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Effects of Flaxseed Oil Consumption on Anthropometric Parameters in the Patients with Metabolic Syndrome: A Randomized Clinical Trial

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Abstract

Background: Flaxseed oil, as the main source of Alpha linolenic acid (ALA), decreases the production of Arachidonic acid (AA) from linoleic acid (LA) that plays an important role in the development of metabolic syndrome (MS). The aim of the present study was to compare the effects of flaxseed oil and sunflower oil on anthropometric parameters in patients suffering from MS.**Materials and Methods:** In this randomized clinical trial, 60 participants aged 30-60 years who suffered from MS were selected according to ATP III definition and were divided into two even groups receiving flaxseed oil and sunflower oil. Each group received 25 ml of the specified oil on a daily basis for 7 weeks. The anthropometric measures were evaluated on the first and last days of the study. **Results:** No significant differences were observed between the two groups regarding weight. However, waist circumference reduced significantly in the flaxseed oil group compared to the control group (P=0.001). **Conclusions:** The ALA might prevent the increase in adipose tissues. Therefore, it seems that flaxseed oil has beneficial effects on MS. **[GMJ.2017;6(1):44-51]**

Keywords: Metabolic Syndrome; Body Weight; Waist Circumference; Linseed Oil; Linoleic Acid

Introduction

Metabolic Syndrome (MS) is one of the greatest global health problems. Individuals suffering from this syndrome are at a higher risk of diabetes, cardiovascular diseases (CVDs), and ultimately death. It is clear that genetic, metabolic, and environmental factors play a significant role in the incidence of this disease [1- 3]. This syndrome was first introduced by Reaven *et al*. in the diabetes magazine in 1988. Kaplan added abdominal fat to this collection, which may be the most important part defined as the fat deposition in the abdominal fatty tissues [4]. In comparison to the MS patients with normal weight, obese ones had more metabolic problems and CVDs [5]. Waist circumference (WC) could also predict MS improvement and diabetes prognosis [6].

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Based on global parameters, MS is breaking out all over the world, particularly after middle ages [4]. In Tehran, Iran, more than 30% of elderly individuals and 10% of the youth were affected by this syndrome. This rate is rising faster compared to developed countries, such as the United States [3]. Overall, according to the international diabetes federation (IDF), one-fourths of the global population is suffering from MS [7]. The risk of diabetes is 10 folds higher in overweight patients with MS. Framingham study revealed that every 2.25 kg of extra weight could lead to 21-45% increased the risk of MS. Besides, 46% of the individuals with MS had a large WC [4].

Treatment of MS, in fact, involves curing its constituents. In definition, all the factors involved in MS have been given equal values. However, reducing the more significant risk factors, such as abdominal fat, can be more effective than treatment of hypertriglyceridemia [4]. Overall, lifestyle changes and appropriate diets have been more successful in reducing the incidence of MS compared to drug consumption.

Considering MS as pre-inflammatory states [4], many studies have shown that type of lipids is more important than the total amount of fat for reducing weight, fatty tissues, and general inflammation related to this disease [8, 9]. Thus, dietary recommendations with the aim of decreasing dietary fat consumption may help control the dangerous factors related to MS [10].

More than 50% of fatty acid in flaxseed oil is alpha-linolenic acid (ALA; 18:3n-3). The ALA produces eicosapentaenoic acid (EPA; 20:5n-3) and docosahexaenoic acid (DHA; 22:6n-3) in desaturation-elongation pathway. These n-3 fatty acids prevent the production of Arachidonic acid (AA; 20:4n-6). Linoleic acid (LA) is also the precursor of some inflammatory metabolites [11]. These fatty acids can alter tissue function or change the size or phenotype of adipose tissue [12].

