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Research Article

Long-term effect of endurance training with myoclinic diet and calorie control on fat profile of overweight women

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Abstract

Background: The aim of this study was to investigate the long-term effect of endurance exercise combined with myoclinic diet and Calorie restriction on the lipid profile of overweight women.

Materials and Methods: The method of the present study was semi-experimental with a pretest-posttest design. For this purpose, 45 women referred to the Tehran Region 1 Fitness Club with a body mass index (BMI) between 25 and 30 and in the age group of 35 to 45 years voluntarily participated in this study. Subjects were homogeneously divided into three groups of 15 people based on weight, height and body mass index, including the endurance training group with myoclinic diet, the endurance training group with Calorie restriction and the endurance training group alone. Endurance exercise was three sessions per week for eight weeks. The program, 30 minutes of aerobic exercise, starting at 65% of maximum heart rate and increasing by 5% every two weeks until it reached 80% of maximum heart rate in the last week. The recommended diet for the endurance training groups with the Myoclink diet and the endurance training group with the Calorie restriction was given. Endurance training was also asked not to change their normal diet. Subjects' lipid profiles were measured before and after the training protocol. One-way ANOVA use for data analyses.

Results: The results showed that in overweight women endurance training combined with myoclinic diet and endurance training combined with Calorie restriction improve the lipid profile (lowering total cholesterol, LDL cholesterol and triglyceride levels and increasing HDL) more than endurance training alone. ($P \leq 0.05$)؛ Also, there was no significant difference between the effect of endurance training with myoclinic diet and endurance training with Calorie restriction on improving lipid profile. ($P \geq 0.05$)

Conclusion: Combining endurance training with myoclinic diet or calorie control can be effective in improving the fat profile.

Keywords:
endurance exercise, myoclinic diet, Calorie restriction, lipid profile

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1. Introduction

Obesity and overweight can be introduced as the syndrome of the New World, which is the biggest health problem in the industrial and modern world today. The metabolic effects of obesity, this very common complication as one of the most important risk factors for diseases such as diabetes High blood pressure, coronary artery disease, and if left untreated, obesity and overweight can lead to other metabolic effects such as high blood fats, blood urea, and low-density lipoprotein (HDL). Together, these complications are known as metabolic syndrome (۱). In addition to increasing energy expenditure, exercise can also control appetite and thus reduce energy intake. Exercise and regular diet affect lifestyle, health and fitness, in other words, it is very useful for all body systems and weight regulation. If people are physiologically inactive, they become more vulnerable to cardiovascular disease, obesity, high blood pressure, diabetes and osteoporosis. Having a good heart rate, normal blood pressure and good body composition is a sign of physical health (2). People who are overweight and therefore have an unfavorable body composition are more likely to have increased risk factors for heart disease. People should always feel the risk of gaining weight and to prevent this risk, you should think of solutions in all categories. Age, the influence of modern lifestyle on body composition has been observed (3). The increasing prevalence of obesity, followed by the development of obesity-related metabolic disorders and related diseases, has encouraged researchers to better understand the mechanism of fat mass gain, the main cause of which is metabolic disorders (4).

Topics such as energy homeostasis, weight regulation, food intake behavior and energy expenditure have always been of interest to researchers in the fields of sports physiology, pharmacology, pathology, health, and so on. The prevalence of overweight and subsequent obesity in women will lead to various health problems. Increased prevalence of dyslipidemia, type 2 diabetes, and cardiovascular disease are among these problems. Currently, there is a global trend towards obesity, and this is not limited to developed countries. An inactive lifestyle makes it difficult to regulate appetite. While physical activity can affect eating behavior, calorie counting in previous research seems to provide an accurate picture of appetite regulation (5). On the other hand, with the onset of inactive participation in exercise programs, the amount of fat burning occurs equally between men and women (6). If you have a regular diet, men will lose weight by participating in exercise programs, while women do not lose as much weight as men. These results are consistent with other observations that have reported sex differences in the amount of fat oxidation in exercise., Does not fit, while this setting is more accurate in women. In other words, with increasing energy consumption, there is a possibility of compensatory increase in appetite and calorie intake. Therefore, it is necessary to identify and evaluate the most effective intensity of aerobic activity for women (6).

