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The Effect of Continuous and Interval Aerobic Trainings on Body Mass Index and Serum Levels of ICAM-1 and VCAM-1 in Men with Heart Failure

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Abstract

Introduction: Adhesive molecules of cellular markers have been applied to identify the process of formation of atherosclerotic plaque of vascular endothelial wall. The present research aimed to evaluate the effect of continuous and interval aerobic trainings on body mass index and serum levels of ICAM-1 and VCAM-1 in men with heart failure.

Methods: In the present research, 42 middle-aged men with heart failure were purposefully and randomly divided to three equal groups (each 14 participants) including continuous, periodic, and control aerobic exercises. Continuous exercise (with the intensity of 45-70% maximum heart rate) and periodic exercises (with the intensity of 45-80% of MHR) were done for 3 days a week, with a total term of 8 weeks. Before and after the implementation of the exercise plan, blood samples were taken from three groups. Data were analyzed by one-way ANOVA ($P \leq 0.05$).

Results: Comparison of mean of intra-group indicated a significant decrease in the level of cellular adhesion molecule-1 and vascular adhesion molecules-1 and body mass index in the exercise groups ($P \leq 0.05$). In Intragroup comparison, the two groups of exercise, VCAM-1($P=0.0001$) and body mass index ($P=0.002$) were significantly decreased, but no significant change was observed in ICAM-1($P=0.107$). Decrease in VCAM-1 levels and BMI between the two exercise groups were more significant than the control group, but there was no significant difference between the two groups of periodic and aerobic.

Conclusion: With decreasing BMI and VCAM-1 levels, aerobic exercises may have a significant role in the prevention and control of cardiovascular disease in patients with heart failure.

Keywords: ICAM-1, VCAM-1, BMI, Aerobic Training, Heart Failure

Introduction

Heart failure as a consequence of a variety of cardiovascular diseases has been the main cause of many death cases and illnesses in patients with cardiovascular diseases (1). With the increase in the age of society, the epidemic of heart failure status is in a crisis status, and despite widespread use of drugs and the use of different therapies for treating patients suffering from heart failure, the treatment outcomes are below the optimal level. According to the European magazine of heart failure, about 80% of men and 70% of women at age 65 and older die after the diagnosis of heart failure (2). Today, knowledge about heart failure has changed from its simple definition in the form of heart failure to a complex disease that affects various systems of the body (3). Heart failure is now a systemic condition that begins with impairment in the heart working process which causes a greater disruption of the body's organs, including the cardiovascular system, skeletal muscle, kidney, nervous and