Despite scientific evidence suggesting the potential importance of various dietary fatty acids on CVDs risk, no consensus has been reached in this respect yet. Evidence has shown the negative health impacts of trans fatty acids (TFA) and saturated fatty acids (SFA) on increase of CVDs risk. Replacing SFA, TFA, and n-6 polyunsaturated fatty acids (PUFA) with n-3 PUFA might result in cardiovascular health benefits [13]. Considering the interaction between nutrients and MS and importance of the type of oil consumed daily in health and prevention of diseases, the present study aims to compare the effects of flaxseed oil and sunflower oil on anthropometric parameters (weight and WC) in 30-60-year-old individuals suffering from MS.

Materials and Methods

Subjects

The study population included the patients who had been referred to Shiraz Healthy Heart Institute affiliated to Cardiovascular Research Center of Shiraz University of Medical Sciences (SUMS) from April to June 2015. The patients with MS were selected according to the Adult Treatment Panel III (ATP III) protocol [14]. The volunteers who had at least 3 of the below criteria were enrolled into the study:

1) Abdominal fat (WC more than or equal to 102 cm in males and more than 88 cm in females),

2) Low high-density-lipoprotein-cholesterol (HDL-C) level (less than 40 mg/dL in males and less than 50 mg/dL in females),

3)High serum triglyceride level (≥150 mg/dL)

4) Systolic blood pressure ≥ 130, diastolic blood pressure ≥ 85 mm/Hg, or already taking anti-hypertension drugs, and

5) Impaired fasting blood glucose (fasting blood glucose ≥ 110 mg/dL).

On the other hand, the exclusion criteria of the study were having the history of allergy to sunflower or flaxseed oil and most of beans and nuts, suffering from thyroid diseases, alcoholism, smoking, simultaneous presence in other clinical researches, consumption of aspirin or any types of non-steroid anti-inflammatory drugs (NSAIDs), propranolol consumption, any kind of infection at the beginning or during the study, having diabetes leg sores, having the history of heart attack, angioplasty, or any kind of hospital surgery 6 months prior to the study, pregnancy or breastfeeding, insulin consumption, supplementation with multi-vitamin or supplements containing omega-3 during 3 months before the study, consumption of any steroids, and taking lipid or glucose-lowering medications or blood lipid modifying agents (e.g., statins and fibrates). It should be noted that there was no prohibition for consuming blood glucose lowering drugs within the past 3 months and during the study. The drug dosage had to remain unchanged during the study.

Study Design

Considering α=5%, power of 80%, and effect size of 40% and using n=2δ2(Z1- α/2+Z1-β)2/(μ1-μ2) formula, a 60-subject sample size was determined for this study. At first, the study objectives and procedures were explained to the participants. Then, written informed consent forms were obtained from the participants. Accordingly, they were allowed to withdraw from the study for any reason at any time. Then, using block randomization method, the study participants were divided into a control and an intervention group each containing 20 males and 10 females. The two groups' subjects were matched regarding sex and age. All the participants passed a 3-week washout period before the beginning of the intervention. Using the estimated energy requirement formulas, the advised diets for keeping weight unchanged included 55% carbohydrates, 15% protein, and 30% fat.

Intervention

All the participants underwent the intervention receiving the appropriate diet in accordance with their weight and physical activity for 7 weeks. During the flaxseed oil diet intervention, the control group continued with the replacement of the oil with the same amount of sunflower oil. Flaxseed oil provided by cold press method and the common sunflower oil were produced by Verzhen factory, Golestan, Iran. According to the specified groups, each participant received 25 ml of flaxseed oil or sunflower oil on a daily basis, which was considered as a part of the total available recommended dietary fat (30% of total energy). The participants were asked to add the specified oil to their salad, rice, or another foodstuff before consumption under the condition that the oil should not be heated. It should be noted that a scaled cup was given to each participant to facilitate the accuracy of daily oil measurements. The participants were advised not to change their physical activities during the study. The participants were followed up every week by phone calls at the beginning of each week during the study. Also, the participants in each group came to Shiraz Healthy Heart Institute every two weeks to get their oil and diet follow-up.

