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The Effect of 8 Weeks of Resistance Training and Supplementation of Apple Vinegar on Resistin and Glycemic Indices in Obese Women

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Abstract

Introduction: The use of antioxidant and anti-inflammatory supplements is important in improving the function of obese people. The aim of this study was to investigate the effect of 8 weeks of resistance training with apple vinegar on resistin and glycemic indices of obese women.

Method: 60 women (mean ± SD: age 23.8 ± 4.81 years, weight 89.04 ± 4.68 and body mass index 34.39 ± 4.31 kg / m2) were purposefully selected and randomly assigned to four groups of 15: 1-resistance training, 2- resistance training and apple vinegar, 3-apple vinegar and 4-control

Groups 1 and 2 performed 8 weeks of resistance training, 3 sessions per week and 60 minutes each session with 80% intensity of 1RM. During this period, groups 2 and 3 consumed 500 mg of apple vinegar per day and the control group did not receive any interventions. Blood samples were taken before and after the study period. To analyze the findings, paired sample t-test, one-way ANOVA and Bonferroni post hoc test were used ($p \le 0.05$).

Result: Resistance training, apple vinegar consumption, and resistance training with apple vinegar had a significant effect on decreasing resistin, insulin, fasting glucose and insulin resistance in obese women ($p \le 0.05$). Resistance training with apple vinegar compared with resistance training and apple vinegar consumption had a greater effect on decreasing resistin, insulin, fasting glucose and insulin resistance in obese women ($p \le 0.05$).

Conclusion: It seems that apple vinegar supplementation and resistance training are likely to be a suitable method for reducing resistine and glycemic indexes and preventing metabolic, cardiovascular and inflammatory diseases in obese women.

Keywords: Training, Apple Vinegar, Resistin, Glycemic Indices, Obesity

Introduction

According to a recent survey, obesity is a significant negative factor in the health and longevity of a community. Based on the latest WHO estimates, 1.6 billion adults are overweight and over 400 million are obese (1). The World Health Organization has also predicted that the incidence of severe obesity will double in the years 1995 to 2025. According to the forecast, in 2025, in developing countries, the prevalence of obesity and overweight is also on the rise at a rapid pace (2). In this regard, researchers are looking for biological markers that can accurately identify the effects of obesity on various physiological systems in the body. Human adipose tissue secretes several cytokine proteins that mediate different biological effects. These proteins from the family of adipocytokines, include adiponectin, tumor necrosis factor factor-α(TNF-α), adipesin, interleukin-6(IL-6), resistin, and leptin (3). Resistin is a 108 amino acid adipocytokine with a weight of 11.3 Daltons belonging to the cysteine-rich proteins family called resistin-like molecules (RELMs) or found in inflammatory zone (FIIZ) proteins (4). High levels of serum resistin in diabetic rats suggests that resistin is a key mediator of obesity and type 2 diabetes (5).In humans, serum levels of resistin are also high in obese and diabetic patients compared with healthy people (6). Resistin gene in humans is located on chromosome 19, and is made up of 108 amino acids in the form of a primary polypeptide that has various isoforms (7).Scientific sources state that resistin is effective in the relationship between adipose tissue, obesity and insulin resistance (8). Recent reports indicate increased levels of resistin and TNF-**α** in obese people and insulin resistance (9).Valsamakis *et al*. (2004) stated that the use of anti-resistin drugs reduces its inhibitory effect on absorption of muscle glucose and other peripheral tissues (10). Some studies also point to the role of diet control in maintaining normal levels of resistin (11).Longitudinal studies have shown that regular exercise has anti-inflammatory effects and leads to reduced levels of inflammatory factors (12). Limited research has investigated the effect of resistance training on resistin and insulin resistance. For example, Giannopoulou *et al*. (2005) after 14 weeks of aerobic training program observed no change in the levels of resistin and reducing insulin resistance (13). In contrast, Jones *et al*. (2009), showed a significant decrease in serum resistin and no change in insulin resistance in obese adolescents after 8 months of aerobic training (14). Prestes *et al.* (2009), also reported that 16 weeks of resistance training had shown a decrease in plasma resistin (15). On the other hand, George *et al*. (2011) showed no significant changes in resistin and insulin resistance levels after 12 weeks of resistance training (16). It has been reported that natural antioxidants, including flavonoids, anthocyanidins, and catechins, affect the regulation of lipid metabolism by modulating antioxidant conditions (17). Apple vinegar has been studied as a medico-nutritional substance, because acetic acid, which is a major component of vinegar, has anti-hyperlipidemic activity (18). Acetic acid, as an active ingredient in vinegar, helps reduce obesity and lower body weight gain (19). These metabolic changes are likely to increase serotonin levels and reduce appetite by sending signal to the brain. In addition, consumption of apple vinegar disperses fat, which facilitates adipose tissue lipase, suppresses body fat accumulation, inhibits lipid cytoplasmic accumulation, regulates adipogenesis, and eliminates body fat (18). Researchers have also attributed anti-glycemic effects of apple vinegar to its acetic acid. Acetic acid is likely to control these agents through various methods such as decreasing the amount of gastric emptying, inhibiting the activity of small intestinal disaccharides, preventing the complete digestion of starch molecules, and increasing the absorption of glucose by active muscle (19).Abdi *et al.* (2013) examined the effect of 8 weeks of interval training with apple vinegar consumption on hematological and blood lipids profiles in young male athletes and reported that training and consumption of apple vinegar was effective on hematological and blood lipids profiles in young male athletes. The use of apple vinegar has been associated with changes in serum total cholesterol, triglyceride, LDL, and HDL (20).Beheshti *et al*. (2012) showed that consumption of apple vinegar was not associated with changes in serum total cholesterol, triglyceride, LDL, and HDL levels (21). Therefore, due to the lack of comprehensive studies on the interactive effect of apple vinegar and resistance training on resistin and glycemic indexes, the present study was conducted with the aim of examining the effect of eight weeks of resistance training and supplementation of apple vinegar on resistin and glycemic Indices of obese women.