endocrine, immunity, homeostasis and inflammation (4). Obesity and sedation are of the factors involved in the development of cardiovascular disease (5). Research findings indicate that the risk of cardiovascular disease increases by eight percent per unit of body mass index (BMI). On the other hand, with the increase in physical activity, the probability of these diseases is reduced by up to 8%, and sport activities reduce fat and BMI in healthy and sick individuals (6). It should be stipulated that researchers have argued that early diagnosis of cardiovascular disease, especially atherosclerosis, plays a significant role in the prevention and treatment of cardiac patients. The extension of cardiovascular diseases has increasing trend and chronic inflammation plays a significant role in the development and extension of atherosclerosis, in a way that with the onset of inflammation in the vessels and endothelial activation and the synthesis of pro-inflammatory proteins such as chemokines and, consequently, increase in the gene expression and the appearance of adhesive molecules and endothelial binding molecules at the level of active endothelial cells, the appearance and inflammation of the cells into the arterial wall starts and the process of atherosclerosis starts as well. Previous studies on heart failure have focused on the role and function of biomarkers and complex clinical pathways involved in cardiac pathophysiology. Among the biomarkers candidate in heart failure, it is probably more important to examine the predictors of heart failure (7). These biomarkers are classified into inflammatory biomarkers, oxidative stress, neural hormones, extracellular matrix remodeling, myositis stress, myocytosis apoptosis, or external cardiac disorders (8).Through the increasing number of studies conducted in recent years to evaluate appropriate inflammatory markers associated with atherogenesis, one of the most sensitive cellular markers in identifying the formation process of atherosclerotic plaques in the vascular endothelial wall is cellular and vascular adhesion molecules (9). The binding of monocytes to the endothelium via vascular cell adhesion molecule-1 and the intercellular adhesion molecule-1 and their movement to endothelial depth and accelerating the formation of inferior cells, the first markers have been atherogenic and have therefore been given special attention and many studies have reported the interconnection between adhesive molecules and acute or chronic arterial vascular disease. Many researchers have found that increased levels of soluble molecules are associated with an increased risk of infarction, both in healthy people and in patients with heart failure (10). In the early stages of the disease, an inflammatory process has been developed that monocytic adherence to the endothelial is done through VCAM-1, ICAM-1 and Selectins, and by the deformation of monocytes into macrophages and sponge cells and plaques. Consequently, the rise in adhesion molecules that exists at the endothelial surface of the cells causes inflammation in the cell wall, which in turn causes the heart's stroke, followed by the inability of a part of the heart muscle known as heart failure. Signorelli *et al.* (2003) investigated and studied the changes in blood cytokines and cellular adhesion molecules in patients with peripheral arterial disease after the exercise test (Treadmill). The findings indicated that ICAM-1 and VCAM-1 levels of cardiovascular risk factors were higher in patients than control group and after exercise in each group; the mentioned variables were associated with a significant increase. These results confirmed that increased white blood cell activity is a symptom of systemic atherosclerosis, as inflammatory markers increase in blood pressure levels (11). In this regard, previous studies have proved that sport activities, proper care and regular medical examinations lead to longer and better quality of life, and sport activities guide encourages people with low mobility to participate in activities to improve the performance of the Cardiovascular system. Performing more exercise can reduce chronic inflammation at low levels and may be a good lifestyle

intervention to prevent cardiovascular disease (12). Concerning the effects of exercise on inflammatory markers of risk of cardiovascular disease and vascular endothelial activity and adhesion, many studies have examined the effects of sport activities on these indices in individuals and species. Most of the results have shown that, inflammatory responses (thus reducing the predictive features of cardiovascular disease) are inhibited after regular aerobic exercises (13). Contradictory results are achieved in the connection with the interrelationship of sport activities and adhesive molecules. In a study, the effect of 12 weeks of biking exercise on environmental inflammatory indexes in patients with chronic heart failure was studied and stated that daily exercise of 30 minutes, for 5 days a week on a bicycle with a 70-80% maximal heart rate significantly reduced the levels of ICAM-1 and VCAM-1; thereby, it resulted in reducing the inflammatory factors of the environment (14). In the study of the effect of 10 weeks of intermittent exercise with moderate intensity versus continuous aerobic exercises program on cell adhesion molecules in patients with heart failure, in both groups, there was a significant reduction in the level of adhesion molecules (15). It was also shown that after 14 weeks of aerobic exercises of 50 minutes (each session including two-minute frequencies of high-intensity aerobic exercises of 75-90% and 55-65% heart rate reserve); healthy women indicated no significant change at the level of plasma complex molecules (16). Despite a wide range of studies on the impacts of exercise and aerobic exercises on various aspects of physical and mental health, most studies have investigated continuous exercises and only a few studies have considered periodic exercises. According to Pate *et al.* (1995), the majority of the public believes that the exercise should only be carried out over a continuous period and maybe this is one of the reasons why people are not involved in the exercises (17). Periodic exercises do not have a continuous and boring mode of continuous exercise and they are more attractive in result of time savings because one of the reasons why adults do not participate in regular exercises is that there is not enough time and it seems that doing aerobic exercises can be enjoyed by people. A wide range of studies have indicated that more people will participate in exercises with periodic exercises, as well as a further reduction in inflammatory indices (18). In this regard, Friedenreich (2016) also examined and compared the effects of high volume exercises with moderate-intensity exercises on inflammatory marker changes, which reduced inflammatory markers in subjects who had been practicing more during the week than in Subjects who had a shorter duration of activity per week (19). Regular physical activity can therefore be considered as a treatment plan, and its main advantage is helping to maintain health, reducing and delaying the recurrence of many cardiovascular diseases that can be used. Given the controversial results of recent studies on cardiovascular responses to exercise in the last decade, as well as the limitations in some studies, one should seek to determine the activity of regular aerobic exercises with an appropriate intensity and a specified period among the community of people to provide a good model for improving and maintaining health in people. Regarding the low mobility of patients with heart disease and the high prevalence of these diseases through the country, the researcher considers the positive results of performing regular aerobic exercises activities in reducing cardiovascular complications and with a preventive approach in active lifestyle, the effect of two continuous and aerobic exercises methods on changes in body mass index and serum levels of ICAM-1 and VCAM-1 in men with heart failure to express appropriate non-pharmacological therapies for preventing and reducing disease.