Data Collections

The participants' demographic characteristics, including age and sex, height, weight, WC, body mass index (BMI), and dietary intake measurements (calories and macronutrients) were fully recorded in separate forms. After explaining the treatment to the participants, they received a paper including the advised diet information. After the washout period, the measurements were done for all the participants. Considering anthropometric measurements, height was measured in the form of standing stature, standing upright without shoes, using a standard measuring tape. Additionally, WC was assessed as the minimum measurement in the span under the chest (ribs) and above the iliac bone by a standard measuring tape with 1 mm accuracy. Finally, weight was measured with the patients putting on light clothes using Seca analogue scale with 0.5 kg accuracy. The BMI was also calculated for each participant as weight (kg) divided by height squared (meter). The anthropometric measurements were repeated on the 49th day of the study (at the end of the survey).

Ethical Issue

This study followed the guidelines of the Declaration of Helsinki and was approved by the ethics committee of SUMS (Ref. No. 7420). It was also registered at the Iranian Registry of Clinical Trials (No. IRCT2015012020737N1).

Statistical Analysis

All the statistical analyses were performed using the SPSS statistical software v. 20.0 (SPSS Inc., Chicago, IL). $P< 0.05$ were considered to be statistically significant. The results were expressed as mean ± SD. At first, one-sample Kolmogorov-Smirnov normality test was performed to confirm normal distribution of the data. Within-group differences between baseline and post-intervention values were analyzed using paired t-test, while unpaired t-test assessed between-group differences.

Results

Out of the 60 study participants, 26 finished the study in each group (n= 52). However, 4 participants abandoned the study due to loss of follow-up, lack of enough motivation, and unpleasant oil taste. Consort fellow chart of the study population has been presented in Figure-1. The final composition and demographic information of the participants in each group have been presented in Table-1.
The participants' anthropometric characteristics have been depicted in Table-2. Accordingly, weight, BMI, and WC were similar in both flaxseed oil and sunflower oil groups at the beginning of the study. However, a significant reduction was found in the flaxseed oil group's weight (P=0.30), BMI (P=0.30), and WC (P=0.003) after the treatment. In the sunflower oil group, on the other hand, weight (P=0.004) and BMI (P=0.004) significantly decreased, while WC showed a slight non-significant increase (P=0.114).
The mean of changes and the difference between the two groups have also been presented in Table-2. Accordingly, no significant difference was found between the two groups regarding weight and BMI. However, a significant decrease was observed in WC after consumption of flaxseed oil compared to the control group (P=0.001).

Discussions

The results of the present study showed no significant changes in weight and BMI after receiving flaxseed oil for 7 weeks. However, WC significantly reduced in the intervention group compared to the control group. Some studies have also found a relationship between WC and ALA.
For instance, Pourniazi *et al*. found a reverse