Methods

The present study was a quasi-experimental design with four groups of pre-test and post-test together with the control group. The study was carried out on a field basis and was applied in terms of using the obtained results.

The sample consisted of 60 obese women with a body mass index of more than 30 kg / m 2, which were selected purposefully out 80 volunteers. After completing the medical questionnaire and obtaining consent, the subjects were randomly divided into four groups of 15 including: 1) resistance training, 2) resistance training and apple vinegar, 3) apple vinegar and 4) control. The criteria for inclusion in the study included no smoking and alcohol consumption, non-participation in a regular training program during the past six months, having a BMI greater than 30, having a relatively similar dietary pattern and avoiding changing nutritional habits during the conduct of the research, no history of any type of disease (cardiovascular, liver, kidney, lung, blood, diabetes, certain diseases, and hormonal, metabolic and motor disorders) and the lack of any drug use that prevented the company from being investigated. Exclusion criteria included the lack of regular engagement in training sessions, the onset of exacerbations of pain or illness that could not continue to work, non-consumption or irregular consumption of supplementation, effective changes in the nutritional pattern, and lack of participation in each blood collecting session. All subjects were first matched based on fat percentage (Table 1). Also, the present study was conducted under the supervision of a specialist physician and sports physiologists. The subjects got acquainted with a method of doing training and blood sampling at a meeting. Subjects in resistance training group and resistance training with apple vinegar group did the trainings for 8 weeks and 3 sessions per week for 60 minutes each session at an equipped sport club. Resistance activities were performed at the station and in the circle. In order to familiarize the subjects with the movements and devices used, at the first session, the subjects were called to the fitness and bodybuilding hall of the club to get acquainted with the proper method of lifting weights and the proper technique of breathability, and one repetition of the maximum (1 RM) of the subjects was recorded in the given movements. Then, after 10 minutes of warm-up, the subjects performed at the following stations: leg press, chest press, Let Pull, triceps push-down, knee extension, seated row, biceps curl, abdominal crunch. During the first and second weeks, the subjects performed two sets of 12-15 repeats and 40 to 50% 1RM each; also, in the third and fourth weeks, three sets of 10-15 repeats and 50 to 60% of 1RM; in the fifth and sixth weeks, three sets of 8-10 repeats and 60-70% of 1RM, and in the seventh and eightth weeks, three sets of 5-8 repeats and 70-80% 1 were performed. The rest time between the stations was 45 seconds and the rest time between each circle was 90 seconds. In addition, in order to comply with the principle of overload and to prevent the effect of compatibility of the subjects, calculations were done biweekly in each station, and in each session the training load was carefully assessed and controlled (23). The subjects in groups 2 and 3 were given 500 mg apple vinegar (two 250 mg capsules) with a glass of water daily after breakfast and before lunch for 8 weeks (20). Apples vinegar capsules were provided from GolDarou Herbal Medicinal Company with health certificate 1228022777 from the Ministry of Health's Food and Drug Administration. Blood sampling was performed at the pre-test and post-test; 24 hours before and 24 hours after the last training session, at 8:00 am and after 12 hours of fasting. At each stage, 5 cc of blood was collected. Serum samples were used to measure the variables. Prepared specimens were centrifuged with 1500 rpm for 10 minutes to separate the serum, and the resultant was distributed in special eppendorf dishes and immediately freezed at -80 ° C for further analysis. All blood samples were removed from the freeze on one day, and then the experiments were performed to measure resistin by ELISA method using CK-E10873 resistin kit, Boster Co., U.S.A., with a sensitivity of 10/21 ng / L. Also, insulin was measured using insulin kite Co., U.S.A., with a sensitivity of 0.5 U / MI and a fully automated ELISA device in Germany. Fasting blood glucose was measured by enzyme colorimetric method using Pars peroxidase oxidase glucose kit. Insulin resistance was calculated and evaluated by the method of evaluation of the homeostasis insulin resistance model based on the following equation:

