Herbal Medicines Journal **2019; 4(3):111-8**
DOI: 10.22087/herb%20med%20j.v4i3.764 **ISSN:** 2538-2144

Original Article

The Effect of Eight Weeks of Soy Supplementation and Aerobic Exercise on Lipid Profile in Overweight Women with Type 2 Diabetes

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Received: 17.07.2019; Accepted: 01.02.2020

Abstract

Background and Aim: This study examines the impact of eight weeks of aerobic exercise and soy supplementation on lipid profiles in overweight women with type 2 diabetes.

Materials and Methods: In this semi-experimental study, 40 women with type 2 diabetes and the mean age of 50.07±1.03 and the mean fat percentage of 30.75±0.37 were purposefully selected and then randomly divided into four groups: aerobic training + soybean, aerobic + placebo, soybean and control. The aerobic exercise program included three sessions per week with an intensity of 60-72% of maximum heart rate for eight weeks. Supplemental groups received one soy pill daily (containing50 mg of isoflavone) for eight weeks. Blood samples were collected in order to examine the variables investigated during fasting conditions in the pre and post-test phases. Data analysis was carried out using one-way ANOVA and t-test with significant the level ($P \leq 0.05$) using SPSS16 software.

Results: Serum levels of triglyceride and HDL-c in the aerobic + soybean, aerobic and soybean groups from the pre-test to post-test phase significantly decreased. Serum levels of cholesterol and LDL-c in the aerobic + soybean and soybean group decreased ($p \leq 0.05$). However, these values were not remarkably altered in the training group ($p \geq 0.05$). Moreover, there was a significant difference in the serum levels of triglyceride and LDL-c in the aerobic + soybean and soybean groups with the control group. There was a significant distinction between HDL-c levels in all three experimental groups ($p \leq 0.05$).

Conclusion: The results of lipid profiling showed that aerobic exercise and soy supplementation had positive impacts on the lipid profiles of overweight women with type 2 diabetes.

Keywords: Aerobic Exercise, Soybean, Lipid Profile, Type 2 Diabetes, Women

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Please cite this article as: Akbarpur M, Fathollahi Shoorabeh F, Fahimi M, Peisbaz S. The Effect of Eight Weeks of Soy Supplementation and Aerobic Exercise on Lipid Profile in Overweight Women with Type 2 Diabetes. Herb. Med. J. 2019; 4(3):111-8.

Introduction

The prevalence of overweight and obesity has led to an unmatched epidemic of type 2 diabetes in developed countries. Diabetes mellitus is known as the most common metabolic disorder in the world (1). It makes up 90-95% of all types of diabetes, and is caused by the failure of muscle cells to respond to insulin (insulin resistance) and insufficient secretion of insulin. This type of diabetes is more common in societies with hypertension and high blood lipids (2). The major concerns associated with type 2 diabetes are fat, high-sugar and cardiovascular diseases. Diabetes, combined with other risk factors for CVD, such as hypertension and dyslipidemia, can lead to a higher risk compared to a single risk factor (3). The purpose of treatment in type 2 diabetes is to regulate glucose, fat and blood pressure in order to prevent or postpone the complications of chronic diabetes (4). The most important risk factors for this disease are high energy intake, old age, immobility and obesity (5). Active lifestyles do not require intense exercise programs, but small changes that increase daily physical activity contribute to the reduction of the risk of chronic illness and might also contribute to the improvement of the quality of life of individuals (6). Life style changes include regular exercise by changing the diet and taking drugs that lower blood glucose (7). The American Diabetes Association recommends people with type 2 diabetes to have at least 150 minutes of moderate aerobic exercise, or at least 90 minutes of high intensity aerobic exercise, plus two sessions of resistance training (8). Regular physical activity improves lipid and glucose metabolism through increasing insulin as well as HDL-C and decreasing triglycerides (TG) and LDL-C (9). The results of a review study showed that moderate and severe aerobic exercises for 12 weeks and more could increase lipoprotein and decrease low-density lipoprotein, cholesterol and triglyceride in adult women and men (10). On the other hand, in addition to training, proper nutrition also plays a major role in preventing high blood lipid, but providing appropriate food strategies is still vague (11). Research has shown that special foods are beneficial for people with high levels of fat (12), and there are currently more than 400 types of herbal medicines in the world for diabetes, while only a few of them are considered as countermeasures (13). Complex compounds of soy include carbohydrates, proteins, dietary fiber, oligosaccharides, phytosterols, saponins, lysine, isoflavones, phytic acid, tyrosine inhibitors, and minerals. Complex carbohydrates and dietary fiber lower the glycemic index. It is useful for people with diabetes and also reduces the risk of diabetes (14). Several studies have shown that a soy-based diet might have beneficial impacts on glucose, lipid profile and insulin resistance (15). According to some findings, soy in women might have a better effect than men (11). Moreover, the effects of soy protein on the reduction of blood cholesterol in people with high blood lipids have been reported (16). Soybean protein can lower cholesterol, triglyceride and low density lipoprotein in healthy people as well as people with diabetes. Hence, the consumption of foods containing soy and soybean compounds is related to a reduction in risk factors such as heart disease and diabetes. The isoflavone combination of soybeans, especially gene stein, might help lower the amount of fatty acids produced by smaller and smaller cells (14). It has also been shown that the parenteral protein reduces cholesterol (17). That is, when diabetic patients were fed with legume-rich diets, in addition to improving blood glucose levels, serum triglyceride levels also decreased compared with other sources (15). Furthermore, according to the results of a research that investigated the combined impacts of aerobic exercise and soy consumption on serum monocytes and obesity in postmenopausal women, soybean intervention in the soybean training group did not have any effect on serum lipoprotein in postmenopausal women. As the results of the present study indicates, moderate and short-term aerobic exercise with soy consumption is associated with a decrease in body mass index and waist to hip ratio, and the reduction of total cholesterol, triglycerides and low density lipoprotein, and risk factors for cardiovascular disease in postmenopausal women and obese individuals (11). Few studies have examined the effect of soybean supplementation in people with type 2 diabetes, particularly on their inflammatory factors and the interaction between these supplements and exercises. Moreover, there is controversy about the effect of exercise on the lipid profiles of type 2 diabetes. Given the lack of adequate research on the interaction between aerobic exercise and soy supplement on the lipid profiles of type II diabetic patients, the purpose of the present research was to determine the effect of aerobic exercise and soy supplement on lipid profile in women with type 2 diabetes.

