Iranian Journal of Health and Physical Activity (2013) 4 (1), (57-66)

The Effect of Selected Aerobic Activities and Consumption of Omega-3 Supplementation on Plasma Concentrations of sICAM-1 and sVCAM-1 in Elderly Obese Women

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Received 28 October 2012 Accepted 6 January 2013

Abstract

Purpose: Obesity is considered a growing cause of cardiovascular diseases. The cellular and vascular cell adhesion molecules have been identified as the new inflammatory indicators of forecasting and predicting cardiovascular diseases. The purpose of this study, therefore, was to investigate the effect of selected aerobic activities and consumption of omega-3 supplementation on plasma concentrations of sICAM-1 and sVCAM-1 in elderly obese women.

Material and Methods: In a double-blinded study, 40 obese women (BMI ≥ 30) 55 to 65 years old, were selected in a non-random and easily-accessible way and were randomly categorized into 4 groups of 10 individuals: exercise-placebo, exercise-supplements, supplements, and placebo. Subjects in the supplement groups consumed 2080 mg of omega-3 supplement for 8 weeks and placebo groups used sunflower oil produced in Zachariah Company, as placebo. Exercise program included aerobic exercise activities at 45 to 60 percent of maximum heart rate for 8 weeks, three 60-minute sessions per week. After 12 h fasting in the pre-test and 48 h fasting after the last training session, blood sampling was conducted. Data analysis included paired-t test and two-way ANOVA and was carried out using SPSS software (version 16).

Results: The obtained results showed that there was a significant interaction between exercise and supplements in reducing serum sICAM-1 factor, suggesting that sICAM- 1 reduction was both influenced by the separate effects of supplements and exercise, and the combined intervention of both exercise and supplements which had a synergistic effect on reducing the concentrations of this inflammatory factor. In addition, serum sVCAM-1 decreased significantly only in the exercise-supplement group (combined) ($P < 0.05$).

Discussion and Conclusion: The results indicated that considering sensitivity and accuracy of new inflammatory indices, measuring these indicators could be useful in the diagnosis of inflammation and vascular disorders. Besides, regular aerobic exercise and omega-3 supplements are two effective and moderating factors reducing the level of adhesion molecules (sICAM-1 and sVCAM-1) and inflammation.

Key Words: sICAM-1, sVCAM-1, Cardiovascular diseases, Omega-3, Elderly women

Introduction

Approximately 12 million people annually lose their lives due to cardiovascular diseases [1]. There are a variety of cardiovascular diseases one of the most important being atherosclerotic: a progressive disease that begins in childhood with its clinical symptoms manifested mainly in adults and from the middle age on. This disease is the most common cardiovascular disease determined by the abnormal accumulation of lipids and fatty substances in the vessel walls causing obstruction, vascular stenosis and reduction of blood flow to myocardial muscle. Atherosclerosis is the major cause of mortality in the present world [2]. Therefore, treatment and prevention of its progression is significantly important. Although the known coronary heart disease increases the risk of sudden death to a great extent, it is not clinically recognized in more than half of the victims of sudden cardiac deaths before their death. [3]. Therefore, diagnosis of a new indicator can help identifying susceptible individuals. In this regard, researchers have introduced the intra-cellular and vascular adhesive molecules (sICAM-1 and sVCAM-1) as new inflammatory markers in predicting and forecasting cardiovascular problems [3, 4]. Connecting to the

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monocytes and their binding to the depth of endothelial, soluble Intercellular Adhesion Molecule-1(sICAM-1) and soluble Vascular Adhesion Molecule-1 (sVCAM-1) accelerate the formation of foam-like cells [5]. In recent reviews, changes in the levels of adhesion molecules caused by endurance exercises have been reported [6, 7]. For instance, Puglisi et al (2008) showed that 6 weeks of increasing physical activity in 50 to 70-year old men and women resulted in lipid profile improvements and reduction of serum levels of sICAM-1 [7]. Becky et al also (2010) conducted a study investigating the effects of a cardiac rehabilitation exercise program on inflammation and metabolic syndrome in 91 patients (with the mean age of 61 years) with cardiovascular diseases and indicated that participating in a 12-week cardiac rehabilitation exercise program was associated with a significant decrease in the plasma serum level of sICAM-1 [6].

