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Original Article

The Effect of Endurance Training with Flax Seed on Cortisol and Lipid Profile of Obese Women

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Abstract

Introduction: Obesity is one of the global health problems that causes tissue damage and mortality due to hormonal changes and increased inflammatory markers and metabolic syndrome indices. For this reason, this study was conducted to investigate changes of endurance training with flax seed on cortisol concentration and lipid profile of obese women.

Methods: In the present study, 48 obese women aged 30-40 years old were randomly divided into four groups of 12, including 1. Endurance training, 2. Flaxseed supplementation, 3. Endurance training with flaxseed supplementation and 4. Control. Groups 1 and 3 performed endurance training for 8 weeks and 3 sessions per week at 40-70% of maximum heart rate, group 2 consume 6 grams flax seed daily and group 4 did not have any exercise and flaxseed consumption. Blood samples were measured before and after 8 weeks of endurance training and flax seed consumption. To analyze the data, descriptive and inferential tests of one-way ANOVA, Tukey' s post hoc, and paired sample t-tests were used at the significance level of 0.05.

Results: The results showed a significant difference in endurance training, endurance training with flax seed and control groups also showed a non-significant difference in flax seed group in cholesterol (p=0.003, p=0.001, p<0.001, p=0.065 respectively), triglyceride (p=0.002, p=0.001, p=0.01, p=0.12 respectively) and LDL (p=0.008, p=0.003, p=0.028, p=0.091 respectively) HDL (p=0.011, p=0.014, p=0.031, p=0.26 respectively), also based on the findings of the study, non-significant differences were found between the levels of cortisol in the research groups (p=0.26, p=0.12, p=0.18, p=0.75 respectively).

Conclusion: It seems that endurance trainings with flax seed can improve the lipid profiles of obese women.

Keywords: Cortisol, Training, Flaxseed, Lipid Profile, Obesity

Introduction

The national cholesterol education program, based on the diagnosis, evaluation and treatment of high blood cholesterol levels in adults has reported that obesity, especially abdominal obesity, is the most common cause of metabolic abnormalities, such as metabolic syndrome (1, 2). The process of aging due to the lack of mobility and the increased deposition of visceral fat in the abdomen and decrease in muscle mass are more likely to lead to metabolic syndrome in women and men (3, 4). In women with menopause and estrogen reduction, this process becomes faster and more intense (4). Recent findings have shown that obesity and metabolic syndrome indices are closely related to the secretion of fatty tissue (5). It seems that among the components of metabolic syndrome, obesity is considered the most important factor (6, 7). Akbaraly *et al.* (2010) reported that the prevalence of metabolic syndrome in Iran is about 33%, which is much higher than in America, Europe (25%) and in many Asian countries (8). It is also higher in women than in men (8). False food habits, inactivity, race and genetic factors are considered to be the cause of high metabolic syndrome (9). The metabolic syndrome increases the risk of cardiovascular disease. According to the World Health Organization, the prevalence of metabolic syndrome after 20 years of age in men is between 16% and 20%, and in women between 22% and 37%, and with rising age and weight, this percentage increases (10). Cortisol is an essential glucocorticoid in humans (11), which plays an important role in the function of some of the body's cells. This hormone has profound effects on the stress, metabolism of carbohydrates, lipids and proteins, stimulatory effects on the central nervous system, as well as on the circulatory system and inflammation (12). The response of cortisol to exercise depends on the type of exercise activity, intensity and duration of exercise. Endurance exercise activity with moderate intensity and duration does not show a change in blood cortisol levels (13), although some studies have reported cortisol decline. In contrast, longer and more intense exercise, causes increased levels of cortisol in the blood (13). Also, regular and long-term exercise is a non- pharmacologic strategy that through functional improvement, regulates body weight, adiposity and fat mass, and improves lipid profile; also, by changing the viscosity of fat in individuals, reduces the prevalence of cardiovascular diseases and prolongs individuals' lifespan (14,15). Thus, it is suggested that obese individuals take part in weight loss programs to reduce their body weight and cardio-metabolic risk factors (16). In addition, scientific evidence suggests that eating foods rich in omega-3 fatty acids significantly reduces the risk of inflammation, diseases and deaths from cardiovascular disease (17, 18). One of the ways to reduce inflammatory markers and prevent cardiovascular diseases is to use anti-inflammatory supplements (19). One of the most important sources of this fat is flaxseed. Flaxseed is rich in essential Omega-3 fatty acids. These fats help reduce low density lipoprotein (LDL) and help lose weight (17). Flaxseed is rich in protein, fat and dietary fiber. It has been shown that dry flaxseed contains 41% fat, 28% edible fiber, 21% protein, 4% ash and 6% other carbohydrates such as sugar, phenolic acid, lignin and hemicellulose (17). Among flaxseed fatty acids, alpha-linolenic acid or omega-3 can have a significant effect on the prevention of cardiovascular diseases and metabolic syndrome. However, among the studies carried out separately we can mention the study conducted by Poudel-Tandukar *et al*. (2009) in which it was indicated that flaxseed powder combined with a simple diet lowered serum lipid levels significantly and could be effective in reducing metabolic syndrome (18). Regarding the anti-inflammatory effects of flaxseed, Lakka *et al*. (2007) indicated that unsaturated fatty acid receptors, mainly G-protein 120 receptor, were present in the hypothalamus and reacted by omega-3 or omega-9 fatty acids. G-protein receptor is known as an important anti-inflammatory mediator (19). Shavandi *et al*. (2015) showed that flaxseed consumption significantly decreased triglyceride, LDL, body weight, body mass index (BMI), waist circumference and fat mass (20). Even though the beneficial effects of endurance training and flaxseed intervention on inflammatory factors have been investigated, the interactive effect of these two factors on cortisol and lipid profile in obese women is not clear. Therefore, the purpose of this study was to investigate the effect of eight weeks endurance training with flaxseed on cortisol and lipid profile in obese women.