Materials and Methods

This research was carried out with a quasi-experimental and randomized design with the two-stages of pre-test and post-test. The statistical population of type 2 diabetic women who participated in this study was in Qazvin (Alborz city). The subjects had a two-year history of diabetes, and their ages ranged from 36 to 58. Other features included the body mass index of 29-38 kg per square meter, fat percentages of 23-33 percent, blood glucose levels between 160 and 314 mg / dl, and regular exercise in 3-5 years. More than one session of exercise per week had not been done by them in the last two month. After distributing the participation form, and following a complete description of the goals and methods of measurement by the researcher, the subjects who were ready to participate in the research project completed the informed consent form and medical history questionnaires, and a 24-hour nutritional recall was examined by medical examination. Of the eligible candidates, 40 subjects were purposively selected according to the percentage of fat so that each group had the same fat percentage average and then they were randomly assigned to 4 groups of 10 (aerobic-soybean, aerobic-placebo, soybean and control). They numbered 39 subjects at the end, and one person was excluded from the protocol due to lack of cooperation and firm participation. In this regard, none of the subjects was treated with insulin, and patients from all four groups used oral metformin glibenclamide during the study period. All soybeans have been shredded from a standard-label manufacturing company. It should be noted that this research was approved by the Committee for Research and Ethics of the University of Qom, Faculty of Literature and Humanities, IR.QOM.REC.1398.007.

Aerobic Exercise Protocol

During the aerobic exercise program, the maximum heart rate was measured using the formula (age 0.7) - 208 (18) for each person. In this study, the training group performed an eight-week aerobic exercise program. The aerobic training program included ten minutes of warm-up, fast walking, slow running, and stretching and tightening movements. Continuous running was performed in 60-72% of the maximum heart rate of the subjects. The subjects completed the first session with 60% of the maximum heart rate, and the two sessions were heavily rehearsed by 2%, which increased sharply by 72% during the seventh week, and this intensity was maintained in the eighth week. Moreover, running in the first session took fifteen minutes; both sessions were incremented by one and a half minutes running time, and by the end of the twenty-third meeting, running time increased by 26 minutes. The age of the term was deleted in a final session. The intensity of the exercise was controlled using a polar belt. At the end of each session, the cooling operation was performed with softness, tensile and tensile strength for ten minutes.

Soy-supplement groups consumed a soy tablet containing 50 mg of soy for eight weeks before each meal. It should be noted that the aerobic group received a placebo capsule filled with casein protein at the same daily dose. During the study, the control group did not have physical activity and received no supplement or placebo.