The increase in the concentration of soluble adhesive molecules may impair immune system responses. These molecules may also act as mediators in the inflammatory process of atherosclerosis. On the other hand, the increase of cell adhesive molecules in obese patients plays a significant role in the development of endothelial dysfunction or atherosclerosis [8]. Bosanska et al (2009), after investigating the effect of the obesity and different fat reserves on the gene incidence of fat tissue (adipose) and protein levels of cell adhesive molecules, showed that obesity increased levels of sVCAM-1 and sICAM-1. The increase in the level of adhesive molecules in visceral fat may establish a new directional relationship between visceral fat and increased risk of cardiovascular damages [9]. disruption in the regulatory performance of the adipose tissue (especially in the inner visceral chamber) and obesity are associated with low-grade chronic inflammation, with the former being involved in the development of secondary metabolic complications associated with obesity, including atherosclerosis [8]. Thus, studies have shown that sICAM-1 and sVCAM-1 plasma concentrations in obese and overweight people are higher compared to those with a normal weight [9]. Among the ways to reduce inflammatory markers and prevent cardiovascular diseases, is using anti-inflammatory supplements [10]. Studies show that omega-3 fatty acids exert their anti-inflammatory effects through reducing the production of Eicosanoids-omega-6 and inflammatory cytokines (TNF, IL-6, IL-1 β) [11]. Omega-3 unsaturated fatty acids include essential linolenic fatty acids. Linolenic acid is metabolized in body and is converted into eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). The obese and diabetic patients have lower ability in converting linolenic acid to EPA and DHA. Complications of atherosclerosis, including coronary artery diseases, in these individuals are more common compared to healthy individuals [12]. The body eventually converts EPA and DHA to prostacyclin, which prevents formation of blood clot in vessels and causes vessel expansion.

The fatty acids also inhibit production of thromboxane A2 which acts as a vasoconstrictor and platelet collector [13]. In this regard, Hjerkinn et al (2005) in a study on hyperlipdemic individuals showed that daily consumption of 2/4 grams of EPA and DHA fatty acids for three years significantly decreased sICAM-1 concentration in the experimental group compared to the control group while no significant change was observed in serum levels of sVCAM-1 and sE-selectin [14].

Accordingly, and based on previous studies, this study was undertaken to investigate the effects of aerobic exercise and omega-3 supplementation on adhesive molecules in obese patients in order to help preventing cardiovascular diseases and promote public health.

Material and Methods

Statistical population and sample

The present study was of pre-test post-test, semi-experimental research with a control group. The participants included 40 non-active women, from a nursing home, aged between 55-65 years, with no previous history of regular physical activity in the past two years. These people were selected in a non-random way and from the easily-accessible samples. In a meeting with the participants, the manager, physicians, and nurses of the nursing centers, research objectives and methods were described, and a letter of invitation explaining the purpose and manner of conducting the research, along with consent forms of voluntary participation, and health and disease risk questionnaires were given to all the subjects. None of participants had a history or clinical signs of cardiovascular diseases, diabetes, and hypertension. They also did not take any specific medicine, dietary and pharmaceutical supplements. Anthropometric data of subjects are presented in Table 1.

Table 1: Pre- & post-test values of the anthropometric data of the study groups

Variable	Groups							
	Exercise-supplement		Exercise-placebo		supplement		placebo	
Age(years)	61.65±7.42*		60.71±4.81		59.66±4.39		60.38±5.33	
Height(Cm)	162.25±7.44		159.25±4.26		158.95±4.99		159.66±6.46	
Weight(Kg)	pre	87.78±5.41	pre	84.94±6.22	pre	85.36±5.12	pre	88.42±4.13
	post	84.22±5.21#	post	82.39±4.41#	post	84.62±4.13	post	89.48±5.41
Body Fat percentage	pre	33.78±3.60	pre	32.68±3.59	pre	30.62±4.07	pre	31.03±2.96
	post	29.21±5.04#	post	30.12±4.22#	post	29.24±5.12	post	32.16±4.35
BMI(Kg/m^2)	pre	32.56±2.37	pre	33.81±2.10	pre	32.24±3.67	pre	33.84±2.74
	post	29.24±2.21#	post	30.11±1.20#	post	30.08±2.13	post	32.44±2.12
VO2max(Ml/ Kg/min)	pre	25.12±5.18	pre	24.65±4.26	pre	23.65±3.48	pre	23.58±4.8
	post	24.74±4.19	post	24.02±2.37	post	23.01±2.37	post	23.12±2.37

*Data are expressed as Mean ± SD, # Significant compared to the pre-test values in each group ($P < 0.05$).