Methods

In this study 48 women aged 30-40 years old (BMI>30) were divided in four groups of 12 including 1. Endurance training, 2. Flaxseed supplementation, 3. Endurance training with flaxseed supplementation and 4. Control. In the present study, there were some criteria for inclusion of participation in the research; Subjects were examined by a physician and participated in the study for 8 weeks in the absence of any illness or discomfort. Written consent and medical health certificate were obtained from eligible persons to participate in the present research. Subjects of each group were lacking a history of exercise, smoking background and illness to affect the study. A week before the beginning of the training program and the random division of the subjects, they were asked to refer to a trusted physician to check up for confirmation of general health, cardio-respiratory health, control of non-use of medication, absence of specific and motion diseases. Then, information about age, height, weight and heart rate were recorded. Finally, eligible individuals were randomly assigned to the groups. The training program for the endurance group was that one week before the start of the study, in an awareness session, they first got acquainted with the correct performance of training. The training program lasted 3 days per week and lasted for 8 weeks, with 48 hours rest between the sessions. All training sessions started with 10 minutes of warming up and stretching. The exercise program was carried out based on the recommendations of the American College of Medicine for women over 30 years of age (21). In the first week, the subjects completed the training for 15 minutes and 40% of maximum heart rate, in the second week, 20 minutes and 40% of the maximum heart rate, in the third and fourth weeks, 25-30 minutes and 50% of maximum heart rate, in the fifth and sixth weeks, 35-40 minutes, 60% of maximum heart rate; also in the seventh and eighth weeks, subjects received 45-50 minutes training with 70% maximal heart rate (21). The trainings were performed for all people at a certain hour of the day. The heart rate of the subjects was controlled using a polar beacon (Table 1). Flaxseed group, as well as the training with flaxseed group, consumed 6 grams of flaxseed powder (as 6 gram capsules) each day for 8 weeks, which was based on Jalali *et al*. (22). During the 8-week training period, the control group had just their daily activities. In order to measure the cortisol and lipid profile, in the first week before the beginning of the exercise protocol, blood samples were collected from the brachial vein (10 cc), and after eight weeks of intervention, blood samples were collected again. Immediately after bleeding and in order to separate the plasma, the samples were centrifuged for 15 minutes at 3500 rpm and the plasmas were stored at -70 ° C. Cortisol was measured by ELISA, using Monobind Company kit, the United States, with a sensitivity of 0.25 µg / dL, and lipid profile index was measured by colorimetric enzymatic method using Pars azmun kits. The Shapiro Wilk test, paired sample t-test, one-way ANOVA test and Tukey's post-hoc test were used to analyzed the results ($p \leq 0.05$). All aspects of this study have been approved by Islamic Azad University. The current approval code is 14121404962007.

