Original Article

The Effect of Aquatic Exercises on Inflammatory Markers of Cardiovascular Disease in Obese Women

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Abstract

Aims: the purpose of this study was to investigate the effects of aquatic exercises on inflammatory markers of cardiovascular (homocysteine, C-reactive protein [CRP], and fibrinogen) in obese women. **Materials and Methods:** It was a semi-experimental with pre- and posttest design. Thirty-seven obese women volunteered to participate in the research, of which 28 had inclusive criteria for research. The age of participants ranged from 35 to 40 years and their body fat percentage was above 30%. The exercise protocol included a combination of resistance, stretching, and balance exercises that were carried out three sessions a week for 10 weeks. **Statistical Analysis Used:** Paired *t*-test and independent test were used to analyze the data. **Results:** The results suggested that homocysteine, CRP, and fibrinogen indices of obese women were significantly improved following combined aquatic exercises ($P \leq 0.05$). Furthermore, a significant decrease in body fat percentage with improvement of cholesterol and systolic blood pressure were found in experimental group ($P \leq 0.05$). **Conclusions:** The overall result was that combined aquatic exercises would not only attenuate cardiovascular risk factors such as homocysteine, fibrinogen, and CRP but also improve the other cardiovascular disease risk factors such as obesity, cholesterol, and blood pressure.

Keywords: Cardiovascular, C-reaction protein, fibrinogen, homocysteine

Introduction

Despite significant advances in the prevention and treatment of cardiovascular disease (CVD), these diseases are also the leading cause of death in the world.[1,2] The American Heart Association studies reported that 2.4 million people in the United States die from various illnesses each year, of which 39% are due to CVD.[3] Based on the World Health Organization, noncommunicable diseases (NCDs) will be accountable for 70% of all deaths in 2030 and CVDs are among the first four causes of death in worldwide.[4] Based on the evidence, it seems that CVDs are the major causes of death in Iranian population.[5,6] Fat profiles have always been used as a standard tool for identifying people at risk for CVD. However, the results of some recent studies indicate that CVD has been reported in people whose blood and body fat and cholesterol levels were in the normal range and even in some cases below the normal range.[7] This suggests that other indicators may help identify those susceptible to CVD. In this regard, an indicator of CVD is the levels of C-reactive protein (CRP) that is highly predictive of heart attacks and stroke and progression of peripheral arterial disease.[1] The risk of CVD in people with high CRP levels is about two-thirds higher than those with lower CRP levels.[8] In the past decade, it has been found that inflammatory mechanisms play an important role in the pathogenicity process of several chronic diseases, including CVDs.[9] Several inflammatory plasma indices have been introduced to predict CVD. Among these indicators, CRP, fibrinogen, and homocysteine are highly associated with increased cardiovascular risk. Therefore, any intervention, including exercise that reduces inflammatory indices, leads to a reduction in CVD. Exercise interventions have always been considered as an effective treatment for early inhibition, as well as treatment and control of NCD.[10] There

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are several studies reporting that aerobic exercises make the hormonal, vascular, and structural nervous system compatible. These physiological adaptations included left ventricular reconstruction, improved ventilation, as well as reduction of catecholamine and overall peripheral resistance and changes in levels of vasoconstrictors.[2,11,12] Although the benefits of aerobic exercise have well been documented on inflammatory and cardiovascular risk factors, obese people cannot easily do the exercises because of overweight and stress that comes from aerobic training on joints. Hence, we tried to investigate the effect of aquatic exercises (produce less pressure on the joints while exercising) on inflammatory markers of CVD in obese women.