Nutritional status

The necessary nutritional data were collected using a 24-h dietary intake questionnaire (two working days and one day off in a week, to determine the average nutrient intake)in which all the participants were asked to write down everything they ate and drank in the past 24 h [15]. To help participants remember the exact amount of food eaten, household containers and modules were used. The questionnaire was completed for each participant in 12 non-consecutive days (3 times a week for 8 weeks). The food values were converted to grams using household scales' guide [16]. Each food was then coded according to the food-processor software program and was analyzed by a nutrition expert to evaluate the energy content and nutrients [15].

Research protocol

This investigation was a semi-experimental, double-blind study. The subjects were randomly categorized into 4 groups of 10 individuals: exercise-placebo, exercise - supplements, supplements, and placebo. Individuals in the omega-3 supplement groups consumed 2080 mg of omega-3 supplement in form of two Maxepa Forte capsules (DHA 210 & EPA 310 produced by the British company Seven Seas), for 8 weeks. The placebo group used 2100 mg of sunflower oil (produced by Zacharia Company) which contained12 % saturated fatty acids, 16 % unsaturated fatty acids with a double bond, and 71 % unsaturated fatty acids. The aerobic exercise program lasted for 8 weeks, and was conducted three sessions a week, with 45 to 60 percent of the subjects' maximum heart rate. The participants exercised with 0.45% of their maximum heart rate in the first three weeks. The intensity then increased to 0.55% in the fourth and fifth and ultimately reached 0.60% in the sixth to eighth week. It should be mentioned that these intensities were maintained during the original exercises and heart rate values during the warm up and cool down were lower than these intensities. Each training session included 5-min stretching, 10 to 15-min dynamic warm up, 20 to 30-min core exercises (e.g. brisk walking, soft and light running, motion and movement, and endurance training) and, a 10-min cool down and recovery. Maximum heart rate for each subject was calculated using the following formula:

MHR= 220 – age (years)

Each participant's heart rate was monitored during the training sessions using the Polar watch (model Pox 1000 made in Japan).

Laboratory methods

10 cc of venous blood was taken from subjects' left arm after 12 h of fasting at the pre- (beforethe study began) and post-test (48 h after the last training session) stages, in vitro, after 5 min of full rest, using sterile Venojek syringes containing the anticoagulant EDTA (Ethylene Diamine Tetra Acetic Acid). After collection, the samples were immediately placed on ice and were centrifuged at 1500 g for 15 minutes to obtain the plasma. Plasma was stored at -70 ° C for later analysis. sVCAM-1 and sICAM-1 were measured applying an enzymatic Immunosorbent method by Elisa Stat Fax 2100, using the ELISA kits (manufactured by BMS232TEN and BMS232 company ,Netherlands).

Statistical analysis

After conducting the appropriate tests to confirm the normality of the variables' distribution and the equality of variances, two-way ANOVA in a public linear model was done to determine the effects of exercise and supplement on the research variables. In case of any significant results post hoc Tukey test was used to determine the differences between the groups. To determine the difference between pre- and post-test values, paired t-test was conducted for each group. Statistical significance was set at $P < 0.05$.

Results

Anthropometric data

The results from statistical tests indicated that the post-test mean values of weight, body fat percentage, and body mass index (BMI) significantly decreased in the exercise- supplement and exercise-placebo groups after 8 weeks of intervention ($p < 0.05$) (Table 1).