Regarding the intensity of exercise, it has been reported that both types of resistance and acute aerobic activity with high intensity (one session) increase the feeling of hunger and appetite in both groups of obese and thin men, while resistance activity with High intensity reduces appetite (7). In one study, only intense activity in non-obese women reduced appetite. Also, moderate activity increased the appetite of obese people, while in none of the activities in non-obese women there was no significant response (8). In another study, activity at 70% and 40% of maximal oxygen consumption in normal weight women did not alter appetite (9). Therefore, it can be said that the pattern of intensity and duration of aerobic exercise to cause weight changes and appetite is not the same among obese and normal weight women. In general, a lot of research has been done on the effect of exercise intensity on appetite (regardless of gender). A general study found that in the case of low-intensity exercise, no change in appetite was reported (10). In the case of moderate-intensity sports activities, no change, decrease (2,7,10,11) And even increase appetite (12) have seen. Both high-intensity and high-intensity sports activities have been reported (9-11). According to conflicting research evidence, it is currently not possible to draw accurate conclusions about the effect of aerobic exercise at different intensities on appetite. Therefore, there is a need for careful research in this area. Since 1860 and more recently, in 1972, low carb diets (low carb) have been a strategy for weight loss. Today, there is still interest in low-carb approaches. While all low-carb approaches reduce overall carbohydrate intake(12).

The Mayo Clinic diet is one of the most popular diets for weight loss, which has been shown to contain 47% fat, 32% protein and 20.3% carbohydrates. Therefore, it can be said that this diet is a type of low carbohydrate diet (13). In this diet, it is recommended to consume foods rich in useful nutrients, low in fat and low in calories, and emphasizes on the consumption of fruits, vegetables and whole grains. Recommended foods in this diet include healthy carbohydrates (fruits-legumes-vegetables-whole wheat flour-wheat bran) and high-fiber foods such as nuts and beans, and heart-healthy foods such as fish. Salmon, mackerel, tuna, and good fats found in avocados, almond kernels, olives, walnuts, and foods that should not be eaten include saturated fats, trans fats, and foods high in cholesterol and sodium (14). Lifestyle changes, ie changes in diet and physical activity patterns, play an important role in changing fat profiles and reducing the risk factors associated with cardiovascular disease. Recommended lifestyle changes for those with high cholesterol include changing diets and regular exercise and staying healthy(15). Changing the macronutrient content of the diet to beneficial substances, even without changing the total calories received, helps to improve the fat profile. It is worth mentioning that the prevalence of overweight among Iranian women is higher than American women and the prevalence of obesity is approximately equal between Iranian and American women, Obesity and overweight is the biggest public health challenge of the current century, and the health sector in most countries of the world is involved in issues and complications caused by the increasing incidence of obesity (16).

Therefore, due to the prevalence of overweight and obesity in Iran and the world(17) Examining the relationship between changes in pituitary levels (which are effective in regulating energy and food intake behavior) and exercise reveals their true role in regulating appetite and weight management. Exercise is a strategy used to combat obesity. It is important to know how effective exercise can help overweight people lose weight and prevent weight gain. Sports activities are divided into two categories: endurance (aerobic) and resistance (anaerobic). Endurance training (aerobic) causes physiological adaptation such as increased oxidation enzymes, decreased adipose tissue, decreased inflammatory factors, increased anabolic hormones (ultrastructure), increased capillary density, increased mitochondrial number, increased maximal oxygen consumption and cardiovascular function (18,19). There is strong evidence that resistance training; Improves body composition, fat metabolism and muscle growth, and reduces metabolic risk factors such as obesity, fat disorders, and type 2 diabetes (20). In addition to weight loss, resistance training can also increase muscle strength (21). Considering the role of any exercise and myoclinic diet and calorie control in improving weight loss, it seems that there is a need for further study in this field. Therefore, the aim of this study was to evaluate the effectiveness of myoclinic diet and low calorie diet in improving the fat profile of overweight women.

