

Research Article

The effect of 8 weeks of aerobic training and resveratrol consumption on the indicators of metabolic syndrome in overweight women

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Abstract

Background: Metabolic syndrome is a set of risk factors for cardiovascular disease and type 2 diabetes. The purpose of this study was to investigate the effect of 8 weeks of aerobic training and resveratrol consumption on the indicators of metabolic syndrome in overweight women.

Materials and Methods: In this quasi-experimental study, 32 women with metabolic syndrome with body mass index of 25-29 / 29 were purposefully selected and randomly divided into four groups (8 people): aerobic training, resveratrol supplementation, training + supplementation and control. The training protocol was performed on a treadmill for 8 weeks with 3 sessions of 60 minutes per week, with an intensity of 75-60% of the heart rate. The supplement groups took one capsule containing 400 mg of resveratrol daily. Blood sampling was performed before the start of the research protocol and 48 hours after the last training session. Analysis of covariance and Bonferroni post hoc test were used ($P \leq 0.05$).

Results: The results showed that aerobic training with supplementation led to a significant decrease in waist circumference, blood pressure, fasting blood sugar, triglycerides, total cholesterol and LDL and a significant increase in maximal oxygen consumption ($P = 0.001$).

Conclusion: Based on the results of the study, taking resveratrol supplementation along with aerobic training can have a positive effect on the indicators of metabolic syndrome. It is recommended to use aerobic training and resveratrol supplement to improve the physical condition of overweight women.

Keywords: Resveratrol, Aerobic training, Metabolic syndrome, Overweight

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1. Introduction

Obesity and overweight as one of the most important chronic diseases, has an increasing prevalence in many countries, including Iran (1). Abdominal obesity, which is known to increase with the size of the waist circumference, is the biggest risk factor for chronic diseases such as diabetes, cardiovascular disorders, hypertension and cancer (2). Among the various environmental factors, dietary patterns and physical activity of individuals as two important protective factors can play a special role in reducing the incidence of obesity (3). Aerobic training in terms of health and physical fitness is useful and effective on body composition, metabolic fitness and improving physiological and mental health of individuals. These training can have different effects based on the intensity, duration and different training periods, as well as physical, age and sexual conditions of people (4). Metabolic syndrome is a condition that is associated with impaired glucose metabolism and lipid profile, hypertension, and some anthropometric parameters such as waist circumference (5). It is given that a person is simultaneously holding at least three of the risk factors, ie waist circumference of more than 102 cm in men and 88 cm in women, Triglycerides greater than 150 mg / dl, blood pressure greater than 130/85 mm Hg, fasting blood glucose greater than 110 mg / dl, and high-density lipoprotein (HDL) less than 40 mg / dl (5). Attarzadeh et al. (2012) examined the effect of six weeks of aerobic training and diet on the indicators of metabolic syndrome in obese middle-aged women and found that insulin resistance, weight, body mass index, fat percentage and lipid profile decreased significantly (6).

Resveratrol is a natural compound found in raspberries, peanuts and grapes that affects energy metabolism and mitochondrial function and has antioxidant and anti-inflammatory properties. Scientific evidence suggests that resveratrol supplementation reduces systolic blood pressure and metabolic changes. These include lowering blood sugar, cholesterol and triglycerides (7). Malekian Fini et al. (2015) in a study of women with type 2 diabetes found that after 8 weeks of aerobic training and resveratrol, fasting blood sugar, LDL-C decreased and HDL-C increased (8). Due to the fact that research on the use of resveratrol on human samples is relatively limited and also the contradictory results observed in studies and the lack of simultaneous study of the effect of aerobic training and resveratrol on the indicators of metabolic syndrome and the importance of women's health. The present study seeks to investigate the effect of aerobic training and resveratrol supplementation on the indicators of metabolic syndrome in overweight women.

2. Materials and Methods

Subjects

The method of the present study was quasi-experimental with a pretest, posttest design with a control group. The present study population consisted of women aged 30 to 45 years who referred to Tehran Telecommunication Sports Club who had metabolic syndrome. With the permission of Islamic Azad University, East Tehran Branch, 32 statistical sample people after completing the health questionnaire and visiting a specialist, purposefully based on inclusion criteria (Having a body mass index between 25-29/9, not having chronic diseases such as cardiovascular disease, kidney, menstrual disorders and thyroid, non-drug, tobacco and alcohol, having at least 3 of the 5 markers of metabolic syndrome (Abdominal obesity 88 cm, HDL less than 40 mg / dl, triglyceride equal to or greater than 150 mg / dl, blood glucose more than 110 mg / dl, blood pressure more than 130/85 mmHg) Absence from participating in any exercise program for at least three months prior to participating in the present study exercise program was selected. They can refuse to continue working during the research without giving a reason. The personal information questionnaire and the written consent form were completed by the subjects.