Materials and Methods

It was a semi-experimental with pre- and posttest design. Thirty-seven obese women volunteered to participate in the research, of which 28 had inclusive criteria for research (See Figure 1). The age range of participants was 35–40 years and their body fat percentage was above 30%. Body composition analyzer (Model in Body 320; Korea) was used to analyze the body composition (body fat percentage). The inclusive criteria consisted of lacking the history of specific illness or regular physical activity in the past 6 months, nonsmoking, having readiness for physical activity, no use of medication that could interfere with the study's objective, and body fat percentage ≥30%. These items were evaluated by a medical history questionnaire and a preparedness questionnaire as well as expert examination for physical activity. All participants' diet was under supervision of weight and health control monitored by food questionnaire recall. They were given diet based on recommended caloric intake specified by body composition analyzer.

Participants were asked to avoid any heavy physical activity or stressful conditions 3 days before blood sampling. Participants were then taken to the medical diagnostic laboratory, and 8 ml of blood from their venous vein in a sitting position was taken by laboratory medicine expert. Blood samples were frozen at −20°C until the second test. Second stage blood sampling was performed 24 h after the last training session. The measurement instruments are cited in Table 1.

As it can be seen in Table 2, the exercise protocol included a combination of resistance, stretching, and balance exercises that were carried out three sessions a week for 10 weeks (water temperature: 29°–30°C and water depth of 0.7–1.3 meters)[13] in the shallow end of the pool. The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (Imam Khomeini International University) and with the Helsinki Declaration of 1975. Paired *t*-test and independent test were used to analyze the data.

Results

The results suggested that body fat percentage of exercise group was significantly decreased after intervention ($P = 0.002$), while no significant change was found for control group ($P = 0.64$). As it can be seen in Table 3, all inflammatory markers of CVD were significantly changed in exercise group after intervention ($P \leq 0.05$). Furthermore, it was suggested that there was a significant difference in both groups after intervention ($P \leq 0.05$).

As seen in Figure 2, cholesterol level was significantly decreased after exercise intervention ($P = 0.02$), while no significant improvement was found in control group ($P = 0.07$).

The results of paired *t*-test for systolic and diastolic blood pressure of the two groups can be seen in Figures 3 and 4. As suggested, systolic pressure was decreased significantly in exercise group ($P = 0.04$). However, no significant changes was found for diastolic pressure ($P = 0.27$).

Discussion

The purpose of this study was to investigate the effects of combined aquatic exercises on inflammatory markers of cardiovascular including homocysteine, CRP, and fibrinogen in obese women. As shown, homocysteine, CRP, and fibrinogen index of obese women were significantly improved following combined aquatic exercises. Furthermore, it was found that the body fat percentage of the participants in experimental group was significantly improved. Based on combined favorable changes in CVD risk factors, it was shown that exercise that induces weight loss favorably improves the other factors including cholesterol and blood pressure. This study suggests that aquatic exercises lower homocysteine levels and that exercise programs could positively affect homocysteine control. The study of e Silva Ade and da Mota is consistent with our study[14] reporting the constructive effects of chronic exercise on homocysteine, while Deminice *et al.* obtained the contrary results and demonstrated that acute exercise increased homocysteine levels in the blood.[15] It should be noted that factors such as duration, intensity, and mode of exercise appear to impact blood homocysteine levels differently and

Table 1: The names of the kits, the device, the measurement of homocysteine, fibrinogen, and C-reactive protein

Variable	Kit	Apparatus	Technic	Temperature	Reactive method
HCY	Axis-Shield	BT3500	Enzymatic	37	Kinetic
FIB	Mahsa Yaran	Steellex Paber	Coagulometers	37	-
CRP	Bionik	-	Slide agglutination	22-25	Agglutination