Results

Anthropometric characteristics of age, height, weight and BMI in subjects of the four groups are listed in Table 2. Comparison of lipid profile (cholesterol, triglyceride, HDL, and LDL) and cortisol in four research groups were investigated at the beginning of the first week and the end of the eighth week (Table 3). Analysis of paired sample t- test showed a significant difference in endurance training, endurance training with flaxseed and control groups and also showed a non-significant difference in flaxseed group in cholesterol (p=0.003, p=0.001, p=0.000, p=0.065 respectively), triglyceride (p=0.002, p=0.001, p=0.01, p=0.12 respectively) and LDL (p=0.008, p=0.003, p=0.028, p=0.091 respectively) HDL (p=0.011, p=0.014, p=0.031, p=0.26 respectively), also based on the findings of the study, non-significant differences were found between the levels of cortisol in the groups (p=0.26, p=0.12, p=0.18, p=0.75 respectively) (Table 3).

Table 1. Process of training protocol implementation

Week of Training	Training Duration per session (min)	Training Intensity per session (MHR%)	Training Time
First Week	15	40	17-19 PM
Second Week	20	40	17-19 PM
Third Week	25-30	50	17-19 PM
Forth Week	25-30	50	17-19 PM
Fifth Week	35-40	60	17-19 PM
Sixth Week	35-40	60	17-19 PM
Seventh Week	45-50	70	17-19 PM
Eight Week	45-50	70	17-19 PM

Table2. Anthropometric characteristics of the subjects in four groups

Variable group	Age (years)	Weight (kg)	Height (cm)	BMI (kg/m^2)
Endurance training	35.80 ± 10.01	72.12 ± 4.31	154.17 ± 5.44	30.51 ± 3.42
Endurance with Flaxseed	32.91 ± 11.24	71.55 ± 5.64	153.68 ± 4.63	30.34 ± 4.01
Flaxseed	29.35 ± 6.01	74.32 ± 5.51	156.34 ± 7.58	30.45 ± 4.12
Control	33.62 ± 7.46	75.46 ± 4.63	155.32 ± 5.71	31.25 ± 4.24

One-way ANOVA analysis showed a significant difference in cholesterol (p=0.0001), triglyceride (p=0.01), LDL (p=0.02) and HDL (p=0.03), but this difference was not significant in cortisol (p=0.07) (Table 3). Tukey's post hoc test results showed there is significant difference in endurance training with flaxseed than flaxseed and control groups in cholesterol (p=0.001, p=0.0001 respectively), triglyceride (p=0.036, p=0.0001, respectively) and LDL (p=0.024, p=0.0001 respectively) and HDL levels (p=0.01, p=0.0001 respectively), but this difference in cholesterol, triglyceride, LDL and HDL in endurance training with flaxseed than endurance training were not significant (p=0.08, p=0.12, p=0.051 p=0.25 respectively) (Table 4).

Discussion

The results of this study showed that endurance training with flaxseed compared to flaxseed and control groups significantly decreased cholesterol, triglyceride and LDL levels and also significantly increased HDL. These changes in endurance training with flaxseed compared to endurance training group were not significant. It was also reported that cortisol concentration changes weren't significant in all groups. Some studies that investigate the effects of exercise and flaxseed have reported consistent results with present study, and some reported inconsistencies.

Table 3. The results of one-way ANOVA test and paired sample t-test to examine the effects of endurance training and flaxseed on cortisol and lipid profile