Methods

The present research method was designed with pre-test and post-test designs in three groups and in semi-experimental mode. The

statistical population in this study was all male patients with heart systolic dysfunction who were under the control of one of the cardiology clinics of Mashhad. After recalling and inviting to participate with the approval of specialists, 42 people from men who aged 50-60 years old with heart failure grade 1 to 3 and with heart rate less than 45% (inclusion criteria) were selected using selective and purposeful sampling and were randomly divided into three groups of continuous aerobic exercises (14 people), periodic exercise (14 people) and control (n = 14), and to hide the random allocation, encoded boxes with random sequence were applied. In this study, the alpha value of 0.05 was determined for each group of ten to estimate the sample size of G Power software and considering the 0.8 test power, but considering the probability of sample drop and to increase the accuracy of the research, 14 participants were considered for each group. In order to comply with the ethical charter before sampling, all volunteers learned verbally about the nature and manner of carrying out their work and its possible risks, and the essential and major points about nutrition, physical activity, illness and drug use and they were reminded to be careful about its observance. They were informed of the fact that at any time they will be allowed to leave this study unconditionally; they will be ready to complete the written consent form of the company. This research was conducted at the Iranian Center for Clinical Trials (IRCT20180721040545N1) and that the Ethics Committee of the Research Institute of Sport Sciences (IR.SSRI.REC.1397.214) approved the study. It is to be noted that having a history of heart disease for less than 5 years, a history of regular exercise during the past six months, and performing other exercises along with the exercises during the study period were criteria for leaving this study. All items of age, height, weight, and body mass index were recorded at a coordinated session. Weight of volunteers was measured using Seca scales with the least clothing, no shoe, standing in the middle of the scales, and the placement of hands along the body, eyes and face forward. The height of people was recorded with a Seca timer with a precision of 0.1 cm with no shoe conditions. The weight distribution (kg) to height (2 m), BMI was calculated after measuring the height and weight of the subjects. For examining the biochemical variables, subjects were requested to appear one hour prior to the beginning of the exercise program at the laboratory site, then a blood sample with 12 hours of fasting, recording the ambient temperature and the test hour (to maintain the conditions in step Pre-test), 5 ml of blood was taken from the right hand vein of the subject after 5 minutes in the sitting position on the chair and that at the time of sampling, at the time of sampling, twenty four hours before the start of the tests have no intense physical activity and have enough rest. An experiment was performed 48 hours after the last exercise session with the same pre-test conditions in order to reduce the fatigue interference. It is notable that in order to reduce the nutritional interference in the pre-test and post-test, we tried to write nutrition 24 hours prior to the start of the experiments and, as far as possible, feed on the post-test stage. Blood samples were taken by the nurses of the center. After centrifugation and serum separation, serum was placed in microtips and stored at -80 ° C until the data were analyzed in two steps. Descriptive and physiological measurements of the subjects were taken after blood sampling. Then, continuous and periodic aerobic exercises groups participated in the exercise program for eight weeks and weekly three sessions of intensity and duration. The test subjects were regularly monitored during the exercise by a cardiologist and during each exercise session. The physicians were physicians and nurses in the rehabilitation department and complete control of the person's vital signs. Levels of adhesive molecules were measured and analyzed using ELISA commercial kit of Bender Med System in Austria, with a sensitivity of 2.17 ng/ml and Elisa Reader. The exercise program was based on the individual's ability and after performing an exercise a test was given to determine the