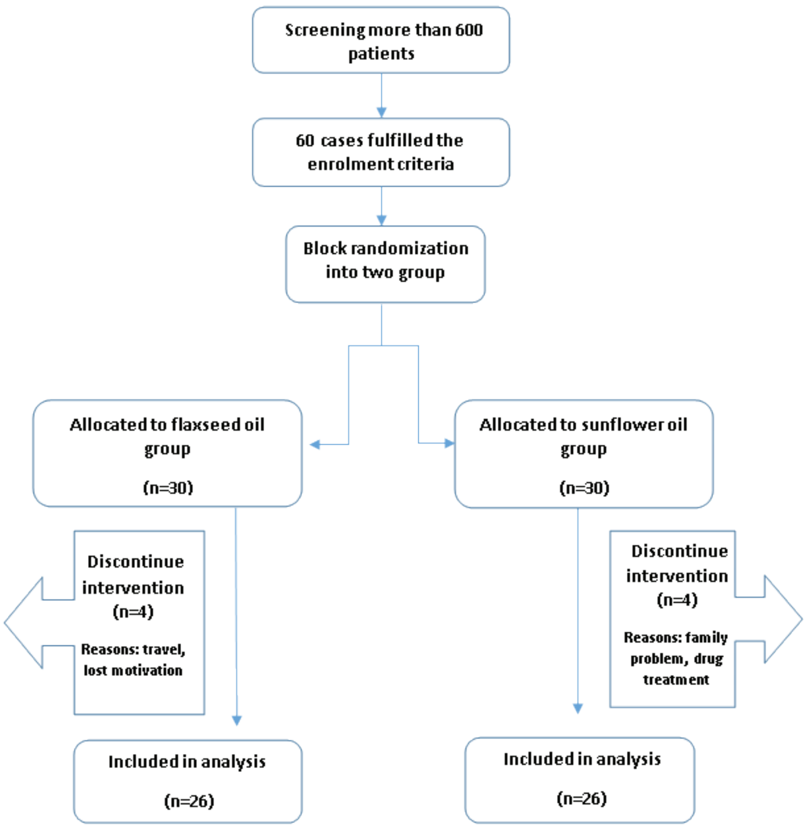

Figure 1. Consort fellow chart of the study population

Table 1. The Patients' Demographic Information. Data Are Presented as Mean ±SD

	Total	Sunflower oil	Flaxseed oil	P-value
Age (year)	48.62±6.6	48.8±6.4	48.3±6.9	0.773
Sex (M/F)	33/19	16/10	17/9	0.779

Table 2. Comparison of the Mean Values of the Study Variables Before and After the Intervention. Data Are Presented as Mean ±SD

Variables	Phases of intervention	Flaxseed oil group	Sunflower oil group	P-value	95% CI
Bodyweight (kg)					
Phases of intervention	Before	81.17±11.23	84.50±14.89		
	After	80.31±11.55	83.57±15.01		
	Change	0.85±1.90	0.93±1.52	0.879	0.88 – 1.03
P-value		0.030	0.004		
95% CI		0.08 – 1.62	0.31 – 1.54		
BMI (m^2/Kg)					
Phases of intervention	Before	28.68±3.99	29.74±4.29		
	After	28.38±4.14	29.41±4.38		
	Change	0.29±0.66	0.33±0.53	0.853	0.30 – 0.36
P-value		0.030	0.004		
95% CI		0.03 – 0.56	0.11 – 0.54		
WC (cm)					
Phases of intervention	Before	99.42±6.95	101.85±10.73		
	After	97.15±7.89	102.69±11.75		
	Change	2.26 ±3.58	0.84±2.63	0.001	4.86 – 1.36
P-value		0.003	0.114		
95% CI		3.71 – 3.22	1.91 – 0.21		

BMI: Body Mass Index; **CI:** Confidential Interval; **WC:** Waist Circumference.

association between receiving ALA and abdominal fat [15]. Also, another research revealed a reverse relationship between receiving fish and abdominal fat [16]. In obese individuals, the ALA provided from flaxseed contributed to a rise in EPA and DHA blood levels without the need to consume fish and seafood. It also prevented the increase in weight, BMI, and WC [11].

Most of the interventional studies on humans and animals have indicated that although flaxseed oil did not reduce weight significantly, it could prevent or reduce extra weight gain observed in the control group at the same time. In the present study, weight reduction was observed in both groups, which could result from the dietary advice and calorie adjustments.

Prasad *et al*. conducted a study in 1997 and investigated 4 groups of rabbits: control group, flaxseed receiving group (7.5 gr/kg/

day), one group with 1% cholesterol in their diet, and the last group receiving 1% cholesterol diet with 7.5 gr/kg/day flaxseed. Weight gains were equal in the control and 7.5 gr/kg/day flaxseed receiving groups. However, no weight gain was observed in the group receiving the hyper cholesterol diet and flaxseed. They suggested that receiving flaxseed could prevent the weight gain effect of the high cholesterol diet [17].

