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Effects of Aquatic training on body composition and inflammatory markers in obesity elders

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Abstract:

Background: There is limited information on the association of aquatic exercise training with CRP and IL-6 levels in elders. Therefore, this study aims to evaluate the effects of 8 weeks Effects of aquatic training on body composition and inflammatory markers in obesity elders.

Materials and Methods: In a quasi-experimental study and pretest and post-test design, 31 obesity elder's males (mean ± SD, age: 66.97±5.26 years and body mass index: 30.84±0.69 kg/m^2) were randomly into two aquatic exercise group (n=16) and control group (n=15). Exercise group performed an aquatic exercise program three sessions per week, with and intensity of 50-75% MHR, 60 minutes per session for eight weeks. Weight, BMI, PFB and serum levels of CRP and IL-6 were measured before and after the study period. The data were analyzed using paired sample t test and analysis of ANCOVA at the level of less than 0.05.

Results: After 8 weeks intervention, there was significant decreases in weight, BMI, PFB, CRP and IL-6 serum levels in the aquatic exercise group compared with baseline values (p >0.05). However, ANCOVA test showed a significant decrease in PFB and CRP serum levels in the aquatic exercise group compared to the control group after intervention (P<0.05).

Conclusion: The findings suggest that 8 weeks of aquatic exercise program were an effective and safe method of improving the inflammatory markers in in obesity elders. However, more research with more control is needed to determine the effects of this non-pharmacological intervention on inflammatory markers.

Keywords: body composition, CRP, IL-6, aquatic exercise, obesity, elders.

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Introduction

Obesity in old age is associated with many physical and psychological complications, including cardiovascular diseases, diabetes, hypertension, increased blood cholesterol and triglycerides, arthritis, anxiety, depression, and certain types of cancer (1). Currently, several risk factors for obesity have been identified, including lipid and inflammatory disorders (2). Given the dangerous complications and problems of cardiovascular disease, finding ways to prevent this disease early in the elderly is being investigated. These include the study and transformation of lipids and lipoproteins, LDH, acute phase reactant protein CRP, and inflammatory markers. C-reactive protein (CRP) is a plasma component that is made in the liver and its increased production is a response to infectious diseases, inflammation, or tissue damage. Recent studies have shown that CRP is a stronger indicator than LDL in predicting cardiovascular events (3). In healthy livers, plasma CRP concentration is an important inflammatory marker. Its concentration may be as high as 100-fold in diseased individuals, but in healthy individuals, its concentration is usually low. The highly sensitive measurement of CRP has made it possible to assess it in subjects for studies (4).

According to research, CRP, as an acute phase reactant protein, increases in inflammatory processes, stress, infections, and exercise. Several studies have also shown that high levels of CRP are closely related to obesity. It is assumed that interleukin secreted from adipose tissue plays a role in the increase in CRP observed in obesity. It has also been observed that CRP has a high positive correlation with indicators of adipose tissue measurement, such as body mass index, waist circumference, and waist-to-hip ratio (5). The findings of some studies have shown that physical inactivity, independent of obesity, plays a role in increasing levels of inflammatory markers. According to research findings, exercise and physical activity in any form and type can modify these risk factors (6). Physical activity can probably reduce mortality in people at risk by reducing inflammatory, coagulation, and obesity markers. In this regard, the results of two studies show that resistance training can reduce CRP levels. A study reported a decrease in CRP levels after one year of resistance training in obese women (7). Therefore, given the relationship between inflammatory markers and the prevalence of various diseases, especially cardiovascular diseases, it seems that any factor that reduces inflammatory markers can reduce the risk of cardiovascular events (8). Various studies have been conducted on the effect of exercise training on these markers, and many of them have shown that aerobic training is associated with a significant decrease in environmental inflammatory factors, including CRP and IL-6, in healthy individuals, cardiac patients, and diabetics, reducing cardiovascular outcomes (9).