range of heart rate and the level and intensity or speed of the treadmill and resistance and the wattage of the fixed bicycle for each subject. In accordance with the principles of the design of the workout, the College's advice of American College of Sports Medicine (ACSM) includes a progressive increase in work load, a diversified schedule, an individualized and targeted schedule (to increase functional capacity), and according to the expert opinion, as well as by examining and modeling the maximum of the study. Continuous aerobic exercises were performed for eight weeks, and three sessions per week, and each session lasted between 30 to 50 minutes with intensity 45-70% of maximum heart rate, which was designed using treadmill. The periodic exercise program was also designed for eight weeks, three sessions per week, and with an intensity of 45 to 80% of the maximum heart rate, which was designed using treadmill and wheelchair. Subjects underwent 5 to 10 minutes of rest between sequences, according to individual conditions. At the beginning of each session, 10 minutes of stretching and relaxation were performed with the aim of warming up. During the exercise, the subjects were monitored and the intensity of exercise was monitored and recorded using their heart rate and ECG, then at the end of the exercise, using the movements stretching cold. The practice protocol is given in Table 1 (20). To analyze data Shapiro-Wilk, paired sample t- test, one-way ANOVA with Tukey's post-hoc tests used ($P \leq 0.05$).

Results

Table 2 indicates the demographic features of the participants in the three groups. The data obtained from the Shapiro- Wilk test exhibited the distribution of data in all variables in the normal group ($P \leq 0.05$). Levene's test findings also indicated that the variance of groups is equal in all variables ($P < 0.05$). According to Table 3, the correlation t-test indicated a significant reduction in the BMI, serum levels of cell adhesion molecule 1 and vascular adhesion molecule -1 after an eight-week intervention in the two groups of continuous and periodic aerobic exercises ($P \leq 0.05$). However, there was no significant difference between the pre-post and post-test findings in the control group. Compared to the intermediate mean, a significant difference was found in the body mass index ($P = 0.023$) and vascular adhesion molecule -1 ($P = 0.0001$), but no significant difference was observed in the serum levels of cell adhesion molecule -1 ($P=0.107$).

Table 1. Exercise protocol used in the research study

Exercise Plan	Type of Vehicle	Variable	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Continuous aerobic	Treadmill	Intensity (%)	45-50	50-55	55-60	55-60	60-65	60-65	65-70	65-70
		Intensity (%)	30	30-35	30-35	35-40	35-40	40-45	40-45	45-50
Periodic aerobics	Treadmill	Intensity (%)	45-50	50-55	55-60	60-65	65-70	70-75	75-80	75-80
		Duration (min)	10-12	10-12	12-15	12-15	15-18	15-18	18-20	18-20
	Fixed Bicycle	Intensity (watt)	15	15	20	20	25	25	30	30
		Duration (min)	10-13	10-13	13-15	13-15	15-17	15-17	17-20	17-20

Table 2. Demographic features of the participants in the three studied groups (mean±SD)

Group Variable	Continuous aerobic exercise	Periodic aerobic exercise	Control
Age(year)	57.07±3.31	57.21±3.37	57.85±2.79
Height(cm)	172.92±3.97	171.85±3.67	171.64±3.41
Weight(kg)	83.42±4.76	83.78±4.79	84.50±6.04

Table 3. Comparison of Inter-group and intra-group changes in the three groups before and after eight weeks of intervention

Group Variable		Continuous aerobic exercise (mean±SD)	Periodic aerobic exercise (mean±SD)	Control (mean±SD)	F	P
Body Mass Index (kg/m2)	Pretest	1.37±28.01	1.61±28.38	1.94±28.68	7.11	0.002**
	post-test	1.52±27.34	1.76±27.36	1.67±28.96		
	T Intra-group	4.069	3.336	1.053		
	P Intra-group value	0.001□	*0.005	0.311		
ICAM-1 (ng/ml)	Pretest	273.99±9.66	274.03±11.14	270.60±11.86	2.37	0.107
	post-test	268.72±9.66	265.55±12.28	267.25±13.94		
	T Intra-group	4.189	5.059	1.837		
	P Intra-group value	*0.001	*0.0001	0.089		
VCAM-1 (ng/ml)	Pretest	1179.5±92.38	1181.85±140.96	1144.71±126.36	10.12	0.001**
	post-test	1109.46±119.99	1071.42±123.76	1184.07±107.01		
	T Intra-group	2.235	7.862	1.501		
	P Intra-group value	*0.035	*0.0001	0.157		