2. Materials and Methods

Subjects

The present study is a quasi-experimental study which was conducted with a pre-test-post-test design with a control group in a field and laboratory manner. The present study is based on the ethical principles of the Islamic Azad University of East Tehran and with the code of the IR Ethics Committee. IAUETB.9971012 was performed.

The statistical population of the present study consists of all inactive women in Tehran with a body mass index (BMI) between 25 and 30 and in the category of 35 to 45 years. The statistical sample of the present study was available and selected from the people referring to the fitness club of Tehran Region 1 who were interested in participating voluntarily in the present project. Forty-five healthy overweight women with no history of regular participation in physical activity and exercise, no history of supplementation, medication or even diet during the past six months with a body mass index between 30-30 were included in the study. The physical health of the subjects in terms of cardiovascular diseases, blood, hormonal and metabolic disorders (diabetes, hypertension, obesity), smoking, etc. were evaluated and approved by a physician. The present study was conducted in compliance with all matters related to personal health at the time of blood sampling and also the subject is allowed to cancel the continuation of the study at any time. In addition, the researcher provided the subject with complete information about the research method, potential risks and benefits of participating in the research.

Initially, the consent form was filled out by all subjects. Then, data from weight, height and body mass index of the subjects were collected. Measurements were performed three times and the average was measured three times. Measurements were taken in the morning shift and after a light breakfast at the fitness club and were recorded on an information sheet. Subjects were homogeneously divided into three groups of 15 people based on weight, height and body mass index, including the endurance training group with myoclinic diet, the endurance training group with calorie control and the endurance training group without using a special diet. Aerobic exercise was three sessions per week for eight weeks. The researcher advised the subjects to refrain from participating in any other organized sports activities during the eight weeks of endurance training program described below, and the recommended diet for endurance training groups with myoclink diet and the endurance training group was provided with calorie control. Endurance training was also asked not to change their normal diet. In the pre-test (one day before the protocol) and also in the post-test (one day after the protocol), 5 cc of heparinized blood was taken with the patient's consent and in the refrigerator and at a temperature of 2-8 degrees. Celsius was stored for a maximum of 24 hours and then sent to the laboratory. All experiments were performed in a single laboratory by one person. Total cholesterol, HDL, Low-density lipoprotein (LDL) and triglyceride (TG) were measured in the laboratory. The enzymatic method using Pars Azmoun kits was used to measure the plasma levels of fat profiles by an automatic biochemistry analyzer (Flexor / Selectra EL200) made by the German company Lab-Plus International (22).

To measure the height of the subjects, the height meter of the Seca model is made in Germany, which has a graduated bar on which another movable bar is perpendicular. The movable bar was adjusted on the bar so that it was exactly above the subject's head. However, the number marked on the bar indicated the subject's height (with an accuracy of one millimeter). To measure weight, a digital scale (Seca model made in Germany) with an accuracy of 100 grams was used. Fat, fat weight and BMI of the subjects were measured using a portable device (Omron-Body model (logic / body fat analyzer). In this way, first, the age, height, weight and sex of the subject are entered into the device by the examiner, and then the measurement is performed by placing the edge of both subjects' hands on the metal part of the device and pressing the start key.

Endurance exercises

First, the maximum aerobic capacity was measured based on the 1600-meter walking test. In this test, the person walked the distance of 1600 meters with the maximum possible speed and his heart rate was measured at the end of the test and the maximum aerobic capacity was calculated (23). Aerobic exercise was three sessions per week for eight weeks. The program consisted of 10-15 minutes of warm-up, 30 minutes of aerobic exercise, and 10-15 minutes of cooling, starting at 65% of maximum heart rate and increasing by 5% every two weeks until the last week. 80% of heart rate peaked (24).