HOMA- IR =
(FBS (mmol/L) × FBI (IU per ml) ÷ 22.5)

In the above formula HOMA is the homeostasis insulin resistance model, FBS, fasting blood glucose and FBI stands for levels of fasting blood insulin. The height of the subjects was measured using a wall height measuring device (Seca) with accuracy of 0.1 cm and weight was measured using a digital scale (Seca) with accuracy of 0.1. To determine the fat percentage of the subjects, the inbody Korean Model of body composition Instrument was employed. Levene's test was used to test the homogeneity of variances in the pre-test. Kolmogorov-Smirnov test was used to ensure the normality of the variables. paired smple t-test was used to compare means in the pre-test and post-test within the groups, and one-way ANOVA was used to compare (pre-test post-test difference) between the groups, and in case of significant results Bonferroni post hoc test was used. All data analysis was done using SPSS software version 22 at significant level p≤0.05.

Results

The demographic characteristics of the subjects in the study, such as age, height, weight, fat percentage and BMI, are presented in Table 2. The results of t-test showed that resistin levels in the resistance training group (P = 0.001), apple vinegar (P = 0.001) and resistance training with apple vinegar (P = 0.001) were significantly decreased in the post test compared to the pre-test. There was no significant difference in the pretest and posttest levels of resistin in the control group (P = 0.8). Insulin levels in resistance training group (P = 0.001), apple vinegar (P = 0.017), and resistance training with apple vinegar (P = 0.001) decreased significantly in the post-test compared to the pre-test. There was no significant difference in the pre-test and post-test levels of insulin in the control group (P = 0.4). The fasting glucose level in the resistance training group (P = 0.001), apple vinegar (P = 0.001) and training resistance with apple vinegar (P = 0.001) decreased significantly in the post-test compared to the pre-test. There was no significant difference in the pre-test and post-test levels of fasting glucose in the control group (P = 0.7); also insulin resistance in the resistance training group (P = 0.001), apple vinegar (P = 0.02) and resistance training with apple vinegar (P = 0.01) in the post-test was significantly decreased compared to the pre-test. There was no significant difference in the pre-test and post-test levels of insulin resistance in the control group (P = 0.2). The results of one-way ANOVA showed that there was a significant difference in the levels of resistin (p = 0.001), insulin (p = 0.001), fasting glucose (p = 0.005) and insulin resistance (p = 0.001) in four groups of study. The results of the post hoc test in Table 3 showed that resistin levels in the resistance training group, apple vinegar and resistance training with apple vinegar significantly decreased compared to the control group (p = 0.001); in the resistance training group with apple vinegar significantly decreased compared to resistance training group (p = 0.001) and apple vinegar group (p = 0.001). Also, in the resistance training group significantly decreased compared to vinegar apple (p = 0.001). The results of the post hoc test showed that insulin levels in the resistance training group, apple vinegar and resistance training with apple vinegar decreased significantly (p = 0.001); in the resistance training group with apple vinegar significantly decreased compared to resistance training group (p = 0.001) and apple vinegar group (p = 0.001). Also, in the resistance training group significantly decreased compared to vinegar apple (p = 0.001). The results of the post hoc test in Table 3 showed that fasting glucose levels in resistance training group (p = 0.001), apple vinegar (p = 0.01) and resistance training with apple vinegar (p = 0.001) significantly decreased compared to control group (p = 0.001); in the resistance training group with apple vinegar decreased significantly compared to resistance group (p = 0.01) and apple vinegar group (p = 0.01); also, in the resistance training group significantly decreased compared to apple vinegar group (p = 0.001). The results of the post hoc test in Table 3 showed that the levels of insulin resistance in the resistance training group, apple vinegar and resistance training with apple vinegar significantly decreased compared to control group (p = 0.001).