The significance level is P≤0.05

* Significant mean of intra-group meanings

** Significant meanings of intermediate groups

Table 4. Significant results of Tukey's post hoc test, BMI and VCAM-1

Intragroup difference		BMI	VCAM-1
Periodic exercise	Continuous exercise	0.593	0.483
Control group	Periodic exercise	0.002	0.001*
	Continuous exercise	0.029	0.008*

*Significant difference at p≤0.05

Tukey's test results (Table 4), BMI and VCAM-1 levels indicated a significant difference between the aerobic exercises group and control group, and also between the aerobic exercises and control group ($P \leq 0.05$). However, there was no significant difference between the post-test results between the two groups of periodic and continuous aerobic exercises.

Discussion

The research findings on the impact of aerobic exercises on body mass index indicated that eight weeks of continuous aerobic exercises and periodic exercise had a significant effect on the level of BMI ($P \leq 0.05$). BMI in the periodic exercise group ranged from 28.38 kg/m2 to 27.36 kg/m2 (rated 3.59%) and in the continuous exercise group from 28.01 kg/m2 to 27.34 kg/m2 where the size dropped by 2.39%. it is notable that the aerobic exercise program on the level of adhesion molecules did not significantly differ in serum ICAM-1 level in subjects with heart failure. The findings of this study indicated that ICAM-1 in the continuous exercise group was 273.9 ng/ml to 267.8 ng/ml which is equivalent to 2.25% reduction in the periodic exercise group 274.03 ng/ml to 265.5 ng/ml corresponding 3.10%, but this decrease was not significant between the tested groups. On the other hand, this sport intervention resulted in significant changes in serum levels of VCAM-1. The serum level of vascular adhesive molecule-1 in the continuous exercise group was 1179.5 ng/ml changed to 1109.4 ng/ml, equivalent to 5.94%, in the periodic exercise group from 1181.8 ng/ng/ml to 1071/4 ng/ml, equivalent to 9.34%. There is a wide range of evidences that there is an inter-correlation between the increase in vascularinflammatory factors and the risk of cardiovascular disease ICAM-1 and VCAM-1 from the family of immunoglobulins play role of a key factor in the gradual passage and penetration of leukocytes into inflammatory injuries and an increase in endothelial activity. These inflammatory agents expand from damaged vascular cells or leukocytes. Note that leukocytes stop at the site of inflammation by binding to adhesive molecules and enter the endothelial wall and cause inflammation. Existing information recommends that these molecules, in addition to being at the start of the process of atherosclerosis, may have a negative effect on the healing process of heart patients. In previous studies, the increase of cellular adhesion molecules in heart failure patients at risk for ischemic disease has been documented that inflammation includes leukocyte activity has a pathogenic role in the development of heart failure, and adhesive molecules and selectin are an important mediator of leukocyte adhesion to endothelium vascular, chronic inflammation leads to vascular failure and this process takes leukocyte activity and adherence to vascular endothelium (19). Carbon *et al.* (2016) evaluated the capacity of aerobic exercises and its association with obesity indices in patients with heart failure. His results indicated that in the group of patients with BMI and in particular the levels of FMI and leptin levels, sporting abilities and capacities were lower, and caloric restriction and physical activity resulted in weight loss and decreased BMI and improved Vo2. Generally, these data suggest that reducing exercise capacity in patients with obesity or overweight may be related to any specific cardiac function disorder, and that obesity is a condition that is likely to increase the workout capacity in the inferiority Heart restricts (21). Previous research findings have indicated that the expression and concentration of adhesion molecules in the circulation are affected by factors such as stress, smoking, lifestyle, nutrition, antioxidant use, diabetes, alcohol consumption, obesity, and environmental conditions and physical activity. And more controlled studies are needed to make a decisive conclusion about the effect of the exercise on these indices. Physical activity and appropriate sports exercises to reduce the risk factors are important in cardiovascular patients. It has been argued that regular exercise and long-term exercise can reduce