Variable	Group	Time	Mean± SD	Changes amount	Paired sample t-test	One way ANOVA
Cholesterol (mg/dl)	Endurance training	Pre- test	35.1±197.4	-55.8	0.003*	0.0001*
		Post- test	24.2±141.6			
	Flaxseed	Pre- test	29.3±200.1	-29.5	0.06	
		Post- test	30.1±139.4			
	Endurance training with flaxseed	Pre- test	55.2 ±228.9	-60.7	0.001*	
		Post- test	48.2±199.4			
	Control	Pre- test	48.1±231.1	+5.1	0.36	
		Post- test	50.2±237.2			
Triglyceride (mg/dl)	Endurance training	Pre- test	42.6±135.5	-32.7	0.002*	0.01*
		Post- test	46.7±102.8			
	Flaxseed	Pre- test	48.7±156.2	-14.8	0.12	
		Post- test	49.6±141.4			
	Endurance training with flaxseed	Pre- test	51.7±149.6	-41.5	0.001*	
		Post- test	49.5±108.1			
	Control	Pre- test	56.5±146.9	+5.3	0.29	
		Post- test	52.9±152.2			
LDL (mg/dl)	Endurance training	Pre- test	19.7±127.1	-25.6	0.008*	0.02*
		Post- test	22.8±101.5			
	Flaxseed	Pre- test	22.6±133.9	-11.35	0.09	
		Post- test	21.9±118.7			
	Endurance training with flaxseed	Pre- test	25.9±146.4	-37.8	0.003*	
		Post- test	27.6±108.6			
	Control	Pre- test	30.5±142.6	-2.2	0.16	
		Post- test	29.7±144.8			
HDL (mg/dl)	Endurance training	Pre- test	6.9±48.6	+7.3	0.01*	0.03*
		Post- test	8.7±55.9			
	Flaxseed	Pre- test	7.1±44.2	+3.2	0.26	
		Post- test	7.7±47.4			
	Endurance training with flaxseed	Pre- test	9.2±52.7	+8.7	0.01*	
		Post- test	8.7±61.4			
	Control	Pre- test	6.7±47.50	+0.7	0.45	
		Post- test	6.9±48.2			
Cortisol (ng/mL)	Endurance training	Pre- test	2.3± 8.21	-25.6	0.26	0.07
		Post- test	2.1± 8.14			
	Flaxseed	Pre- test	7.29±2.2	-3.9	0.12	
		Post- test	6.9±2.4			
	Endurance training with flaxseed	Pre- test	1.8±7.65	-0.43	0.18	
		Post- test	7.22±2.4			
	Control	Pre- test	6.81±1.9	+0.14	0.15	
		Post- test	6.95±1.7			

* Significant difference at p≤ 0.05

Table 4. Tukey's post hoc Results of lipid profile

Variable	Group		Mean differences	P
cholesterol (mg/dl)	Endurance training	Flaxseed	-27.2	0.03*
		Endurance training with Flaxseed	+4.9	0.08
		Control	-50.7	0.0001*
	Flaxseed	Endurance training with Flaxseed	+32.1	0.001*
		Endurance training	+27.2	0.032*
		Control	-33.7	0.045*
	Endurance training with Flaxseed	Endurance training	-4.9	0.08
		Flaxseed	-32.1	0.001*
		Control	-65.8	0.0001*
Triglyceride (mg/dl)	Endurance training	Flaxseed	-17.9	0.041*
		Endurance training with Flaxseed	+8.8	0.12
		Control	-38.0	0.0001*
	Flaxseed	Endurance training with Flaxseed	-26.7	0.036*
		Endurance training	-17.9	0.041*
		Control	-20.1	0.061
	Endurance training with Flaxseed	Endurance training	+8.8	0.12
		Flaxseed	-26.7	0.036*
		Control	-46.8	0.0001*
HDL (mg/dl)	Endurance training	Flaxseed	+4.1	0.039*
		Endurance training with Flaxseed	-1.4	0.25
		Control	+6.61	0.0001*
	Flaxseed	Endurance training with Flaxseed	-5.5	0.01*
		Endurance training	-4.1	0.039*
		Control	+2.51	0.048*
	Endurance training with Flaxseed	Endurance training	-1.4	0.25
		Flaxseed	-5.5	0.01*
		Control	+8.01	0.0001*
LDL(mg/dl)	Endurance training	Flaxseed	-10.4	0.031*
		Endurance training with Flaxseed	+12.2	0.048*
		Control	-27.8	0.001*
	Flaxseed	Endurance training	+10.4	0.031*
		Endurance training with Flaxseed	+22.6	0.024*
		Control	-17.4	0.043*
	Endurance training with Flaxseed	Flaxseed	-22.6	0.024*
		Endurance training	-12.2	0.051
		Control	-40.0	0.0001*