Table 1. Resistance training protocol

Movements	Set	Repeat	Intensity	Number of training cycles per week
First & Second Week	3	12-15	40-50 % 1RM	3
Third & Fourth Week	3	10-15	50-60 % 1RM	3
Fifth & Sixth Week	3	8-10	60-70 % 1RM	3
Seventh & Eighth Week	3	5-8	70-80 % 1RM	3

Table 2. Demographic characteristics of the subjects in pre-test

Variable Group	Resistance Training	Apple Vinegar	Resistance Training with Apple Vinegar	Control
Age (Year)	23.8±4.81	24.18±6.78	22.2±7.15	23.69±4.77
Height (cm)	161.1±2.79	163.14±2.04	165.17±6.2	166.65±4.3
Weight (Kg)	89.04±4.68	90.8±3.79	88.7±5.51	87.5±3.9
BMI (kg/m^2)	34.29±4.31	33.40±3.18	32.19±3.77	33.80±1.77
Fat Percentage (%)	39.38±6.58	38.12±6.79	37.93±6.88	38.82±6.24

Discussion

The results of this study showed that 8 weeks of resistance training resulted in significant reduction of resistin, fasting glucose, insulin and insulin resistance in obese women. The results of this study were consistent with studies by Botero *et al*. (2013), Prestes *et al*. (2009) Arzu –Vardar *et al*. (2017), Jamali *et al*. (2017) (22, 15, 4, 23). On the other hand, the findings of this study are not consistent with the results of Hagighi *et al.* (2013), Jorge *et al*.(2011), Giannopoulou *et al*. (2005) (24,16,13). This discrepancy can be due to the implementation of the training protocol and the duration, sex and age of the subjects, physiological adaptations of the trainings. Prestes *et al*. (2009) also showed a decrease in resistin levels in postmenopausal women following 12 and 16 weeks of resistance training. Jamali *et al.* (1396) investigated the effect of eight weeks of endurance training on expression of resin genes in visceral adipose tissue of obese rats. The results of this study showed that obesity can increase the expression of resistin genes in visceral adipose tissue and reduce endurance training (23). Jorge *et al*. (2011) showed that none of the training types (aerobic, resistance, and combination) did not change the resistin level of individuals with type 2 diabetes (16).

Table 3. Results of one-way ANOVA and paired sample t-test study resistin changes and glycemic indexes in four groups of study

Variable	Group	Measurement Time	SD±Mean	paired sample t-test	One-way ANOVA
Resistin (Pico gr/ ml)	Resistance Training	Pre-test	78.15±18.1	P = 0.001	P=0.001
		Post-test	48.05±14.1		
	Apple Vinegar	Pre-test	79.59±19.1	P = 0.001	
		Post-test	74.72±15.1		
	Resistance Training with Apple Vinegar	Pre-test	78.24±17.84	P = 0.001	
		Post-test	44.03±14.03		
	Control	Pre-test	79.2±16.29	P =0.8	
		Post-test	81.21±17.7		
Insulin (Micro-unit /ml)	Resistance Training	Pre-test	8.23±.93	P = 0.001	P=0.001
		Post-test	7.1±.96		
	Apple Vinegar	Pre-test	8.12±0.71	P = 0.0.17	
		Post-test	7.9±.45		
	Resistance Training with Apple Vinegar	Pre-test	8.21±.69	P = 0.001	
		Post-test	6.1±.78		
	Control	Pre-test	8.52±.89	P =0.4	
		Post-test	8.66 ±.84		
Fasting Glucose (Mg / dl)	Resistance Training	Pre-test	118.9±13.73	P = 0.001	P=0.005
		Post-test	109.10±67.88		
	Apple Vinegar	Pre-test	117.9±80.97	P = 0.001	
		Post-test	107.12±33.12		
	Resistance Training with Apple Vinegar	Pre-test	116.11±47.76	P = 0.001	
		Post-test	98.11±66.78		
	Control	Pre-test	118.19±79.19	P = 0.7	
		Post-test	119.66±66.84		
Insulin resistance (HOMA-IR)	Resistance Training	Pre-test	3.12±1.18	P = 0.001	P=0.001
		Post-test	2.13±1.19		
	Apple Vinegar	Pre-test	3.13±1.17	P= 0.02	
		Post-test	2.18±1.21		
	Resistance Training with Apple Vinegar	Pre-test	3.16±1.40	P = 0.001	
		Post-test	2.10±1.21		
	Control	Pre-test	3.18±1.33	P=0.2	
		Post-test	2.19±1.45		