The Method of Measuring Blood Variables

Blood sampling was performed between 8:00 - 9:00 a.m. after 12 hours of fasting and in two stages 24 hours before the beginning of exercise and supplementation and 48 hours following the last training session after eight weeks of aerobic training and supplementation. In the first stage, 5 cc of blood was taken from the left ventricle vein of the subjects while sitting and resting. Subsequently, the experimental group received supplemental aerobic exercise for eight weeks. Forty-eight hours after completing the training and supplementation, which took eight weeks, blood samples were taken from the subjects, just like the first stage. After blood sampling, the serums were separated immediately and centrifuged at 3000 rpm for 10 minutes and were kept at -80°C until the day of the experiment. Samples were removed from the freezer and placed at room temperature for 30 minutes to melt and reach the room temperature. Then, they were held upside down 5 times to reduce the concentration gradient of freeze-thaw and make it alike in all samples.

The Measurement of Body Composition Variables

The measurement of the weight of the subjects was carried out using the Xiaomi Smart Scale (Mi model, made of China) without shoes and with minimum clothing. The height of the subjects was measured by a wall scanner, SEKA 206, made in Germany with a precision of 1 mm in a standing position without shoes, while the scapula was in normal condition and the body weight was evenly divided on both legs and the eyes were parallel to the horizon. To measure the body mass index of subjects, their height and weight were measured first, and then the weight was divided by height squared. In this formula, weight was in kilograms, height was in meters, and the unit of body mass index was in kilograms per square meter. The body-mass percentage in the subjects was measured using the caliper method in three points (triceps, supra pelvic and thigh) and an American-made Slim Guide body fat caliper.

Statistical Methods

To investigate the homogeneity of the data in the basic state and to evaluate the sample deviation in the target population, the Kolmogorov-Smirnov test was used, and in order to examine the homogeneity of variances, Levene's test was used. Moreover, a paired t-test was used to compare intergroup changes and to compare the changes in pre-test and post-test in each group. Furthermore, one-way analysis of variance, ANOVA, with the LSD post hoc test was used to analyze the intergroup changes in the groups.

Results and Discussion

The characteristic features of the subjects in the study groups have been shown in Table 1. According to the results of Table 1, there was no significant difference between height, weight, fat percentage and body mass index between the study groups ($P > 0.05$). The Kolmogorov-Smirnov test also indicated a natural distribution of data among the groups, and Levene's test showed the homogeneity of variance analysis in the four groups.

According to the results mentioned in Table 2, the intra group evaluation of data revealed a significant difference in the cholesterol index from the pre-test to post-test in the aerobic + soybean and the soybean groups ($p \leq 0.05$). A 5.76% decrease and, a 15.74% decrease were observed in the aerobic + Soybean group and the soybean group respectively. However, the results of one-way ANOVA did not show any significant difference in the inter-group cholesterol level ($P \geq 0.05$).

The results of the intra group evaluation of the data in the triglyceride index showed a noticeable distinction between the pre-test and post-test stages in the aerobic + soybean, aerobic and soybean groups ($p \leq 0.05$) so that this level decreased in the training + soybean group (21.69%), the training group (12.66%), and finally the soybean group (23.43%). Moreover, the results of one-way ANOVA showed a significant difference in the level of intergroup triglyceride ($p \leq 0.05$). That is, it was observed to be significant between the control group + soybean and the control group ($P = 0.010$) and also between the soybean group and the control group ($P = 0.011$).

Intergroup evaluation of the data in the LDL-c index showed a significant difference between the pre-test and post-test stages in the soybean + soybean + soybean groups ($p \leq 0.05$) so that this level decreased in the training group + soybean (11.39%) and in the soybean group (13.28%). The results of one-way analysis of variance analysis showed a significant difference in LDL-c level between the groups (p≤0 / 05) so that it was found to be significant between the soybean + exercise and the control group ($p = 0.048$) and also between the soybean group and the control group ($p = 0.042$). Moreover, the results of the intra-

Table 1: Comparison of Anthropometric Indices in the Four Groups.

	Aerobic	**Aerobic-Soy**	**Soy**	**Control**	**P**	**F**
Age (years)	56.1±50.50	13.2±80.48	21.2±22.52	31.2٠٠±48.	0.42	0.96
Weight (kg)	4.42±80.10	4.42±81.10	2.12±79.55	1.27±93.20	0.88	0.21
Height	165±2.5	166±2.4	165±2.2	164±1.9	0.79	0.28
WHR	0.84±0.008	0.85±0.1	0.85±0.005	0.85±0.2	0.20	1.60
VO_{2max}(ml.kg/min)	.751±29.38	1.45±28.12	0.91±84.25	0.83±25.79	0.14	89.1
BMI	30.1±22.32	1.16±32.00	1.23±31.90	0.88±33.22	0.90	0.19
Body fat percentage	31.01±0.74	29.26±0.83	31.72±0.50	31.08±0.71	0.11	14.2

Table 2: The Comparison of Blood Indicators of the Participants in the Four Groups after Eight Weeks of Training (the data have been shown as Mean ± Standard Deviation).