* Significant difference at $p \leq 0.05$

The results of present study in lipid profile were consistent with some studies (23- 26). They reported that light-to-moderate intensity endurance activity reduced triglycerides, cholesterol, LDL, and increased HDL, which was consistent with the results of the study. In some of these studies, it has been reported that these exercises do not have a significant effect on cortisol, while other treatments report significant changes. Lee *et al*. (2011) confirmed that low intensity to moderate physical activity and diet modification play a key role in weight loss and consequently, effective management of obesity-related illnesses (27). Kelley (2012) reported that it would be best to use endurance exercise with moderate intensity and 21 to 31% of the maximum oxygen consumption in most of the week days (28). Also, regarding the effect on the metabolic syndrome, Narayani *et al*. (2010) showed that the walking program reduced fat percentage and total cholesterol in obese women (29). Non the less, the study on four weeks of endurance exercise also showed reduced TC and LDL and increased HDL in healthy women and men, which were consistent with the findings of the present study (30, 31). Some researchers also believe that weight loss (decrease in fat percentage) is important for the effect of exercise on lipid profile, but weight loss is not necessary for changes in plasma lipoproteins (32, 33). Moreover, sport exercises more often affect the lipid profile of women who have a higher LDL level (TG) or lower HDL (34, 35). According to Lynn study, VLDL hydrolysis has increased to HDL-c synthesis. It seems that in this study eight weeks of endurance training and diet improvement have been able to stimulate cholesterol reverse transfusion system (36). On the other hand, Buyukyazi *et al*. (2008) after 8 weeks of training, 5 sessions per week with an intensity of 55-65% of heart rate store for 30 minutes indicated that this kind of exercise did not significantly affect the metabolic syndrome indices, so their results inconsistent with the findings of the present study (37). Concerning the possible mechanism of the effect of physical activity on lipid profile and cortisol, the findings of the previous studies indicated that physical activity increased the activity of cortisol, lipoprotein lipase enzymes and lecithin cholesterol acyl transferase, which reduced LDL, triglyceride and cholesterol and increased HDL. On the other hand, lipoprotein lipase can increase VLDL and LDL catabolism after endurance activities (30). Other factors affecting these responses include genetic, environmental factors such as excessive intake of food, inappropriate diet, and decreased physical activity (34). Wilund *et al*. concluded that endurance exercise by increasing cholesterol absorption interventions, can lead to a decrease in lipid profile and consequently, to prevent heart disease (35). Research on flaxseed can be found in Poudel *et al*. (2009) and Winzer *et al*. (2004), which indicated flaxseed had a decreasing effect on lipid profile and was consistent with the findings of this study (18,38), while the findings of this study are inconsistent with results of Alekseeva *et al*. (2000) and Matsushita *et al*. (2006) (39,40). One of the reasons for discrepancy between the results of some studies with the present research is the type of subjects (healthy or diabetes, human or animal, degree of obesity, etc.), type of exercise activity, intensity and duration of training protocol, and duration of training activity. Each of these cases can have some effects on the results. One of the reasons for effect of flaxseed on the improvement of metabolic syndrome indices is the presence of omega-3 and lignan. Part of the effects of omega-3 is exerted through the activation of adenosine monophosphate-sensitive protein kinase. This enzyme acts as a metabolic sensor, which causes a balance between cellular metabolism such as oxidation and biosynthesis of fatty acids. Also, these components of flaxseed seeds, by increasing the receptors of the peroxisomes, increase liver excretion and oxidation of free fatty acids and equally oxidize fats in skeletal muscle (39, 40). Therefore, it can be argued that these metabolic properties of flaxseed along with the metabolic effects of endurance exercise can exert significant effects on hormonal responses and lipid profile in humans. The limitations of this study include mental health, sleep and rest, as well as nutritional status and daily activity of subjects which can affect the results.

Conclusion

In this study, it was shown that endurance training with flaxseed seeds could have a better effect on cholesterol, triglyceride, LDL and also increased HDL. These changes, along with increased cortisol secretion, increase fat metabolism and also improve weight control, which can be important in the treatment and prevention of cardiovascular disease.

Ethical issues

Not applicable.

Authors' contributions

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

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