sICAM-1

results from paired t-test showed significant changes in post-test sICAM-1 plasma levels in the exercise-supplement (P=0.004), exercise-placebo (P=0.012), and supplement (P=0.042) groups compared to the baseline values. However no significant difference in the sICAM-1 plasma levels was observed in the control group (p=0.367) (Table 2). On the other hand, the ANOVA results showed a significant interaction between exercise and supplement in reducing serum concentrations of sICAM-1 in obese elderly women ($p <0.05$). Thus, changes in sICAM-1 serum were affected not only by the separate effects of exercise and supplements, but also by the combined intervention of both exercise and supplements and this reduction was greatest in exercise - supplement (combined) group.(Table 3). Moreover, results from the Tukey test (tukey post hoc)also showed significant differences in the mean changes of this factor between exercise- supplement and supplement group (p =0.037), exercise - supplement and placebo (P =0.000), exercise and placebo (p=0.25) and supplement and placebo (p =0.05) groups. Maximum reduction and range of variation of this index also corresponded to the exercise-supplement group.

sVCAM-1

The results of paired t-test showed that, at the post-test stage, significant differences in the sVCAM-1 plasma levels were only observed in the exercise-supplement group (P=0.037). However, in the placebo group, post-test values of this inflammatory factor showed a mild increase within the natural range for this index, but this change was not significant (p=0.174) (Table 2). On the other hand, The ANOVA results showed that, the effect of supplement alone (regardless of the effect of exercise), and the effect of exercise alone (regardless of the effect of supplement) in reducing sVCAM-1 serum concentrations was not significant (p>0.05). while the interaction between supplement and exercise in lowering sVCAM-1 serum concentrations was significant (p<0.05). Thus, although changes in sVCAM-1 serum concentrations were affected by the separate effects of exercise and supplement, the combined intervention of supplement and exercise, had a synergistic effect on the significant reduction of sVCAM-1 serum levels in elderly obese women (Table 3). Moreover, results from the Tukey test (tukey post hoc) showed that differences in the mean changes of serum sVCAM-1 levels were significant comparing . exercise-supplement and placebo (p=0.001), and exercise and placebo (p=0.031) groups (p<0.05).

Table 2: A comparison of plasma sICAM-1 and sVCAM-1, before and after the implementation of exercises in different study groups

Parameter ** Variable	group	Training stages Pre-test	Post-test	p
sICAM-1 (ng/ml)	Exercise-supplement	285.602±53.701	212.400±32.213	0.004*
	Exercise-placebo	280.206±42.044	238.300±38.032	0.012*
	supplement	282.703±47.791	234.409±31.811	0.042*
	placebo	281.502±39.783	289.401±48.070	0.367
sVCAM-1 (ng/ml)	Exercise-supplement	722.302±50.622	689.800±44.674	0.037*
	Exercise-placebo	717.700±58.101	706.700±44.393	0.087
	supplement	737.111±33.811	719.803±19.328	0.102
	placebo	725.704±48.036	733.208±46.274	0.174

** paired-t test

* Significant at 5% alpha error level ($p < 0.05$).

Table 3: Results of ANOVA test, serum sICAM-1 and sVCAM-1 levels in different study groups

Parameter ** Variable	Source	Sum of Squares	df	Mean Squares	F	P
sICAM-1 (ng/ml)	effect of supplement	49006.225	1	4906.225	4.273	0.047*
	effect of exercise	11363.675	3	3787.892	3.299	0.033*
	intervention of exercise and supplement	19135.475	3	6378.492	5.555	0.003*
	Error	36746.400	32	1148.325	-	-
sVCAM-1 (ng/ml)	effect of supplement	11233.600	1	1123.600	1.134	0.295
	effect of exercise	67483.800	3	2261.267	2.283	0.048*
	intervention of exercise and supplement	93333.800	3	3111.267	3.141	0.039*
	Error	317000.800	32	9900.650	-	-

**two-way ANOVA test
*Significant at 5% alpha error level (p < 0.05).

Anthropometric data and adhesion molecules

The results of statistical tests indicated that there was a poor correlation between the baseline values of weight, BMI and body fat percentage, with resting levels of adhesive molecules. However, further relationships were observed between changes in the body composition indices and adhesive molecules' levels. Finally, a significant relationship was observed between sICAM-1changes and body fat percentage (P=0.02, R =0.58) and BMI (P=0.04, R= 0.73) changes (Table 4).