Table 4. Results of bonferroni test to compare resistin changes and glycemic indexes among four groups of study

Variable	Group	Apple Vinegar	Resistance Training with Apple Vinegar	Control
Resistin	Resistance Training	P=0.001 M=26.30	P=0.001 M=4	P=0.001 M=32.90
	Apple Vinegar	………..	P=0.001 M=30.30	P=0.001 M=6.60
	Resistance Training with Apple Vinegar	………..	………	P=0.001 M=36.90
Insulin	Resistance Training	P=0.001 M=0.85	P=0.001 M=0.93	P=0.001 M=1.54
	Apple Vinegar	………..	P=0.001 M=1.78	P=0.001 M=0.69
	Resistance Training with Apple Vinegar	………..	………..	P=0.001 M=2.47
Fasting Glucose	Resistance Training	P=0.001 M=2.15	P=0.01 M=11.06	P=0.001 M=10.48
	Apple Vinegar	………..	P=0.01 M=8.91	P=0.01 M=12.64
	Resistance Training with Apple Vinegar	………..	…………	P=0.001 M=21.55
Insulin Resistance	Resistance Training	P=0.1 M=0.05	P=0.2 M=0.05	P=0.001 M=.82
	Apple Vinegar	………..	P=0.1 M=0.001	P=0.001 M=0.77
	Resistance Training with Apple Vinegar	………..	…………..	P=0.001 M=0.78