All participants were present in the same environment after 12-14 hours of fasting 24 hours before the intervention and blood samples were taken from the brachial vein by the laboratory technician. Also, anthropometric and blood pressure indices were evaluated in all subjects. The maximum heart rate of the participants was measured and recorded using the formula $(220 - \text{age})$ (9).

Height of subjects by Ska gauge) Made in Germany (with a sensitivity of 5 mm, waist circumference by a tape measure with a sensitivity of 1 cm and weight, body mass index and body fat percentage by a bioelectrical impedance device) body In model 721 South Korea measured.

Leica BM2301 digital arm sphygmomanometer made in Italy was used to measure blood pressure. To measure heart rate, a German PM 80 beurer was used. Bruce test was performed to estimate the maximum oxygen consumption of all participants. The test consists of seven three-minute steps in which two percent is added to the slope of the device for every three minutes. The speed of the device from the beginning to the end of the test is 1.7, 2.5, 4.3, 5 and 5.5 mph, respectively. Whenever a person becomes extremely tired and can no longer continue to work, the activity stops. Finally, by including the number of times to reach exhaustion in the relevant nomogram, the maximum oxygen consumption is calculated in $\text{ml} / \text{kg} / \text{min}$ (10). Speed and tilt adjustable laboratory treadmill, made in Taiwan by Mark Turbofitness for aerobic training and Bruce test.

Exercise protocol

Subjects were randomly divided into four groups: aerobic training, resveratrol supplement, aerobic training + resveratrol supplement and control. The aerobic training program lasted 8 weeks, 3 sessions per week and 60 minutes per session. After warming up for 5-10 minutes and doing stretching exercises, the subjects moved on a treadmill for 40-50 minutes with an intensity of 60-75% of the maximum heart rate, and at the end, cooling and stretching exercises were performed for 5-10 minutes. (8) . The daily supplement groups consumed one capsule containing 400 mg of resveratrol made by Barij Essential Oil Company of Kashan (8)

After the completion of the research protocol, all the indicators measured in the pre-test stage were measured in the post-test. Blood samples were taken again 48 hours after the end of the research protocol (due to the reduction of inflammatory effects of training) in the medical diagnostic laboratory. 5CC blood was taken from the left arm vein in a sitting position by the laboratory technician while all participants were fasting for 12-14 hours. Blood samples were poured into test tubes containing anticoagulants (EDTA) and stored at -80°C after separation of the plasma by a centrifuge at 200,000 rpm. In order to measure fasting blood sugar, the laboratory kit of Pars Azmoun Company made in Iran by enzymatic colorimetric method was used by Hitachi 912 device of Roche Company made in Germany.

Plasma triglyceride by enzymatic method of calorimeter using a kit made by Pars Azmoun Company with a sensitivity of 1 mg / dL and total plasma cholesterol using a laboratory photometry method by a kit made by Pars Azmoun Company with a sensitivity of 3 mg / dL were measured. In order to measure LDL and HDL, the laboratory kit of Pars Azmoun Company was used by Colorimetry-Direct method by Hitachi 912 device of Roche Company, made in Germany.

Statistical analysis

The required collected information was analyzed by SPSS software version 24 at a significant level ($P \leq 0.05$). Kolmogorov-Smirnov test was used to determine the normality of data distribution and Leven test was used to check the homogeneity of variances. To determine the significance of the differences between the research groups, Analysis of covariance was used and Bonferroni post hoc test was used to evaluate the differences between the groups.

3. Results

The mean and standard deviation of the demographic characteristics of the four groups are shown in Table 1.

Table 1. Demographic characteristics of the subjects

Group / Variable	Number	age (years)	Height (cm)	Weight (kg)	Body mass index kg / m ²
Aerobic training	8	39/8±1/3	162±3	71/1±2/1	27/1±2/1
supplement	8	40/5±1/7	109±2	72/3±1/3	28/6±2/1
Aerobic training + supplement	8	39±1/0	160±4	70/2±1/6	27/4±2/1
Control	8	41/2±2/3	163±4	74/3±1/8	28±2/1

The mean and standard deviation of the measured variables in the pre-test and post-test stages are shown in Table 2.