Although it has been established that land-based exercise, such as walking, running, and cycling, has been documented as an effective treatment for reducing inflammatory markers (10). Unfortunately, these land-based exercise methods may not be suitable for most individuals due to the risk of joint damage. However, swimming, with its minimal weight-bearing stress, humid environment, and reduced thermal load, has become an attractive alternative form of exercise and is always recommended for health promotion and prevention and treatment of cardiovascular disease risk factors (11). Therefore, additional research is needed on the effects of swimming training on the levels of inflammatory markers in overweight or obese elderly individuals. Given the conflicting results regarding the results of different forms and types of exercise with different intensities and different training protocols in reducing environmental inflammatory markers, the researcher in this study aimed to study the effect of eight weeks of aquatic exercise on C-reactive protein and interleukin-6 in obese elderly men in Isfahan.

Materials and Methods

In this study, a semi-experimental and applied research method was used. The research design was a pre-test-post-test design, which used an experimental group (exercise) and a control group. The statistical population included all obese elderly men aged 65 to 75 years in Isfahan, from whom, purposefully and voluntarily, eligible elderly people based on the inclusion criteria, including having a body mass index higher than 30 kg/m2, not participating in regular sports activities, were randomly assigned to two groups: aquatic exercise (16 people) and control group (15 people).

All participants in both groups consciously accepted all responsibilities and consequences of participating in the study in this form. The participants' height was measured using a SEGA model height gauge made in Germany and their body weight was measured using an Omron model BF511 digital scale made in Japan. The subjects' body mass index was also calculated using the formula of dividing body weight in kilograms by height in meters squared. A blood sample was taken to measure C-reactive protein and interleukin-6 was measured using the ELISA method. A physical activity questionnaire was completed to determine the physical condition of the participants in the study and an informed consent questionnaire was completed by the participants in the study.

Aerobic exercise in Aquatic was performed for two months, 3 sessions per week and each about 60 minutes. According to the guidelines of the American College of Sports Medicine (ACSM), the participants started exercising 3 sessions per week and for 30 minutes and the intensity and duration of the exercises were increased accordingly over the course of 8 weeks. Each exercise session included a 10–15-minute warm-up with various stretching and flexibility exercises, and then aerobic exercises were performed with a specific intensity and time in each session, and at the end of each session, a 10-minute cool-down was performed. The intensity of the exercises, which was designed based on the heart rate, was controlled by a heart rate monitor. Aerobic exercise sessions started from 15-30 minutes and with an intensity of 50-55% of the maximum heart rate in the first week and increased to 60 minutes and with 75-70% of the maximum heart rate.

Blood samples were taken in a standard manner in a sitting position, 10 cc of venous blood after 5 minutes of complete rest of the subjects and after 10-12 hours of fasting, using sterile veno-jack syringes containing EDTA anticoagulant by a laboratory expert and then placed in an ice container. Serum was obtained by centrifugation at 1500 g for 15 minutes and stored at -70°C for subsequent analyses. This procedure was performed 24 hours before the start of the study and 24 hours after the last training session. Finally, serum concentrations of CRP and IL-6 protein were measured by ELISA using a Diagnostic Biochem kit made in Canada (The intraassay coefficient of variation is 4.5% and the sensitivity is 10 ng/ml.).

Descriptive and inferential statistics were used to examine and statistically analyze the raw data. Descriptive statistics were used to calculate the central and dispersion indices, quantitative scales, and draw tables. The Kolmogorov-Smirnov test was used to check the normality of the data. In inferential statistics, the Levene test was used to assume equality of variances and the covariance test was used to determine the mean difference between the groups. Statistical work was performed using SPSS-$_{22}$ software. Also, a significance level of $P<0.05$ was considered for statistical tests.

Results

The mean and standard deviation of the physical characteristics of the subjects in the two research groups are presented in Table 1.

Table 1. Mean and standard deviation of physical characteristics of research participants by group before the study

Variable (Group)	Aquatic exercise (n=16)	Control (n=15)
Age (Year)	67/4±5/46	66/6±7/56
Height (centimeter meters)	166/3±9/61	167/2±10/77
Weight (kg)	83/3±7/57	82/4±6/09
Index Mass Body(kg/m^2)	30/06±2/62	30/02±4/72

In Table 2, the results of the dependent t-test for comparing the mean changes in weight values before and after the study within each group are reported.

Table 2. Results of the paired t-test for comparing weight before and after the study period by group.