The findings of the study by Tint *et al*. (2011) revealed that after 90 days of receiving a low dose of flaxseed oil (1.2 g/day ALA), no rise was observed in BMI compared to the same period of consuming corn oil. Meanwhile, corn oil consumption led to an increment in BMI. Currently, no ALA-containing oils, such as canola or soybean oils, were consumed by their participants before the intervention and, consequently, ALA deficiency was possible in their study population [18]. Vijaimohan *et al*. (2006) also came to similar results and showed that increase in the fat portion of the diet resulted in an increase in weight. Nonetheless, significantly less extra weight gain was observed in the flaxseed oil group in comparison to the soybean oil group [19].Ennsa *et al*. (2014) found that in a high-fat diet, enrichment with MUFAs or PUFAs with different n-3 and n-6 contents or increase in receiving ALA might lead to slight changes in the parameters related to obesity, adipose tissues function, and inflammation. After the liver, adipose tissues are the main secondary center for fatty acid synthesis. In spite of the changes in the adipose tissues' fatty acids contents following the changes in receiving dietary fatty acids contents, the diet indicated insignificant effects on adipose tissues function [12].

The PUFAs contribute to lipogenic gene expressions, such as fatty acid synthesis, but this contribution is specific to hepatocytes. The mechanism of action for PUFAs enriched diets, as a dietary intervention in fatty acid synthesis, has not been clarified and no changes were observed in mRNA fatty acid synthesis levels in fat cells. Despite no change in the function or volume of the fat tissue, the cell size might get minimized or change into a phenotype that can improve its function [12].

Considering insulin functions and anabolic effects, Pouteau *et al*. (2010) measured insulin levels in their study groups. Based on the results, the highest subcutaneous fat accumulation (80%), which is the biggest source of body fat, could be observed when 0.8% instead of 10% ALA-containing diet was provided in guinea pigs diet after birth. The 0.8% ALA diet group had higher insulin levels compared with the other group. This hyperinsulinemia might be related to the increase in adiposity, which may occur in many animal species and humans. Moreover, the eicosanoids resulting from fatty acids metabolism contribute to proliferation and differentiation of adipose tissues cells. Eicosanoids show various effects on different types of adipose tissues (visceral and subcutaneous). The content of diet or essential fatty acids deficiency might also have effects on intervention outcomes. For instance, smoking mothers had lower levels of ALA in their milk compared to non-smoking ones. These mothers also had a higher risk of extra weight gain in future [20].

Considering the aforementioned mechanisms, ALA can affect the weight or adipose tissues in several ways, including the direct effect of ALA, its long-chain metabolites, or the eicosanoids resulting from ALA metabolism.

In spite of the reverse relationship found between ALA and CVDs in some studies, the direct effects of ALA on weight have not been studied perfectly. Many epidemiological studies have revealed that BMI and WC were strongly associated with mortality and CVDs [11]. Therefore, further studies have to be designed considering the possible mechanisms involved in ALA effects on patients at high risk of CVDs, such as MS.

One of the strong points of our study was using a nutritional strategy to stabilize the patients' physical activities and dietary intakes. These strategies were consulting, planning, and monitoring the patients' diets during the study. The novelty of our study is also related to the use of the first cold press oil without any processing or extracting. On the other hand, our study had some limitations, including not checking insulin secretion, insulin receptors' response, sensitivity changes, and energy metabolism rate or indicators.

Conclusion

Flaxseed oil is a suitable replacement for saturated fatty acids. By replacing saturated oil with flaxseed oil, its beneficial effects will be more clarified. It can also be an appropriate substitute for the daily oil consumed by the patients who suffer from MS.

Despite the ambiguous mechanisms of action of ALA on visceral fat, it seems that flaxseed oil may have some beneficial effects on reducing WC.

Hence, it can be helpful in the prevention of MS and its adverse effects.

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Conflict of Interests

None declared.

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