Haghighi *et al*. (2013) conducted a study on the effect of aerobic training on serum resistin and anthropometric variables in obese women. The results of this study indicated that performing 9 weeks of aerobic training significantly reduced body mass index and did not affect serum resistin levels in obese women (24). Some of the anti-inflammatory properties of training may be associated with modulation of adipokines produced from adipose tissue. In addition, long-term training reduce the production of atherogenic adipokines, while increasing the production of anti-atherogenic adipokines (20). Moderate regular training, with reduced sympathetic stimulation and increased anti-inflammatory adipokines, inhibit the release of inflammatory mediators from adipose tissue that play an important role in chronic diseases, and this may also be true about resistin (23). Among the mechanisms that can increase insulin action after training are increased insulin receptor signaling post, insulin protein expression of glucose transporter (GLUT4), increased glycogen synthase and hexokinase activity, reduced release and increased cleansing of free fatty acids, increased glucose release from blood to muscle due to increased muscle capillaries and changes in muscle composition to enhance glucose uptake (24). Therefore, one of the ways to reduce insulin resistance and reduce the incidence of type 2 diabetes, especially in obese people, is to training.Previous research has shown that insulin secretion is inhibited by training because of increased levels of norepinephrine (23). It is also likely that training -induced reduction in insulin is due to saving glucose whereby blood glucose uptake is limited by muscles and blood glucose is more accessible to the brain. Also, among the possible causes of insulin resistance decrease as a result of activity, we can refer to mechanisms that are independent of insulin, such as increasing GLUT4 levels due to muscle contractions (25).The results of this study showed that 8 weeks of supplementation of apple vinegar (500 mg) resulted in significant decrease in resistin, glucose, insulin and insulin resistance in obese women. Considering the investigations conducted, no study was found to examine the effect of exercise with the consumption of apple vinegar on resistin and glycemic indexes. Therefore, further research is needed to examine possible mechanisms for reducing resistin as a result of the use of supplements containing antioxidants and flavonoids.In the study of Budak (2011), the reducing effect of apple vinegar on cholesterol levels in rats receiving high-cholesterol diets has been observed (27). Actually, acetic acid is an active ingredient in vinegar, which reduces body fat and increases body weight (26). These metabolic changes are likely to send signals to the brain, which lead to an increase in serotonin levels along with decreased appetite. Additionally, the use of apple vinegar causes fat dispersion, which facilitates lipase action on adipose tissue, suppresses body fat accumulation, suppresses lipid cytoplasmic aggregation and regulates adipogenesis and hence limits body fat (27).The triglyceride reducing effects of apple vinegar supplement are probably due to decreased hepatic triglyceride storage. This idea is supported by the fact that acetic acid diet inhibits serum triglyceride levels by inhibiting liver lipogenesis, and these changes are associated with increased beta-oxidation of fatty acids (28).Although in the present study, measurement of lipid profile indexes was not carried out, which is among the limitations of the present study, apple vinegar seems to decrease weight loss, fat mass, fat percentage, body fat percentage, as well as IL- 6, which results in decreasing resistin, glucose, insulin resistance and serum insulin resistance levels (27).Carmelo *et al*. (2013) examined the use of apple vinegar on lipid profiles and anthropometric indices in type 2 diabetic patients. Serum lipid profiles (cholesterol, TG, LDL, and HDL) and anthropometric indices (weight, height, and waist circumference) were measured before and after intervention. Results showed that there was no significant difference between apple vinegar and control despite reduced cholesterol and low density lipoprotein (LDL) in apple vinegar (28).The results of this study showed that 8 weeks of supplementation of apple vinegar with resistance training resulted in significant decrease in resistin, glucose, insulin resistance and insulin resistance in obese women. Concerning decreasing resistin, glucose, insulin and insulin resistance induced by resistance training and supplementation of apple vinegar, Tofighi *et al.* (2013) described the cause as reducing anthropometric indices and proinflammatory cytokines such as IL-6, IL-1, and TNF-α (30). Because these cytokines stimulate the expression of the resistin gene in mononuclear cells of the blood, on the other hand, in humans, resistin, in addition to adipose tissue, is also produced from mononuclear cells and leukocytes, so training with its anti-inflammatory property may reduce plasma resistin levels (30).In general, along with this, there are different mechanisms on the part of researchers. Some researchers have found it necessary to reduce weight and fat mass in order to reduce resistin levels in the blood circulation (24), while others in their studies observed changes that were independent of weight loss (20-26).Obviously, the combination of resistance training and apple cider vinegar through the phosphorylation of the C Jun NH2 and NF-κB terminal kinase prevents hyperinsulinemia, insulin resistance, and inflammation from obesity in animals with fructose diets (31).Among the possible mechanisms for the beneficial effects of resistance training on insulin resistance index are: 1. Increased expression of type IV glucose (GLUT4) in cellular membranes by activating the intracellular message transmission pathway after muscle contractions caused by resistance training 2. Increased insulin receptors, glycogen synthase and protein kinase-B, and 3-transducting components involved in the insulin signaling cascade (25-31). Researchers have also attributed anti-glycemic effects of apple vinegar to its acetic acid. Acetic acid is likely to control these agents through various methods such as reducing the amount of gastric emptying, inhibiting the activity of small intestinal disaccharides, preventing the complete digestion of starch molecules, and enhancing the absorption of glucose by active muscle (26). The limitations of the present study included full control of subjects' nutrition and daily activity of subjects. It is suggested that the following investigators conduct analogous studis with complete nutritional control and measuring other cytokines, for example, IL-6, IL-1 and TNF-α.

Conclusion

Based on the findings of this study, resistance training, apple vinegar supplementation and resistance training with apple vinegar reduced the levels of resistin, glucose, insulin and insulin resistance in obese women. Resistance training with vinegar consumption had the highest reduction in resistin, glucose, insulin and insulin resistance compared to resistance training group and apple vinegar. Finally, the results of this study showed that resistance training and apple vinegar consumption may be effective in reducing serum resistin and insulin resistance and preventing metabolic, cardiovascular and inflammatory diseases in obese women.

Ethical issues

Not applicable.

Authors' contributions

All authors equally contributed to the writing and revision of this paper.

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