inflammatory factors and the prevalence of cardiovascular disease (22). However, the findings we obtained in this study are consistent with research findings in that sport exercises lead to a reduction in body mass index and inflammatory markers, but with some results from previous studies did not match. In this regard, most of the results of previous studies indicate that sport activities reduce the percentage of fat and BMI in healthy individuals and patients (6). In their study, Behboudi *et al.* (2017) examined the impact of six weeks of aerobic exercise on physical activity and serum IL-10 levels. In the experimental group, there was a significant decrease in body weight, body mass index, body fat percentage and abdominal obesity, and aerobic exercises Short-term moderate to severe severity leads to a decrease in indices of obesity and an increase in serum levels of IL-6 in individuals (23). Mahdizadeh *et al.* (2016) examined the effect of 8 weeks of aerobic and low resistance exercise on anthropometric indices of obesity (body mass index, waist circumference, waist to hip ratio, waist to height ratio, fat percentage, arm circumference, Hip circumference, hip circumference) on overweight middle-aged subjects. The aerobic exercises with a 60% maximum heart rate had a positive effect on these indices, especially BMI (24). Lee *et al.* (2015) evaluated the impacts of eight-week exercise on body composition and risk factors for cardiovascular disease, which indicated a significant decrease in body fat percentage and body mass index at the end of exercise program. Additionally, the level of C-reactive protein in the combined exercise group (aerobic and resistance) was significantly lower than the aerobic group alone, while IL-6, tumor necrosis factor and cholesterol levels were significantly lower in both groups (25). On the other hand, Youssefi *et al.* (2017) in a clinical study to evaluate the effect of aerobic exercise with supplemental supplementation on lipid profiles and glucose indexes of overweight men, aerobic exercises led to a significant reduction in lipid profiles but changed BMI did not respond. It is to be noted that, the results indicated that aerobic exercise with supplementation had a greater effect on the variables in question than aerobic and complementary exercises alone. The unchanged BMI is likely to be due to an increase in body fat (26). Esmaili *et al.* (2016) investigated the effect of aerobic exercise on IL-6, insulin resistance and glucose, indicated that eight weeks aerobic exercises had a significant effect on body mass index, fat percentage, interleukin-6, insulin resistance and glucose The findings of these researchers indicated that the effect of exercise fitness program (body mass index, waist and fat ratio) and weight loss, the role of physical activity time was greater than the effect of exercise intensity, and the total time of physical activity during the week was an important factor In improving the health and safety of individuals (27), as well as Rabi'i *et al.* (2015), with the aim of determining the effect of aerobic exercise on blood specimens and markers Inflammation, their subjects were randomly assigned to the aerobic exercises group and the control group. Exercise exercises consisted of 5 sessions per week with intensity of 50% - 70% of maximum heart rate and 25 minutes of walking. Findings indicated that there was no difference in BMI between groups after 8 weeks of aerobic exercise. He claims that regular aerobic exercises can improve lipid profiles and reduce risk factors for cardiovascular disease in diabetics. However, the results of this study are based on the inconsistency of BMI, which indicates that this lack of BMI can be due to lack of accurate control of diet in participants and differences in subjects in two studies (28). From another point of view, Pearson *et al.* (2018) in their systematic review of the effects of aerobic and resistance exercise on inflammatory markers in patients with heart failure. Twenty studies, representing 18 independent trials, are included in this review. Two-way data from six studies indicated the positive effects of exercise exercises on VCAM-1, IL-6, CRP, TNF-**α** index. However, due to the complexity