Statistical Indexs	Average ± Deviation Standard		df	t	Sig
group	Pre-Test	Post Test			
Aquatic exercise	83/3±7/57	70/2±4/87	15	-3/118	0/007
Control	82/4±6/09	81/2±5/12	14	-7/337	0/08

As the findings in Table 2 show, a significant difference was observed between the mean weight values of the obese elderly men in the exercise intervention group after 8 weeks of the study period ($p \geq 0.05$), while this difference remained unchanged in the control group. In order to investigate the effect of Aquatic exercise compared to the control group on the weight of the obese elderly men, a fixed-effect analysis of covariance model was used, the results of which are presented in Table 3.

Table 3. Results of analysis of variance test for comparing the mean of weight variable after intervention between groups

variable	Factor	Mean of squares	df	t	Sig
Weight (kg)	Pre-test effect	339/99	1	134/13	0/06
	* Group effect	12/57	3	49/587	0/07

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In Table 3, the mean post-test weight values in the exercise intervention group did not differ significantly from the control group ($p \leq 0.05$). This means that 8 weeks of Aquatic exercise had no effect on the weight of obese elderly men compared to the control group.

Table 4 reports the results of the dependent t-test for the intra-group comparison of changes in body mass index values before and after the study.

Table 4. Results of paired t-test to compare body mass index before and after the study period by group.

Statistical Indexs / groups	Average±Deviation Standard		df	t	Sig
	Pre-Test	Post-Test			
Aquatic exercise	30/06±2/62	25/00±3/61	15	-3/107	0/015
Control	30/02±4/72	29/40±2/52	14	7/298	0/060

In Table 4, a significant difference was observed between the mean values of body mass index of obese elderly men in the intervention group ($p \geq 0.05$), while this difference was unchanged in the control group. In order to investigate the effect of Aquatic exercise on body mass index of obese elderly men, a fixed-effect analysis of covariance model was used, the results of which are presented in Table 5.

Table 5. Results of analysis of variance test for comparing the mean of body mass index variable after intervention between groups

variable	Factor	Mean of squares	df	t	Sig
Index Mass Body (kg/m^2)	**Pre-test effect**	11/554	1	330/741	0/06
	*** Group effect**	1/409	3	40/323	0/07

In Table 5, the group effect is not significant and the mean values of body mass index at post-test in the exercise intervention group did not differ significantly from the control group ($p \leq 0.05$). This means that 8 weeks of Aquatic training has no effect on the body mass index of obese elderly men compared to the control group.

Table 6 reports the results of the dependent t-test for within-group comparison of changes in body fat percentage values before and after the study.

Table 6. Results of the paired t-test to compare changes in body fat percentage values before and after the study period by group.

Statistical Indexs / groups	Average±Deviation Standard		df	t	sig
	Pre-Test	Post Test			
Aquatic exercise	33/3±6/77	29/03±4/67	15	-4/858	0/000
Control	33/6±7/00	34/53±3/63	14	1/113	0/285

In Table 6, a significant decrease in the average fat percentage of the aquatic exercise group and no significant change in the fat percentage of the control group was observed after 8 weeks of the study period in obese elderly men ($p \geq 0.05$). In order to investigate the effect of aquatic exercise on the fat percentage of obese elderly men, a fixed-effect analysis of covariance model was used, the results of which are presented in Table 7.

Table 7. Results of the analysis of variance test for comparing the mean of the fat percentage variable after the intervention between groups.

variable	Factor	Mean of squares	df	t	Sig
Fat percentage	Pre-test effect	414/798	1	53/725	0/001
	* Group effect	189/319	1	24/521	0/001

In Table 7, the group effect is significant, so it can be said that the mean values of fat percentage in the post-test in the exercise intervention group have decreased significantly compared to the control group ($p \leq 0.05$). This means that 8 weeks of Aquatic training has an effect on fat percentage in obese elderly men.

Next, in order to compare CRP levels, the paired t-test and analysis of covariance statistical methods were used, the results of which are reported in Tables 8 and 9.

Table 8. Results of paired t-test for comparing CRP before and after the study period by group.

Statistical Indexs	Average ± Deviation Standard		df	t	sig
groups	Pre-Test	Post Test			
Aquatic exercise	4/39±1/50	3/05±1/52	15	-5/938	0/001
Control	4/05±1/32	3/78±1/32	14	-1/145	0/272

Table 8 showed a significant decrease in CRP levels in the aquatic exercise intervention group and no significant change in the control group.

