys.2018.00601

Ghanbarzadeh, M. (2017). The effect of an intensity interval training (Hit) on the fitness and body composition of the military personnel. Journal Mil Med, 18(4), 367-374. URL: http://militarymedj.ir/article-1-1545-en.html

Gholizadeh, M., Kordi, M., & Akbarnejad, A. (2016). Comparison of two High-Intensity Interval Training (HIIT) for two weeks on fat oxidation, body fat percentage and vo2max in overweight young males. Journal of Education and Community Health, 3(2), 47-53. URL: file:///C:/Users/HP/Downloads/A-10-148-1.pdf

Gibala, M. J., Little, J. P., MacDonald, M. J., & Hawley, J. A. (2012). Physiological adaptations to low‐volume, high‐intensity interval training in health and disease. The Journal of Physiology, 590(5), 1077-1084. doi: https://doi.org/10.1113/jphysiol.2011.224725

Gokee-LaRose, J., Gorin, A., Raynor, H., Laska, M., Jeffery, R., Levy, R., & Wing, R. (2009). Are standard behavioral weight loss programs effective for young adults? International Journal of Obesity, 33(12), 1374-1380. doi: https://doi.org/10.1038/ijo.2009.185

Haghravan, S., Keshavarz, S. A., Mazaheri, R., Alizadeh, Z., & Mansournia, M. A. (2016). Effect of omega-3 PUFAs supplementation with lifestyle modification on anthropometric indices and Vo2 max in overweight women. Archives of Iranian Medicine, 19(5), 0-0. URL: http://aimjournal.ir/Article/1001

Hemmati, M., Kurdi, M., Choobineh, S., & Chupani, S. (2014). The effect of six weeks of high-intensity intermittent exercise (HIIT) on acute inflammatory factors (hs-CRP and fibrinogen) in inactive young men. Modern Olympics, 1(1), 47-57.

Lau, P. W., Kong, Z., Choi, C.-r., Clare, C., Chan, D. F., Sung, R. Y., & Leung, B. W. (2010). Effects of short-term resistance training on serum leptin levels in obese adolescents. Journal of Exercise Science & Fitness, 8(1), 54-60. doi: https://doi.org/10.1016/S1728-869X(10)60008-1

Nikroo, H., & Barancheshme, M. A. (2014). The comparison of effects of aerobic interval and continuous training program on maximal oxygen consumption, body mass index, and body fat percentage in officer students. Journal Mil Med, 15(4), 245-251. URL: http://militarymedj.ir/article-1-1176-en.html

Perry, C. G., Heigenhauser, G. J., Bonen, A., & Spriet, L. L. (2008). High-intensity aerobic interval training increases fat and carbohydrate metabolic capacities in human skeletal muscle. Applied Physiology, Nutrition, and Metabolism, 33(6), 1112-1123. doi: https://doi.org/10.1139/H08-097

Pourabdi, K., Shakeriyan, S., Pourabdi, Z., & Janbozorgi, M. (2013). Effects of short-term interval training courses on fitness and weight loss of untrained girls. Annals of Applied Sport Science, 1(2), 1-9. URL: http://aassjournal.com/article-1-39-en.html

Reyes-Guzman, C. M., Bray, R. M., Forman-Hoffman, V. L., & Williams, J. (2015). Overweight and obesity trends among active duty military personnel: a 13-year perspective. American Journal of Preventive Medicine, 48(2), 145-153. doi: https://doi.org/10.1016/j.amepre.2014.08.033

Sobhani, F., Haghshenas, R., & Rahimi, M. (2019). Effect of eight weeks aerobic training and supplementation of green tea on apelin plasma levels and insulin resistance in elderly women with type 2 diabetes. Journal of Mazandaran University of Medical Sciences, 28(170), 84-93.

Tofighi, A. (2014). The effects of a selected aerobic exercise along with a controlled diet on weight loss in obese men. Iranian Journal of Nutrition Sciences & Food Technology, 9(2), 85-94. URL: http://nsft.sbmu.ac.ir/article-1-1464-en.html

Zouhal, H., Lemoine-Morel, S., Mathieu, M.-E., Casazza, G. A., & Jabbour, G. (2013). Catecholamines and obesity: effects of exercise and training. Sports Medicine, 43(7), 591-600. doi: https://doi.org/10.1007/s40279-013-0039-8