The warm-up protocol, which took 10-15 minutes of each session, included walking, regular joint warm-ups, and stretching exercises. Exercises were then started in the indoor gym with the intensity calculated for each subject, and the subjects' heart rate was monitored using a heart rate monitor, and at the end of each exercise session, activities were performed to return for 10-15 minutes in order to Cooling was performed as the activities included stretching movements (24).

Mayo Clinic Diet: In this study, a myoclinic diet modified by the researcher in consultation with nutritionists was used. The main component of this diet is eggs, because it recommends consuming between 4 to 6 eggs per day. This diet also allows the consumption of fish, poultry, meat and moderate consumption of vegetables, fruits, nuts (Recommends nuts) and whole grain products (cereals) - cooked without fat. People who follow this diet can only drink tea, coffee or water and are prohibited from consuming dairy products. Due to the fact that the lack of dairy products reduces calcium, the researcher consumes the required amount of these products in this diet. Include and also eliminate the consumption of egg yolk, which has a high level of cholesterol. These changes were due to the disadvantages of previous research on the myoclinic regimen.

Low calorie diet: In this study, reducing the amounts of protein, carbohydrates and fats in a balanced ratio to determine the energy intake in the range of 800 to 1500 kcal per day is called a low-calorie diet (25). In this study, the low-calorie diet meant a reduction of 500 kcal of energy required by the subjects (25).

The amount of energy in the daily intake of each of the subjects was calculated and then the amounts of protein, carbohydrates and fats were reduced equally to reduce the 500 kcal of energy.

Data analysis methods

Descriptive statistics and mean and standard deviation were used to classify the data and Shapirovilk test was used to check the normality of the data. Combined analysis of variance was used to examine within-group changes and one-way analysis of variance was used for intergroup comparisons. All statistical analyzes were performed using SPSS18 software at a significant level of $P < 0.05$.

Findings

Mean and standard deviation of physiological and anthropometric indices of subjects including age, height, weight, and body mass index are presented in Table 1. Also, the mean and standard deviation of energy and the share of macronutrients received as well as cholesterol in different diets are presented in Table 2.

Table 1: Statistical indicators related to personal characteristics

Personal profile	group	Average
	Experimental group 1	2.54+30
Age	Experimental group 2	2.30+30
	control group	1.24+30
Height (cm)	Experimental group 1	6.22+159
	Experimental group 2	4.20+157
	control group	5.12+156
Body mass (kg)	Experimental group 1	3.33+77
	Experimental group 2	2.24+75
	control group	1.54+82
BMI	Experimental group 1	2.75+33
	Experimental group 2	2.24+30
	control group	2.75+32

As can be seen in Table 2, there is no significant difference between energy and the share of macronutrients received between the recommended diet and the diet consumed during the study, which indicates good adherence to the diet in the subjects. And the share of macronutrients received between the recommended diet and the diet consumed is not calculated for the calorie control group and the endurance training group alone. Because the exact amount of shares in these two groups was not recommended.

Table 2: Mean and standard deviation of energy and share of macronutrients received as well as cholesterol

Variable		Received diet	Recommended diet	P
Energy intake (kcal per day)	Experimental 1	1490.5±612.3	1500	0.711
	Experimental 2	1476±569.6	1500	0.65
	Control	2369±714	-	-
Carbohydrates (percentage)	Experimental 1	23.5±3.3	0.21	0.521
	Experimental 2	-	-	-
	Control	-	-	-
Fat (percentage)	Experimental 1	44.6±6.3	0.47	0.071
	Experimental 2	-	-	-
	Control	-	-	-
Protein (percentage)	Experimental 1	32.5±4.75	۰/۳۲	۰/۱۲۲
	Experimental 2	-	-	-
	Control	-	-	-

The mean and standard deviation of the research variables, which are indicators related to the fat profile, are presented in Table 3.