Variables	Groups	Measurement Time			Squared Set		** P Intergroup
		Post Test	Per Test	*P Intergroup	Post Test	Per Test	
Cholesterol	Aerobic-soy	54.9±80.179	99.8±80.190	011.0	247.1733	837.1926	648.0
	Aerobic	46.10±30.186	91.9±20.186	993/0			
	Soy	29.10±88.168	02.12±44.200	0.017			
	control	29.13±20.180	37.9±30.182	0.885			
TG	Aerobic-soy	15.14±80.162	14.17±90.207	012.0	919.1889	001.2200	026.0
	Aerobic	18.89±190.50	00.17±10.218	029.0			
	Soy	12.58±88.160	18.83±210.11	004.0			
	Control	27.4±40.214	22.12±90.226	395.0			
LDL-C	Aerobic-soy	85.4±80.87	06.7±10.99	007.0	559.1367	831.7	044.0
	Aerobic	78.6±20.96	77.6±40.99	629.0			
	Soy	52.4±00.87	96.6±33.100	006.0			
	control	60.1±20.101	92.5±70.99	765.0			
HDL-C	Aerobic-soy	11.1±40.43	34.1±40.39	000.1	497.153	488.14	433.0
	Aerobic	90.1±20.43	66.1±90.39	024.0			
	Soy	73.1±66.42	83.1±22.40	001.0			
	control	28.1±60.38	36.2±80.39	484.0			

group evaluation of HDL-c showed a significant difference between the pre-test and post-test groups + soybean, aerobic and soybean groups (p≤0.05). There were increases in the aerobic group + soybean (10.15%), the aerobic group (8.27%) and the soybean group (6.06%). The results of one-way ANOVA test indicated significant differences in HDL-c. There was a significant difference (p≤0.05) between the aerobic + soy and the control groups (p = 0.027) and the aerobic as well as control groups (p = 0.03).