Table 4: Pearson correlation coefficient between initial levels and changes in serum sICAM-1 and sVCAM-1 levels, and body compositions

Variable	baseline level of sICAM-1	Changes insICAM-1	baseline level of sVCAM-1	Changes in sVCAM-1
Body wight	0.21	-	0.13	-
Changes in Body wight	-	0.42	-	0.26
BMI	0.09	-	0.28	-
Changes in BMI	-	0.58*	-	0.42
body fat percentage	0.12	-	0.36	-
Changes in body fat	-	0.73*	-	0.39

* Significant compared to the pre-test values at 5% alpha error level (p < 0.05).

Discussion

Our present study showed that after 8 weeks of doing aerobic exercise, inflammatory indices significantly decreased in elderly women. nutrient analysis also revealed that this decrease was not related to the participants' diet. According to the food processor software there was no significant difference in energy balance and sub-nutrient intake in the subjects during the 8 weeks of research time (table 5). It is well documented that cellular and vascular cell adhesive molecules play an important role in the evolution of atherosclerosis. Blood cell adhesion to the surface of arteries is one of the earliest events in the diagnosis of atherosclerosis disease process. In this regard, the level of adhesive molecules to blood fat level is considered a strong predictor of cardiovascular problems [17, 18]. The results of the present study also showed that the relationship between initial level of adhesive molecules and the participants' weight, fat percentage and BMI was not significant (p<0.05). But there was a significant relationship between changes in body fat percentage and BMI, and changes in sICAM-1. In one study, a relationship between obesity and sVCAM-1 in pre-pubertal period was reported, and some reasons explaining the inability of most studies in showing the initial relationship between the physical variables and adhesive molecules were expressed. Among the most important mentioned reasons was the relationship between serum level of adhesive molecules and those attached to the membrane. The relationship was not strong enough to pronounce the initial correlation between the variables. Decrease in the body fat percentage is one of the major factors leading to loss of adhesive molecules. It is specified that inflammatory factors release in adipose tissue is inhibited in response to decreased body fat percentage and increased anti-inflammatory cytokines [19]. Therefore, decrease in the body fat percentage as a result of physical activity and the probable exercises-induced decrease in inflammatory cytokines may be among the factors decreasing plasma adhesive molecules. Other factors such as decreased blood viscosity and consequently loss of shear stress, and decreased effects of IL-β and TNF-α Paracrine may also be considered responsible for changes in adhesive molecule levels [20].

Table 5: The comparison of mean energy and nutrient intakes in the study groups during the 8-week aerobic activity.

Nutrient	Intake				P
	Placebo	supplement	Exercise-placebo	Exercise-supplement	
Energy (K/day)	2125.14±412.13*	2214.63±81.1	2119.87±451.39	2193.39±617.72	0.27
Protein (g/day)	51.12±23.54	50.86±23.48	49.67±25.37	50.44±26.59	0.43
Carbohydrate (g/day)	231.16±87.81	233.12±87.51	231.86±87.55	239.23±119.67	0.13
Fiber (g/day)	17.08±10.43	17.21±08.77	16.78±15.06	18.40±10.35	0.12
Fat (g/day)	45.77±25.05	43.81±25.73	43.09±25.35	42.72±25.82	0.17
Cholesterol (mg/day)	97.49±154.02	98.89±152.12	96.65±146.26	99.29±143.09	0.184
Calcium (mg/day)	345.25±268.15	342.28±271.13	344.18±270.09	346.21±263.41	0.78
Vitamin C (mg/day)	70.93±26.72	69.40±25.12	71.69±28.31	68.58±28.12	0.11
Vitamin E (mg/day)	5.58±1.89	6.56±2.15	5.78±2.45	7.58±3.23	0.62
Selenium (µg/day)	59.3±25.5	61.4±26.6	60.6±25.7	58.1±23.09	0.14

Processing by the Food-processor software (FP2) and SPSS; *Data are expressed as Mean ± SD.