of heart failure and the pathways involved in the immune and inflammatory process, more tests are needed for the cause of the illness, concomitant disease and musculoskeletal inflammation; so that the anti-inflammatory effects of the exercise in this population are well make it clear (29). Some of the contradictions in the results of studies can be related to the severity of the disease involved in each study. In this regard, Sabatier (2008) did not show a significant difference in performance after fourteen weeks of regular aerobic exercise on serum ICAM-1 levels (16), and Ranković (2009) also evaluated the effect of physical activity on inflammatory parameters in patients with heart disease, there was no change in ICAM-1 serum levels after three weeks of aerobic exercise at the rehabilitation center and three weeks in the home. Haghir (2017) also stated that eight weeks of aerobic exercises exercise on the level of ICAM-1. Middle-aged men had an effect on heart failure, but no significant decrease was observed in the level of VCAM-1 and CRP molecules in cardiac dysfunction (31). His results are consistent with the results of this study, because they are somewhat similar in terms of subjects and severity and duration of exercise. Ribeiro (2012) stated that after two months of aerobic exercise, the mean level of VCAM-1 in the experimental group was significantly reduced, indicating that this decrease was associated with an increase in anti-inflammatory cytokines (32). On the other hand, Aksoy *et al.* (2015) investigated the effects of a 10-week intermittent, intermittent exercise program versus an ongoing aerobic exercises program on cellular adhesion molecules in patients with heart failure. In-group results revealed significant changes in ICAM-1 and CRP in the two groups Exercise and significant changes in VCAM-1 were observed only in the routine exercise group and reported intergroup findings of insignificant differences among the studied groups (15). The results of the present study are based on the results of a non-identical X-ray study that probably relates to the duration of the exercise and the level of disease in their subjects. A recent study indicates that intense periodic exercises with moderate intensity exercises lead to a greater change in body mass index. This relationship between CRP inflammatory factors with BMI and fat content does not detract from the further reduction of the CRP index of the periodic group, which can be related to the increased activity of catecholamines and, consequently, to stimulate the lipolysis process (33). Note that, changes in the level of adhesion molecules and inflammatory markers following exercise in the research paper have different results. The most important contributing factors in the differences between researches can be the duration of research intervention, the intensity and practice of the exercise program, and the gender and bases of the inflammatory indexes of the subjects. Regarding the fact that the subjects of this study were patients with heart failure and the baseline levels of these indices were high, the intensity and duration of exercise were not sufficient to significantly decrease the level of ICAM-1. One of the limitations of this study was the lack of diet control, although there were recommendations for controlling it, the lack of control of stress and mental and psychological problems of subjects and the lack of control of genetic features and the level of motivation of subjects during the measurement can be noted that it may have an effect In the results, the antioxidant use and nutrition of the subjects were not measured in this study, and the probability that these variables would affect the lack of significant change in ICAM-1. Concerning the mechanisms of reduction of postoperative adhesive molecules, this decrease seems to be due to a decrease in the body fat percentage and BMI of the subjects. Since adipose tissue secretes pro-inflammatory cytokines, and since TNF-**α** and IL-6 are produced and released in adipose tissue, they affect endothelial function and produce or express the gene expression of the chemokines and adhesive molecules Provoke. It seems that reducing body fat percentage leads to a

decrease in TNF-**α** and IL- 6, and reducing these cytokines reduces the production and secretion of adhesive molecules. In pathologic conditions, when increased levels of tight molecules are observed, regular exercise exercises can improve and improve endothelial function by reducing inflammation due to leukocyte adhesions and platelets to the endothelial system (34). Physical activity induces changes in the level of adhesion of the cellular adhesion molecule by increasing the shear pressure and expression of nitric oxide and ultimately leading to improved endothelial function (35). Lower levels of inflammation due to compatibility with exercise may be related to the antioxidant effects of exercise, there is evidence of research that shows that aerobic and endurance exercise increases the oxidative stress by significantly increasing oxidative stress reducing the sympathetic stimuli and increasing the anti-inflammatory cytokines can reduce ICAM-1 and VCAM-1 concentrations (12). However, since none of the cases mentioned in this study have been measured, it cannot be stated that they have a relationship and their effect on the significant non-significant difference between cellular adhesion molecules-1. This is to recommend an aerobic exercises program with a controlled diet with varying intensity and duration of exercise on inflammatory indices studied along with lipid and atherogenic indices for future studies, and also take into account Antioxidant status of aerobic exercises (by measuring important antioxidant indices) Further studies are needed in heart failure.

Conclusion

It seems that in present study by decreasing BMI and VCAM-1 levels, aerobic exercises may have a significant role in the prevention and control of cardiovascular disease in patients with heart failure.

Ethical issues

Not applicable.

Author s' contributions

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

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