Table 3: Averages of indicators measured in different stages

Indicator	Experimental group 1		Experimental group 2		control group	
	pre- test	Post-test	pre- test		Post-test	Post-test
Cholesterol (mg / dL)	42.1+168.7	56.32+130.2	40.32+170.6	38.62+133.2	32.4+172.3	24.4+150.2
Triglycerides (mg / dL)	30.45+110.7	34.27+100.3	38.23+112.3	39.23+101.5	30.4+114.7	22.22+18.3
HDL-C (mg/dL)	5.26+44.21	8.3+46.21	20.21+43.8	8.2+45.31	8.4+44.31	5.5+46.35
LDL-C (mg/dL)	17.25+132.52	25.1+110.5	40.46+131.45	12.78+113.29	14.33+132.3	18.5+122.5

3. Results

The results of Shiproville test to examine the data distribution of all variables related to the present study in all groups in the pre-test and post-test are normal (p≥0.05). Therefore, parametric tests can be used to test the hypotheses.

Total cholesterol

The results of combined analysis of variance showed that the main effect of the group ($F_{(1,44)}$ = 4696/212, P = 0/0005, η^2 = 0/991) as well as the main effect of time ($F_{(1,44)}$ = 74/006, P=0/0005, η^2 =0/62) was significant. But the interaction between group and time was not significant ($F_{(1,44)}$ = 0/595, P = 0/622, η^2 = 0/039). The results of Bonferroni post hoc test showed that the total cholesterol of the groups in the post-test was lower than the pre-test. Therefore, it can be said that endurance training combined with different diets reduces total cholesterol in overweight women.

The results of one-way analysis of variance test in the pretest showed that there was no significant difference between the total cholesterol of the different groups in the pretest but there was a significant difference between the total cholesterol scores of the studied groups in the posttest (P= 0/001). F=6/69). Bonferroni post hoc test was used to determine the exact location of the differences. The results of Bonferroni post hoc test showed that there was no significant difference between the endurance training group with myoclinic diet and the endurance training group with calorie control (P = 0/18), but there was a significant difference between these groups and the endurance training group.

Has (0/05≥P); This means that cholesterol levels in the endurance training group with myoclinic diet and endurance training group with calorie control were significantly lower than the endurance training group.

Cholesterol (LDL-HDL)

The results of combined analysis of variance for HDL cholesterol showed that the main effect of the groups ($F_{(1,40)}$=619/810 , P = 0.77, η^2= 0/939) was not significant. Also, the effect of time ($F_{(1,40)}$ = 3/078, P=0/087, η^2 = 0/071) and also the interaction of group and time were not significant ($F_{(1,40)}$ = 2/363, P = 0.086, η^2 = 0/166). This means that endurance training combined with different diets has no effect on HDL cholesterol levels. The results of combined analysis of variance for LDL cholesterol showed that the main effect of the groups ($F_{(1,44)}$ = 40/783, P = 0.0005, η^2 = 0/823) was significant. Also the main effect of time ($F_{(1,44)}$ = 3/501, P = 0.005, η^2 = 0/08) and also the interaction of group and time ($F_{(1,44)}$ = 2/651, P=0/0005, η^2 = 0/166) were significant. The results of Bonferroni post hoc test showed that the LDL cholesterol of the groups was lower in the post-test than in the pre-test, so it can be said that endurance training combined with different diets reduces LDL cholesterol in overweight women. The results of one-way analysis of variance test in HDL cholesterol pretest showed that there is no significant difference between HDL cholesterol of different groups in the pretest (P = 0.035, F = 3.77) Also between HDL cholesterol scores of groups There was no significant difference in the post-test (P = 0.81, F = 15.54)

The results of one-way analysis of variance test in LDL cholesterol pretest showed that there was no significant difference between LDL cholesterol of different groups in the pretest (P = 0.74, F = 53.18) but between LDL cholesterol scores of the groups. There was a significant difference in the post-test (P = 0.0005, F = 12.59). Bonferroni post hoc test was used to determine the exact location of the differences. The results of Bonferroni post hoc test showed that there was no significant difference between the endurance training group with myoclinic diet and the endurance training group with calorie control (P = 0.08), but between There is a significant difference between these groups and the group of mere endurance training(0/05≥P) ; This means that LDL cholesterol levels in the endurance training group with myoclinic diet and endurance training group with calorie control were significantly lower than the endurance training group.