adhesive molecules in the adipose tissue may help serving and activating macrophages in case of obesity and the meaningful relationship between the number of adhesive molecules of visceral fat and BMI and CD68 may explain the relationship between internal visceral obesity and penetration of macrophages in visceral adipose tissue, and endothelial dysfunction. The macrophages transfer into is a factor responsible for the occurrence of chronic inflammation in visceral fat and insulin resistance [21]. Bosanska et al (2008) investigated the contribution of different fat storages in the production of adhesive molecules in obese individuals. 12 women with obesity class 1 (BMI= 30-40Kg/m^2), 13 women with obesity class 3 (BMI>40 Kg/m^2) and 14 slim women participated in this study. The results showed a significant increase in the observed BMI and CRP levels of blood glucose and insulin in the two obese groups. Total cholesterol levels in the two obese groups significantly decreased compared to the control group. (BMI > 40 Kg/m^2) There was not any significant difference between sVCAM-1 and sICAM-1 protein levels in subcutaneous fat. SVCAM-1 and sICAM-1 protein levels significantly increased in visceral fat of both obese groups compared to the control group and showed a positive relationship with BMI. SVCAM-1 concentrations were positively correlated with HDL cholesterol levels. SICAM-1 protein levels in visceral fat had a significant positive correlation with triglyceride (TG) and glucose levels. sVCAM-1 and sICAM-1 levels in visceral fat were significantly higher in obese women , however such a difference was not observed in subcutaneous fat. In general it was observed that both visceral and subcutaneous adipose tissue help produce adhesive molecules, and this production may be greater in obese patients compared to their lean counterparts. Adhesive molecules increase in the visceral fat may provide a new directional relationship between visceral obesity and increased risk of cardiovascular damages [22]. The findings of the present research were consistent with those of Bosanska et al in terms of a positive and significant relationship between BMI and sICAM-1 serum.

Another important finding of the present study was the significant interaction between exercise and supplement in reducing serum concentrations of sICAM-1 index in elderly obese women. Thus, changes in serum sICAM-1 levels were influenced by the separate effects of exercise and supplements, and the combined intervention of the two which had a synergistic effect on reducing the concentrations of this inflammatory factor ($p<0.05$). The response of inflammatory indices to exercise activities depends on factors such as intensity, duration and the type of exercise. For example, resistance training often does not exert significant effects on immune function. Petrido et al (2007) examined the effects of resistance training on serum concentrations of five cell adhesive molecules in 14 healthy young men (8 lean and 6 obese). The subjects exercised 3 sessions a weak, 10 repetitions, with an intensity of 70 to 75% of one maximum repetition. The results did not show any significant changes in the subjects' serum concentrations of P-selectin, E-selectin, sVCAM-1, sICAM-1, L-selectin, and selectin [10]. Many studies have shown that appropriate training programs in the long term have more beneficial effects on health compared to diets [23]. American College of Sports Medicine and the Center for Disease Control and Prevention, in a similar report has recommended at least 30 minutes of physical activity with a moderate intensity, preferably all days of the week for good health [24]. Meanwhile, the role of diets and nutritional supplements in enhancing public health and reducing the risk of diseases could not be ignored. Another way to reduce inflammation and prevent cardiovascular diseases is nutrition. Some nutrition experts believe that omega-3 fatty acid may relieve inflammation symptoms .

Omega-3 is an essential unsaturated fatty acid. As it is not produced by the body it must be received through nutrition. The exact role of omega-3 fatty acids in human health is still unclear. evidence shows that omega-3 plays an important role in brain development and function, and reduces inflammation and risk of acute illnesses. Researchers believe that omega-3 fatty acid supplements may reduce serum levels of inflammatory cytokines and improve exercise tolerance [25]. So far, no research has been done on the role of these two factors (exercise and of omega-3 supplementation) on adhesive molecules (such as sICAM-1 and sVCAM-1) in healthy elderly people. In this regrds, only a limited number of intervention-based studies were carried out with different participants and diets. For instance, Thompson, et al. (2012) showed that 20 weeks of exercise alongwith a diet high in protein and calories significantly decreased sICAM-1 and sVCAM-1 concentrations in obese women. They also reported that sICAM-1 reduction was further associated with body weight loss, while sVCAM-1 reduction was due to body weight loss and a decrease in testosterone [26]. Shorgern et al (2010) conducted a study on systemic and cellular inflammatory indices of 157 healthy middle-aged men. The participants were categorized into four groups including diet (N=40), exercise (N=39), combined diet and exercise (N=39) and control (N=39). Results showed that sICAM-1 concentrations significantly decreased in the exercise and the diet + exercise groups after 6 months of intervention, while sVCAM-1 concentration did not change significantly in any of the groups [27]. Significant reduction in adhesive molecules in these studies (which are consistant with results of the present study) represents the combined effects of exercise and appropriate diets on reducing the cardiovascular risk factor indices. Regular aerobic exercise reduces the level ofadhesive molecules and thus the risk of cardiovascular diseases, by reducing harmful LDL-C, TC, and TG fats and increasing HDL-C [28].