Table 9. Results of the analysis of variance test for the CRP variable

variable	Factor	Mean of squares	df	t	Sig
CRP (mg/d)	Pre-test effect	37/238	1	47/485	0/001
	* Group effect	7/538	1	9/631	0/004

According to the results of the analysis of covariance test in Table 9, there is a significant difference between the CRP values in the study groups with pre-test control after an intervention period. Therefore, it is concluded that 8 weeks of aquatic exercise has an effect on CRP levels in obese elderly men.

In Table 10, the results of the dependent t-test for comparing the mean changes in interleukin-6 levels before and after the study in each of the groups are reported.

Table 10. Results of paired t-test for comparing interleukin-6 before and after the study period by group.

Statistical Indexs	Average ± Deviation Standard		df	t	sig
groups	Pre-Test	Post Test			
Aquatic exercise	0/42±0/10	0/35±0/10	15	-2/612	0/02
Control	0/38±0/12	0/38±0/12	14	-0/512	0/617

According to Table 10, a significant decrease in the mean IL-6 levels of the aquatic exercise group and no significant change in the control group was observed after 8 weeks of intervention. In order to investigate the effect of aquatic exercise on IL-6 levels compared to the control group, analysis of covariance was used, the results of which are presented in Table 11.

Table 11. Results of analysis of variance test for comparison of mean interleukin-6 levels after intervention between groups

variable	Factor	Mean of squares	df	t	Sig
CRP (mg/d)	**Pre-test effect**	0/006	1	0/608	0/001
	*** Group effect**	0/033	1	3/238	0/083

In Table 11, the group effect is not significant, so there was no significant difference between the mean interleukin-6 values at post-test in the aquatic exercise intervention group compared to the control group. Consequently, 8 weeks of aquatic exercise did not affect interleukin-6 levels in obese elderly men.

Discussion

Although the results of this study showed significant improvements in body composition indices (body weight, body mass index, and fat percentage) and inflammatory index levels including CRP and IL-6 levels in the aquatic exercise group after eight weeks of intervention compared to baseline, some body composition indices including body fat percentage and CRP levels decreased in the aquatic exercise group after eight weeks of the exercise program compared to the control group.

In this study, when body composition variables were examined before and after eight weeks of aquatic aerobic exercise, significant improvements were observed in weight indices, body mass index, and fat percentage after 8 weeks of the aquatic exercise program in the exercise group. However, no significant difference was observed between the aquatic exercise and control groups. The results of the present study confirm that regular exercise is one of the most important effective factors in improving body composition and preventing chronic diseases caused by abdominal obesity in obese elderly people.

Our results were consistent with previous studies by some investigators (12-15). They showed that exercise intensity and higher energy expenditure may contribute to improved body composition. A possible explanation for the effect of exercise on body composition control is that higher energy expenditure during exercise may lead to greater loss of body fat (14, 15). Other mechanisms and reasons for weight loss due to exercise include increased energy expenditure due to exercise, increased fat mobilization by increasing adipose tissue activity, a small increase in resting metabolic rate after exercise, a possible increase in the thermogenic response to food if exercise and eating are timed closely together, improved mental performance, and possibly better appetite control (12).

The results of the present study are also consistent with the findings of other researchers (16, 17). These researchers showed in their study that the effect of three months of exercise alone on weight loss was minimal to moderate and even no loss. Perhaps one of the possible reasons for the lack of change in body composition in the mentioned studies after the interventions was the lack of a combination of diet and exercise intervention. Previous studies have also shown that aerobic systems usually use a higher proportion of slow-twitch fibers to create changes during such moderate-intensity exercises (13). In this study, despite a decrease in body fat percentage, no change in weight and body mass index was observed compared to the control group. Perhaps one of the differences between the results and previous studies is the use of different volumes and intensities in the studies. For example, a significant decrease in IL-6 levels has been observed after 10 weeks of low-volume speed interval training (4 repetitions of 30 seconds/3 days per week) at maximum intensity or after 24 weeks of high-volume HIIT training (3 sets of 10 repetitions/60 seconds/3 days per week) in obese middle-aged individuals (14).