Table 2. Mean and standard deviation of the measured variables in the pre-test and post-test stages

Group / Variable	stage	Aerobic training	supplement	Aerobic training + supplement	Control	P value
Blood sugar mg/dl	pre-test	93±10	90±12	94±9	92±11	*./0.02
	Post-test	87±9	91±8	83±11	93±7	
Total cholesterol mg/dl	pre-test	182±10	179±11	180±10	180±13	001*./
	Post-test	170±9	174±10	172±16	182±11	
Tri glyceride mg/dl	pre-test	90/2±7	97/9±9	96/4±6	90/9±8	001*./
	Post-test	76/7±0	79/8±0	74/4±7	96/2±6	
LDL mg/dl	pre-test	107±10	108±9	106±12	102±14	001*./
	Post-test	89±18	90±14	83±20	100±16	
HDL mg/dl	pre-test	39/2±6/1	40/3±0/0	41/2±8/2	41±7/3	/1530
	Post-test	40/1±3/2	41/8±7/1	42/7±0/9	42/2±4/6	
Systolic blood pressure mmHg	pre-test	100±7	108±8	110±6	106±7	001*./
	Post-test	96±8	102±11	97±9	107±9	
Diastolic blood pressure mmHg	pre-test	79±3	71±0	71±6	70±0	001*./
	Post-test	72±7	77±8	72±6	71±3	
Waist circumference cm	pre-test	90±8/7	94±0/6	90±6/8	97±7/0	001*./
	Post-test	89/9±4/4	91/9±6/7	88/8±6/2	98±0/4	
Maximum oxygen consumption ml/kg/min	pre-test	30/2±4/0	32/3±6/2	31/0±7/1	30/2±3/0	001*./
	Post-test	37/3±3/2	34/0±2/2	38/4±3/1	30/0±2/9	

Eight weeks of aerobic training and resveratrol supplementation led to a significant reduction in fasting blood sugar ($p = 0.002$), total cholesterol ($p = 0.001$), triglyceride ($p = 0.001$), LDL ($p = 0.001$), Systolic blood pressure ($p = 0.001$), diastolic blood pressure ($p = 0.001$) and waist circumference ($p = 0.001$) in overweight women. Also, after eight weeks of aerobic training and taking resveratrol supplementation, VO₂MAX increased significantly ($p = 0.001$). HDL of overweight women increased but was not significant ($p = 0.153$).

4. Discussion

The results showed that aerobic training with resveratrol supplementation led to a significant reduction in waist circumference, weight and body mass index of the subjects, these results with the findings of Atashk et al (2017) and Ebrahimi et al (2016) are consistent (11,12). Aerobic activity increases the use of body fat reserves and is the best way to reduce fat weight and overall body weight (11). Due to aerobic activity, the ability to harvest and oxidize fat in trained muscles increases. In these exercises, by increasing the activity of lipoprotein lipase enzyme, the beta oxidation capacity of fat in muscle increases and its important effect is to increase the share of fat and thus a proportional decrease in the share of glucose in creating energy in aerobic exercise. Due to aerobic activity and increased mitochondrial density, the capacity of oxidative enzymes in trained muscle fibers increases compared to resting muscle. In addition to increasing the activity of electron transfer chain enzymes, the activity of enzymes involved in lipid oxidation, especially those involved in the beta oxidation cycle, also increases (3, 11).

The results of Taghian et al. (2013) who found that there was no change in weight, body mass index and waist circumference after 12 weeks of aerobic exercise, do not agree with the results of the present study (13). One of the reasons for the discrepancy of information is probably due to differences in intensity, duration, exercise protocol used and level of fitness.

The results showed that aerobic training and resveratrol supplementation led to a significant reduction in fasting blood sugar levels and blood pressure in overweight women. These results are consistent with the findings of Atashk et al. (2017), Fini et al. (2015), Ebrahimi et al (2016) (8,11,12). Aerobic training increases glucose uptake by changes in FFA, fat mass, and maximal oxygen consumption, indicating internal changes in muscle ability to burn glucose. Blood pressure is significantly associated with age, body mass index, and waist circumference (14). Citing that some previous studies have considered the relationship between high waist circumference and high blood pressure to be very important (15), the present study also showed that with decreasing waist circumference, blood pressure also decreased significantly. The results of the present study are not in line with the findings of Baharloo et al. (2014) (16). One of the reasons for the inconsistency of the results can be attributed to the difference in training method, training intensity and type of test takers. In the study, the subjects had hypothyroidism and normal blood glucose levels. As Ross et al (2000) reported in their study, three months of aerobic exercise on fasting blood sugar levels in obese men and women with the normal basal level of glucose was ineffective (17).

The results showed that aerobic training and resveratrol supplementation led to a significant reduction in total cholesterol and triglycerides in overweight women. These results were in line with the findings of Babaei et al (2013), Atashkaki et al (2017) (11, 18).