Type II diabetes mellitus is a chronic disease which is increasingly affecting human beings worldwide and is considered as a major problem in the current century. On the other hand, overweight and obesity are also significant factors in exacerbating the disease. In addition to drug therapy, changes in lifestyle, including exercise and proper nutrition, are also important factors in controlling the disease. Hence, participation in regular physical activity as a non-prescriptive strategy in the prevention and control of diabetes and its complications, such as heart disease and blood lipids, is considered to be an exception, and aerobic exercises are no exceptions. On the other hand, in addition to training, proper nutrition plays a pivotal role in the prevention of diabetes and lipid profile (2). Hence, the present study aims to survey lipid profile levels following eight weeks of aerobic exercise and supplementation of soy supplement in women with diabetes type 2 obesity. The results of measuring lipid profiles showed that eight weeks of aerobic exercise and soy supplementation could have positive effects on the lipid profiles of women with type 2 diabetes. The results of this study revealed that the intervention of two factors of aerobic exercise and soy has had a role in reducing cholesterol, triglyceride, LDL-c and increased HDL-c. The results of this research concerning exercise were consistent with the results of the study conducted by Sahib Joo *et al.*, which investigated the effect of 12 weeks of aerobic training (with an intensity of 75-85% of maximal heart rate and duration of 32-16 min) on the serum level of reactivity protein C, alpha-tumor necrosis factor, lipid profile, and anthropometric characteristics in middle-aged women with type 2 diabetes. They reported that the levels of triglyceride and LDL-c significantly decreased, whereas HDL-c noticeably increased (19). Our results were also consistent with the findings of the research carried out by Azizi *et al*. that examined the effect of eight weeks of aerobic training (60-60% maximal heart rate and 60 minutes duration) on lipid profiles and Apo proteins of A-1 and B in overweight women. They reported significant reductions in total triglyceride and total cholesterol levels, as well as significant increases in HDL-c levels (20). An increase in LDL-c concentration and a greater reduction in HDL-c in diabetic patients have major roles in cardiovascular disorders (21). LDL-c is more likely to accumulate in the blood vessel wall, causing cardiovascular disorders, while HDL-c causes the transfer of cholesterol from blood vessels to the liver and prevents the accumulation of lipids in the blood vessels (22). The mechanism by which exercise improves lipid metabolism could be due to changes in the activity of lipase enzymes such as lipoprotein lipase (LPL) and hormone-sensitive lipase HL (23). Furthermore, there is a significant reverse relationship between HDL-c and triglyceride levels (24). Indeed, previous researches have indicated that in moderate-intensity exercise, levels of triglycerides decrease due to increased lipoprotein lipase activity, which might increase HDL-c levels (25). Therefore, a significant increase in HDL-c in the present study could be attributed to a decrease in triglyceride levels. Moreover, the results of this study on training were consistent with the results of the study carried out by Byje *et al.,* which investigated the effect of eight weeks of aerobic training (with the intensity of 55-75% of maximum heart rate and duration of 45 minutes) on serum levels of Apo lipoprotein A 1, B and lipid profile of overweight women. There were not significant changes in cholesterol, triglyceride, LDL-c and HDL-c levels (26). The reason for the inconsistency could be attributed to the type of exercise, the duration of the training, the type of subjects and their age. Furthermore, the results of the present study are complementary to the findings of the research that has examined the effect of four weeks of soy supplementation (20). The percentage of soybean seeds in the daily diet of diabetic and healthy rats on glucose, lipid profiles and histological structures of diabetic rats showed a remarkable reduction in cholesterol, triglyceride and LDL-c levels and the rise of HDL-c levels (28). Furthermore, Yang *et al.* reviewed the findings of studies on the supplements of soy products on serum lipids and glycemic control in diabetic patients and the reduction of cholesterol, triglycerides, and LDL-c. They reported an increase in HDL-c (29). Jessie *et al.* indicated the effect of soy supplementation (30 g daily of soy protein containing 60 mg of isoflavone daily) on lipid profiles in postmenopausal women and a noticeable reduction in cholesterol, triglyceride, LDL- c, and high HDL-c levels (30). Moreover, the results of the study conducted on the combined effect of aerobic and soybean exercises were consistent with the results of the research carried out by Zarnashan that examined the combined effect of aerobic exercises and soy consumption (10 weeks training with the intensity 70-60% of maximal heart rate for 60 minutes, and receiving 100 g of soy nuts for 10 weeks daily) and indicated the reduction of cholesterol, triglyceride and LDL-c levels. Dandy was the same. The mechanism of soy's effect on the reduction of fat by decreasing the absorption of intestinal cholesterol and increasing biliary excretion, thereby reducing the volume of liver cholesterol and increasing the withdrawal of low density lipoprotein was indicated. Soy directly affects the metabolism of liver cholesterol and low lipoprotein receptor activity (11). These potential mechanisms of soybean in reducing serum lipids are consistent with the results of this study due to the interaction between aerobic-soybean and soybean exercises alone in reducing the levels of cholesterol, triglycerides and LDL-c. Furthermore, the results of this study were compared with the results of the research conducted by Suzanne *et al.* that examined the supplements of soy isoflavones (for one year, daily 40 mg and 80 mg) without reporting significant changes in plasma lipid levels (31). Moreover, the findings of Reyhani *et al.* who evaluated the use of soy protein (100 grams of soy nuts per day for four weeks) and did not report significant changes in the levels of cholesterol, LDL-c and HDL-c (31) were uncoordinated. Due to the incompatibility reasons, the type and age of the subjects, the type of supplement and its dose as well as the duration of supplementation can be mentioned. Given the fact that the present study was a quasi-experimental type in the type of diabetic patients, all factors, such as genetic determinants or other factors independent of obesity and diabetes, were beyond the scope of this research. Hence, these factors could affect the outcome.

Conclusion

In general, eight weeks of aerobic training, supplementation of soybean and aerobic training significantly reduced cholesterol level and LDL-c in the aerobic + supplementary and supplemental groups. Moreover, a significant reduction of triglyceride in the aerobic + soybean, aerobic and soybean groups as well as a significant increase in HDL –c were observed. Anthropometric indices were also reduced, which was not significant. In other words, both of the two factors are complementary to soybean and aerobic exercise, and have positive and beneficial effects on decreasing the risk of heart attack and metabolic diseases such as blood lipids in women with type 2 diabetes. They are effective in improving the health of type 2 diabetic patients and overweight individuals through different mechanisms. However, further research has to be done regarding the effect of exercise and the use of soybean supplementation in overweight type 2 diabetic patients in order to achieve accurate results.

Acknowledgment

This article is based on a master's thesis conducted on sports physiology entitled, the Effect of Soybean Supplementation and Aerobic Exercise on the Lipid Profile of Overweight Women with Type 2 Diabetes approved via IRCT20180711040425N1 Code of Ethics. We would like to express our gratitude to the efforts of all the contributors and patients who helped us with this research.

Conflict of Interest

The authors declare that they have no conflict of interest.

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