However, the present study showed that 8 weeks of aerobic training in water significantly reduced serum CRP levels and body fat percentage in obese elderly men. Therefore, this type of training can be suggested as an effective preventive method in reducing the incidence of cardiovascular diseases in elderly individuals. In this context, the results of this study are consistent with the results of studies by Kelly et al, on the effect of physical activity on CRP reduction (12, 18). The study by Kelly et al, showed that a significant decrease in CRP is likely to occur more in obese elderly groups, which is consistent with this study (18). also showed that changes in CRP due to regular aerobic exercise are negatively correlated with initial CRP concentration. This means that in individuals with high baseline CRP concentration, regular aerobic exercise in water causes a greater decrease in CRP until it reaches normal levels (14). In the present study, in the experimental group in which baseline CRP concentration was high, after 8 weeks of aerobic exercise in water, the concentration of this inflammatory factor decreased significantly and reached normal levels, which is consistent with the study by Okara et al. (14). Some researchers believe that a decrease in body fat percentage due to exercise can directly cause a decrease in serum CRP levels, and also in individuals whose normal and baseline CRP levels are higher than their normal levels, the effect of exercise on reducing these factors is greater and more pronounced. So that in the present study, body fat percentage decreased significantly after 8 weeks of aerobic exercise in water (18).

Regarding the effect of physical activity on CRP changes (15), also reported that aerobic exercise for 3 sessions per week, each session lasting 45 minutes at an intensity of 50 to 75% of maximum heart rate for 8 months caused a significant decrease in obese men, which is consistent with the findings of the present study (19). Therefore, as with fat percentage, in the case of CRP, the duration of the exercise period seems to be an important and determining factor in the change in CRP due to exercise, so that most studies that have reported a decrease in CRP have used aquatic exercise programs for at least eight weeks. In addition, some researchers believe that exercise programs combined with weight or fat percentage reduction were also more effective in reducing CRP (20). Therefore, one of the reasons for the decrease in CRP in the present study can be attributed to the decrease in the subjects' body fat percentage resulting from eight weeks of aerobic exercise in water.

By reviewing the findings of different studies, it can be seen that the results of these studies are different and researchers have examined and interpreted their findings from various angles. It seems that the difference in the results of different studies is due to the difference in the type of training protocol and the difference in different training intensities. Although the exact mechanism has not been determined.

However, studies have shown that exercise training compensates for age-related functional changes (20) and, while slowing down the rate of satellite cell and muscle tissue destruction (21), it counteracts aging-related muscle weakness and maintains independence in old age for a longer period of time (22). In addition, engaging in physical activity and exercise can have beneficial effects on other aspects of the elderly's life, especially their mental and psychological aspects, and can lead to an improvement in their sense of satisfaction with life (23). In the present study, due to the beneficial effects of aquatic training, especially on maintaining body composition, it seems that this type of training, while increasing the muscular strength of the elderly, improves their postural control (20) and allows them to perform a wide range of movements without increasing the risk of falling or injury, so that even muscle strengthening can reduce the amount of joint pain while reducing mechanical stress on the joints (24).

However, in the results of research conducted in this subject area, there are also contradictions that can be attributed to the role of modulating variables in various studies such as gender, type of sports activity, intensity of exercise, duration of exercise, and not fully controlling the subjects' diet, not controlling the subjects' emotion and anxiety, individual differences in terms of their genetic characteristics and hereditary characteristics in measuring some indicators, as well as individual differences in the subjects' mental and emotional state during exercise sessions. Some limitations also prevented the optimal control of other factors such as diet, smoking, heredity, sleep of the subjects, etc. (25).

Conclusions

Therefore, designing and implementing various studies with the aim of determining the effect of physical activity and aquatic exercise on inflammatory indices, including CRP and IL-6, due to the differences and extensive effects of these factors on the research subjects, results in very scattered results, especially since the optimal level of intensity, duration, and type of exercise still remain a very important and unanswered question. Together, these factors can be considered as the reasons for the lack of a significant decrease in serum IL-6 in obese elderly men in the present study. Overall, the results of the present study showed a significant improvement in body composition indices and inflammatory indices after eight weeks of aquatic exercise in the exercise group after 8 weeks of aquatic exercise intervention compared to the baseline state. However, a significant decrease in body fat and CRP levels was found in the exercise group compared to the control group after 8 weeks of the study period.

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