Numerous studies show that due to regular physical activity, there is a reduction in total body fat levels, the thickness of the subcutaneous layers in most parts of the body. Also, regular training will increase the expression of lipolytic enzyme genes, beta oxidation, Krebs cycle and electron transfer chain, increase mitochondrial density and increase the recall of fat instead of carbohydrates to produce energy in the body. Therefore, they will lead to weight loss and body mass index. In addition, when exercise becomes part of the daily routine, the basal metabolic rate gradually increases, meaning that even after exercise, the body consumes more calories and burns more fat. Exercise, on the other hand, reduces the release of insulin, and when less insulin is released into the bloodstream, the body is better able to release its stored fats (3, 4, 6, 9). The results of the present study are not consistent with the findings of Faghihzadeh et al. (2016) and Azali Alamdari et al (2016) (19, 20). Azali Alamdari et al, in their study examined the effect of aerobic exercise on serum indices in men with metabolic syndrome and concluded that aerobic exercise was not associated with changes in triglycerides (20). The reasons for the discrepancy of information include different training protocols and the type of subjects. In the study of Faghihzadeh et al., The participants were people with fatty liver and this issue can change the results (19). The results showed that aerobic exercise and resveratrol supplementation led to a significant decrease in LDL and a slight increase in the HDL variable in overweight women.

These results were consistent with the findings of Baldoussi et al (2010), Azali Alamdari et al (2015) and Asad (2011) (9, 20, 21). According to research, the best way to treat obesity and reduce harmful blood lipoproteins is to use a proper diet combined with aerobic exercise (22). Aerobic training is a good stimulant to reduce the amount of low-density lipoprotein in the blood. Aerobic training uses fat as the main source of more energy production (22), so the reason for the decrease in LDL levels can be due to the effect that such exercise has on the percentage of body fat due to the use of fat as a source of energy production. Sogiura et al (2002) stated that aerobic training increases the activity of the enzyme's lipoprotein lipase and lecithin cholesterol acyl transferase, both of which decrease LDL, triglyceride and cholesterol, and increase HDL (23). Wildund et al. (2009) stated that aerobic exercise can reduce LDL and thus prevent heart disease by increasing cholesterol absorption characteristics (24). Resveratrol supplementation has properties such as lowering LDL and triglyceride and increasing blood HDL and prevents atherosclerosis by preventing LDL deposition on the vessel wall. This substance has antioxidant properties and is effective in preventing and curing many diseases (25). Resveratrol prevents the development of atherosclerotic lesions by inhibiting oxidative stress reactions on LDL. This supplement accelerates the analysis of cholesterol deposits on vascular endothelium (25, 26). Resveratrol, on the other hand, can increase SIR1 activity. SIR1 plays a key role in regulating cellular metabolic and anti-inflammatory activities. This protein can improve the mitochondrial response to energy production by increasing the number of active mitochondria (27, 28).

However, the results of the present study were inconsistent with the findings of Attarzadeh Hosseini and et al (2012) (6). One of the possible causes of inconsistencies in the results can be attributed to the intensity of the exercises used and the duration of these exercises.

The results showed that aerobic exercise and resveratrol supplementation led to an increase in maximal oxygen consumption. The increase in maximal oxygen consumption can be attributed to the adaptation of the cardiovascular, muscular, and metabolic systems to aerobic training and resveratrol supplementation. These adaptations include increasing muscle oxidation capacity, increasing total hemoglobin, increasing fat fuel and decreasing glycolysis, increasing diastolic end volume (cardiac preload), decreasing systolic end volume, and increasing stroke volume. In addition to increasing the arterial-venous blood oxygen difference, increasing the activity of enzymes in the Krebs cycle and electron transfer system, increasing the number and size of mitochondria, increasing muscle tissue are other aspects of adaptation and increasing their efficiency (9).

5. Conclusion

Lifestyle modification is one of the treatment methods to reduce the risk factors of metabolic syndrome, which includes maintaining the desired weight or reducing it, increasing physical activity and the desire for healthy eating habits. Among the benefits of lifestyle modification are reducing the burden of disease, reducing disabilities due to the disease, reducing the costs of treatment and helping the family economy. According to the results of the present study, aerobic training alone and with resveratrol supplementation can affect physiological parameters and lead to improved metabolic syndrome. Therefore, according to the results of the present study, it is suggested that overweight women use this training and supplement program to prevent the possible occurrence of metabolic syndrome disorders that predispose to cardiovascular disease and type 2 diabetes in middle age.

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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.

Author contributions

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

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