Triglyceride

The results of combined analysis of variance for the triglyceride variable showed that the main effect of the groups ($F_{(1,44)}$ =40/393 , P=0/0005,η^2=0/772) was significant. Also the main effect of time ($F_{(1,44)}$=1/712,P=0/0005,η^2=0/0996) As well as the interaction of group and time

($F_{(1,44)}$ =4/111 , P=0/0005,η^2=0/366) were significant. The results of Bonferroni post hoc test showed that the triglyceride level of the groups in the post-test was lower than the pre-test. Therefore, it can be said that endurance training combined with different diets reduces triglycerides in overweight women. The results of one-way analysis of variance test in the pretest showed that there was no significant difference between the total cholesterol of the different groups in the pretest but there was a significant difference between the total cholesterol scores of the studied groups in the posttest. (P=0/001,F=6/69). Bonferroni post hoc test was used to determine the exact location of the differences. The results of Bonferroni post hoc test showed that there was no significant difference between the endurance training group with myoclinic diet and the endurance training group with calorie control(P=0/22). But there is a significant difference between these groups and the endurance training group(0/05≥P). This means that the triglyceride level in the endurance training group with myoclinic diet and the endurance training group with calorie control was significantly lower than the endurance training group.

4. Discussion

The aim of this study was to evaluate the long-term effect of endurance exercise combined with myoclinic diet and calorie control on the fat profile of overweight women. The results of this study showed that endurance training combined with myoclinic diet and endurance training combined with calorie control and endurance training alone improved lipid profile, decreased total cholesterol (TC), decreased triglyceride (TG), increased HDL-C and decreased LDL. -C becomes. Given that endurance training has been part of the training of all research groups, so it can be said that one of the reasons for improving the fat profile was the existence of endurance training. The results of this part of the present study, which shows the effect of endurance training on lipid profile, and with the results of Durstine et al., Who showed that training with intensities of 50 and 75% of maximum oxygen consumption, cause similar changes in cholesterol reduction, Kraus et al., Who observed a significant effect of physical activity with an intensity greater than 70% of maximum heart rate on cholesterol, agree. Among the possible reasons for this consistency, we can mention the intensity and duration of training similar to the present study. Performing optimal physical exercise is associated with lowering total cholesterol, LDL-C concentration, and increasing HDL-C. This points to the role of peripheral tissues and the liver, which essentially allow existing mechanisms to increase the activity of the enzyme lecithin cholesterol acyl transferase (LCAT) during short-term or long-term exercise, which is responsible for transporting cholesterol ester to HDL. Is. Thus HDL-C increases and on the other hand plasma cholesterol transferase (CETP) activity decreases.

This enzyme is responsible for transporting HDL cholesterol esters to other lipoproteins. These changes are possible. It is related to other mechanisms such as effective factors such as changes in plasma hormone concentrations and lipoprotein lipase and other factors(26).