Studies have shown that muscle micro-injuries occurs less frequently in athletes as compared to non-athletes.Considering the role of cellular micro-injuries in the production of adhesive cells, sICAM-1 reduction following 24 training sessions was probably due to more consistency and fewer muscle micro-injuries in the participants. Another possible mechanism could be that regular exercise inhibits the release of inflammatory mediators TNF-α and IL-6 from adipose tissue by reducing sympathetic stimulation and increasing anti-inflammatory cytokines, which in turnreduces the concentration of cell adhesive molecules [10,29]. Thus in the present study, endurance exercise is likely to be associated with lipolisis increase and fat mass decrease, which could be a mechanism explainig the reduction of inflammatory mediators and cellular adhesive molecules [30]. However some research findings are not in line with the results of the present study. For example, in a study by Aizawa K et al (2009) it was shown that a 24-week program of behavioral adjustment and correction, exercise, diet and modification of life style in 89 diabetic patients, unlike changes in waist circumference, blood pressure and fasting glucose level, plasma sICAM-1 and sVCAM-1 levels remained unchanged [31]. Although the duration and type of training program in the present research was different from Aizawa K et al, it seems that regular and constant monitoring of the exercise intensity could have possibly led to changes in serum sICAM-1 concentration.

Yang et al (2012), in a review study also showed that omega-3 supplement significantly reduced serum sICAM-1 concentrations This effect was recognized in both healthy subjects and patients, and confirmed the hypothesis that omega-3 supplement may be effective in prevention and improvement of atherosclerotic [32]. In another similar study by Kooshki et al (2011) on hemodialysis patients, it was indicated that taking 2080 mg of omega-3 supplement for 10 weeks significantly reduced the concentration of sICAM-1 at the end of the tenth week, compared to the baseline values. While at the end of tenth week serum concentrations of sVCAM-1 showed a considerable decrease compared to its baseline level, this reduction was not statistically significant [33]. According to the related litreture and the findings of the present study it seems that the higher the initial concentration of the inflammatory markers is , the more likely it is to decrease due to the consumption of omega-3 fatty acids.

There is another possible mechanism explaining the effect of omega-3 fatty acids on reducing serum concentrations of sICAM-1. Here when inflammatory cytokines, especially TNF-α, connect to the receptors on the membrane of vascular endothelial cells, nuclear factor inhibitor $_{k}$B (I-$_{k}$B) is phosphorylated and consequently causes the separation of NF-$_{k}$B from an effective factor in different gene transcriptions known as nuclear factor $_{k}$B (NF-$_{k}$B) in cytoplasm. Then nuclear factor NF-$_{k}$B moves from the cytoplasm to the core and through binding to different genes including sICAM-1 and sVCAM-1 gene, leads to the expression of these genes which in turn increases sICAM-1 and sVCAM-1 synthesis. Preventing phosphorylation of I-$_{k}$Bs , omega-3 fatty acid inhibits $_{k}$B-NF separation and consequently reduces gene expression of sICAM-1 and sVCAM-1 in endothelial cells [35]. This reduction in turn decreases the number of I-$_{k}$Bs in endothelial cells' membranes and thus reduces their concentration in blood. The findings of this study could be justified with the mechanism mentioned above, since in this study omega-3 fatty acid suplement led to a significant decrease in the serum sICAM-1concentration.

Conclusion

In summary, the results of the present study indicated that 8 weeks of aerobic exercise along with omega-3 fatty acids consumption reduced the amount of body fat and inhibited the upstream processes of the production of new cardiovascular risk factors, which consequently reduced serum concentrations of these factors, minimizd the negative effects of inflammation in elderly obese women. Accordingly, determining the amount of adhesive molecules (sICAM-1 and sVCAM-1) could be an effective tool in detecting different environmental factors involving in cardiovascular disorders such as atherosclerosis, their prevention andcontrol.

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