HCY: Homocysteine, FIB: Fibrinogen, CRP: C-reactive protein

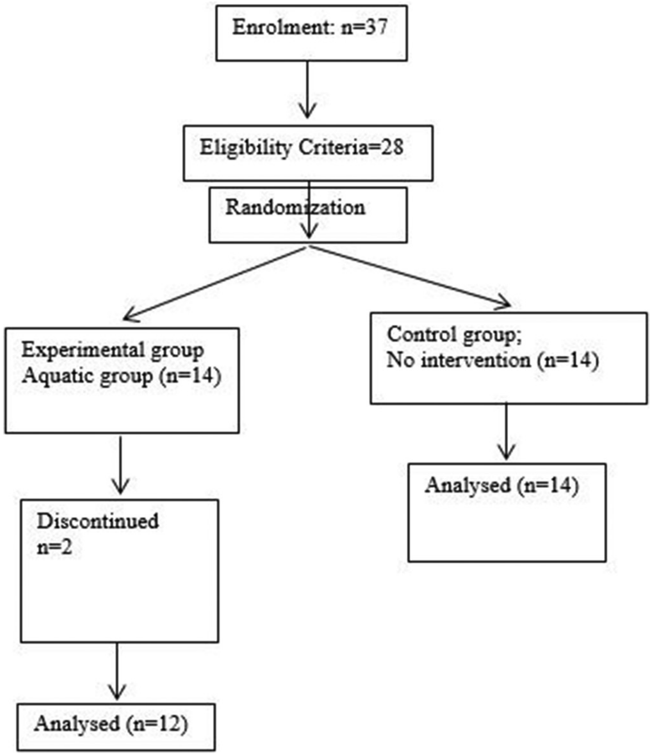

Figure 1: Recruitment and allocation of the study participants

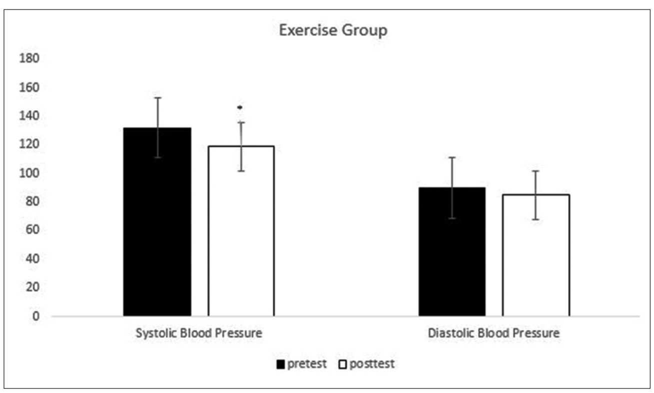

Figure 3: Blood pressure changes before and after intervention in exercise group

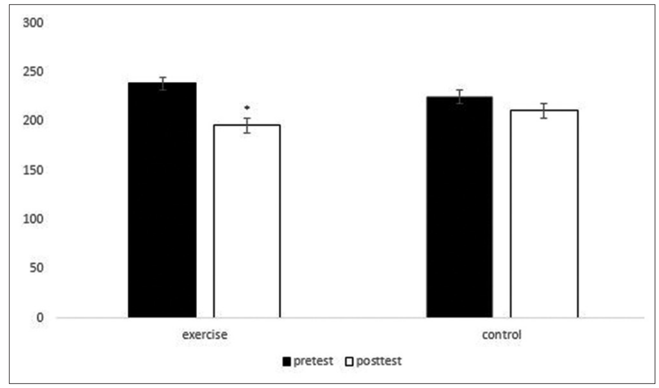

Figure 2: Cholesterol changes before and after intervention

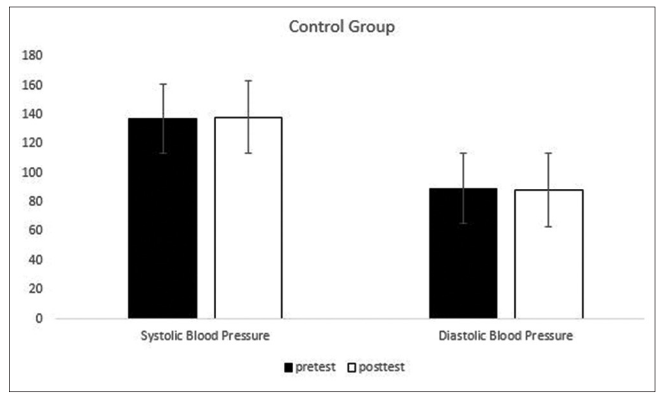

Figure 4: Blood pressure changes before and after intervention in control group

Table 2: Aquatic exercise protocol

Phase (duration)	Program
Warm-up (15-10 min)	Walking around the pool and doing stretching exercises in different directions
The main program, a combination of resistance and balance exercises (30-35 min)	Resistance exercise consisted of resilient exercises include walking in the form of long knee, forward lane, back lane, march walking, and sitting down (in exercising all these movements, the nodule was used to increase the resistance and balance)
	Balance exercises included walking on the smooth line, walking the tandem, walking back, walking with the occasional interruption in the stage of unsteady legs, swimming at the pool floor, walking on the paw, marching in place (nodule was used to increase the resistance and balance in all movements)
Cooling (15-10 min)	Walking, breathing exercises, and flexibility (30 s per movement)

may be dependent on individual fitness levels.[16] In the same way, it was also shown that fibrinogen levels were improved following aquatic exercises that were in line with a study of Church *et al*.[17] that reported is independently related to physical fitness levels (inversely) and fatness (directly). There are many different pathways in the mechanism of anti-inflammatory action of exercises such as beneficial effects on lipids, insulin, and endothelial functions. Other mechanisms including increased anti-inflammatory cytokines, increased bone strength, controlling brain stems for appetite, and satiety have been reported in studies.[18-20]

Dohi *et al*. showed that CRP can predict the incidence of CVD. In this regard, several prospective group studies also found that high CRP levels are associated with an increased risk of CVD. Since the effect of physical activity on the reduction of CVD and the association of physical activity with CVD and other cardiovascular factors has been proven, it is evident that physical activity has a significant relationship with low incidence of cardiovascular risk factors, which confirmed the results achieved in this study.[18-22] Contrary to this study, several studies have reported that physical activity does