In fact, the mechanisms behind this fatty acid mobilization are not well understood. But there are several explanations for the status of different hormones that describe the action of lipolysis (release of fatty acids from the subcutaneous layers). First, regular physical activity increases the transmission and utilization of TG by the muscle. Plasma insulin has been shown to decrease during and after exercise, and probably one of the factors that alters cholesterol is plasma insulin levels. Decreased insulin may activate lipolysis of adipose tissue and increase plasma free fatty acid concentrations. As insulin decreases, glucagon secretion increases, which accelerates the process of lipolysis. Due to the increase in aerobic capacity and adaptations resulting from exercise in this study, it seems that the body prefers to provide its required energy at rest and below maximum exercise, from TG sources, which reduces the lipid profile. But the results of this part of the study, with research by Stoedefalke et al After 20 weeks of activity with an intensity of 75-80% of the heart rate on the tape recorder, did not observe a significant change in the lipid profile (27) And Welsman et al After 8 weeks of training with an intensity of 80% of the maximum heart rate, Showed no change in total cholesterol and HDL, Does not match. Among the reasons for the inconsistency of the studies mentioned with the present study can be the duration, type of training, training status and age of the subjects. It seems that the subjects' physiological responses depend on these factors.

In addition, exercise leads to rapid activity of the sympathetic nervous system, and both the hormones epinephrine and norepinephrine are released immediately, causing lipolysis. inally, stimulant training to increase growth hormone is another important factor in lipolysis(28).

The results of this study also showed that endurance training combined with myoclinic diet further improves the fat profile of overweight women compared to endurance training. The results of this study with the findings of Davis and Helen (2019) And Lou, Van et al. (2018) Is consistent. A review of this study on low-carbohydrate diets shows a slight increase in neutral to slightly LDL, but a decrease in optimal triglycerides and an increase in HDL cholesterol, especially in cases devoted to very low carbohydrate intervention, Has been reported(29,30). Given that it has already been stated that the myoclinic diet is a low-carbohydrate diet, the reason for the improvement in the fat profile of overweight women can be traced to studies that have used a low-carbohydrate diet. Low-carb approaches are based on the hypothesis that lowering insulin, a vital hormone that creates an anabolic and fat-storing state, improves heart and metabolic function and leads to weight loss. This approach has recently been called the carbohydrate-insulin model(31). While weight loss diets are low in calories, the mechanism of low carb diets is still debated. When reducing carbohydrates from the diet, macronutrient intake of fats and proteins generally increases to compensate for the reduction in carbohydrates. One hypothesis as to why low-carb approaches lead to rapid weight loss compared to other diets is that fats and proteins increase satiety and lower blood sugar at the same time. This increase in satiety and lower blood sugar reduces hunger and overall food intake and creates calorie deficiency.

In addition, another hypothesis claims that low-carb diets can cause higher metabolic metabolism than high-carb diets. In recent studies, it appears that approximately 200 to 300 more calories have a metabolic advantage compared to a high-calorie diet(32). Therefore, it can be said that one of the reasons for improving fat profile due to low carbohydrate diet is insulin reduction. Carbohydrates are a major factor in insulin secretion and blood sugar control, which is greatly influenced by carbohydrates in the diet. Decreased insulin may activate lipolysis of adipose tissue and increase plasma free fatty acid concentrations. As insulin decreases, glucagon secretion increases, which accelerates the process of lipolysis. This mechanism (insulin reduction) is seen in addition to endurance training in low carb diets. In fact, reducing carbohydrates in the diet improves atherogenic dyslipidemia (lowering triglycerides and increasing high-density lipoprotein), improving the body's metabolic syndrome, and type 2 diabetes even without weight loss in the presence of saturated fat in the diet. Wu Liu et al. 2014 showed that the combination of exercise and low-carbohydrate diet has beneficial effects on body fat percentage and factors affecting insulin resistance of reactive protein C (interleukin-1 beta) in people with diabetes(33).

The results of this study showed that endurance training combined with calorie control leads to a further improvement in the fat profile of overweight women compared to endurance training. Which was in line with the results of Bernico et al. Similarly, Christiansen et al. Showed that 12 weeks of negative energy balance (8 weeks of very low calorie diet and 4 weeks of balanced diet with exercise) improves the lipid profile (34).

The enzyme triglyceride lipase is essential for initiating the lipolysis process. Inhibition of ATGL has been shown to increase fat mass and weight. ATGL expression may be regulated by some factors, including hunger, glucocorticoids, insulin, leptin, and physical activity. ATGL levels have been shown to decrease in obese people and insulin-resistant mice. On the other hand, an excessive increase in ATGL leads to an increase in DAG, which leads to insulin resistance. Therefore, it can be said that one of the reasons that low-calorie diet improves blood lipid profile, imbalance between fat production processes and consumption due to calorie restriction, may lead to increased concentrations of fatty acid metabolites and increased insulin resistance (35). Previous studies have shown that a certain amount of exercise is needed to reduce fat mass and improve insulin resistance, but this amount of exercise is very hard and exhausting. For example, they reported that to lose half a kilogram of weight per week, you should exercise on a treadmill for 90 minutes and 5 days a week, and on the other hand, calorie restriction, similar to exercises with an intensity of 45-50% of maximum heart rate for 25 to 50 minutes per session and three days a week(36). Therefore, calorie restriction can also be used to reduce the stress of exercise for related benefits. Calorie restriction without malnutrition (35 to 40% of the food consumed) creates various adaptations that can improve performance and health.

One of these benefits is the improvement in insulin resistance reported in animal and human studies (37). Studies have shown that GLUT4 occurs in muscles after exercise, However, Argintino et al. Showed that an increase in dietary restriction also increased GLUT4(38).

But in another study, the effect of calorie restriction on improving insulin resistance was reported (39). The researchers said that calorie restriction could not alter the function of the insulin receptor within normal limits. Regarding insulin signaling pathway, some studies have shown the change and non-change due to calorie restriction (40,41). Metabolic pressure It seems that negative energy balance methods due to calorie restriction and exercise are not equal even by the same percentage because the calorie restriction is applied during the day while exercise activity over a limited period of time enters the corresponding metabolic pressure. he does. Therefore, even considering the equal percentage of negative energy balance, different mechanisms must be considered for different methods of its application. Kashif et al. (2016) in a study entitled the simultaneous effect of conjugated linoleic acid consumption and resistance training on body composition, serum leptin and muscle strength of non-athlete men, randomly divided 23 non-athlete men into two complementary exercise groups (eleven) and Exercise - placebo (twelve people) divided. Based on the findings, in comparison with the resistance training method - placebo, resistance training - conjugated linoleic acid supplementation significantly reduced serum fat and leptin mass and significantly increased lean mass mass (42). It is suggested to study the effect of endurance training with different intensities and durations along with myoclinic diet, calorie control on the profile. It is also suggested that a study similar to the present study in overweight men be reviewed. Because age, sex, and other factors that can affect the results of the present study need further investigation.

۵. Conclusion

The results of this study showed that endurance training combined with myoclinic diet and endurance training combined with calorie control (lowering total cholesterol, LDL cholesterol and triglyceride levels and increasing HDL) improved the fat profile more than endurance training alone. Also, there was no significant difference between the effect of endurance training with myoclinic diet and endurance training with calorie control on improving fat profile. Low-carb approaches (myoclinic regimen) are primarily based on the hypothesis that they reduce insulin, a vital hormone that creates an anabolic and fat-storage state, Improves heart and metabolic function and reduces weight. This approach has recently been called the carbohydrate-insulin model. Decreased insulin may activate lipolysis of adipose tissue and increase plasma free fatty acid concentrations. As insulin decreases, glucagon secretion increases, which accelerates the process of lipolysis. This mechanism (insulin reduction) is seen in addition to endurance training in low carb diets. Low calorie diet also improves blood lipid profile, An imbalance between fat production and consumption processes due to calorie restriction may lead to increased concentrations of fatty acid metabolites and increased insulin resistance.

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Compliance with ethical standards

Conflict of interest None declared.

Ethical approval The Ethics Committee of Islamic Azad University East Tehran Branch approved the study.

Informed consent Informed consent was obtained from all participants.

Author contributions

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

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