Table 3: Inflammatory markers of cardiovascular disease before and after intervention

Variable	Group	Pretest	Posttest	*P* (paired *t*-test)	*P* (independent *t*-test)
HCY (μmol/L)	Exercise	12.25±1.2	10.15±0.90	0.005*	0.03*
	Control	12.11±3.5	13.09±2.9	0.52	
FIB (mg/L)	Exercise	23.35±3.32	19.12±2.89	0.007*	0.001*
	Control	22.89±3.58	23.01±3.56	0.98	
CRP (mg/L)	Exercise	1.65±0.11	0.95±0.05	0.045*	0.001*
	Control	1.89±0.19	1.84±0.16	0.23	

HCY: Homocysteine, FIB: Fibrinogen, CRP: C-reactive protein

not affect CRP.[23-25] Several limitations must be considered in interpreting the results. First, we evaluated the effects of one exercise mode (aquatic exercises) on inflammatory markers of CVD in obese women; thus, our results may not generalize to the effectiveness of exercise therapy on these risk factors. Second, we cannot exclude the possibility that the association of inflammatory markers of cardiovascular risk factors was confounded by unmeasured factors. Low number of participants involving in the research is another possible limitation in this study. Research examining the effect of different kinds of exercise protocols on inflammatory risk factors is equivocal, which is partially due to a lack of control for confounding variables that impact CVD. In conclusion, these data offer that aquatic exercises would not only attenuate cardiovascular risk factors such as homocysteine, fibrinogen, and CRP but also improve the obesity of women. Other risk factors such as cholesterol and blood pressure were also shown to improve the following water therapy exercises. As a result, such exercises are highly recommended to obese people with cardiovascular risk factors.

Conclusions

The overall result was that combined aquatic exercises would not only attenuate cardiovascular risk factors such as homocysteine, fibrinogen, and CRP but also improve the other CVD risk factors such as obesity, cholesterol, and blood pressure.

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Conflicts of interest

There are no conflicts of interest.

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