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Research Paper

The Effect of a Selected Period of Exercise in Water on Cardiovascular Risk Indicators of Overweight Elderly Men

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ABSTRACT

Background and Aim: Voluntary activity decreases in the elderly with increasing age, and this activity causes many physical problems and cardiovascular risk factors. This study aimed to investigate the effect of 8 weeks of selected aerobic exercise in water on some cardiovascular risk indicators in overweight elderly men.

Materials and Methods: After measuring anthropometric indices, 34 overweight men (64.84±5.56 years old, body mass index [BMI]≥25 kg/m^2) were randomly selected and divided into water exercise (n=17) and control (n=17) groups. The water exercise group did the aerobic exercise in the water with an intensity of 45% to 65% of maximum heart rate for 8 weeks. Before and after the intervention, blood samples were taken from all subjects to measure serum levels of triglyceride (TG), total cholesterol (TC), low-density lipoprotein (LDL) cholesterol, and high-density lipoprotein (HDL) cholesterol. The Shapiro-Wilk test was used to check the normality of data distribution, and after assuming the normality of the data, the paired t test was used to examine within-group changes and an independent t test for between-group differences. Data analysis was performed using SPSS software. The results were evaluated at a significance level of less than 0.05.

Results: Water exercise significantly reduced mean blood pressure (P≤0.001), systolic blood pressure (P≤0.000), TG (P≤0.00), cholesterol (P≤0.01), and LDL (P≤0.02) in elderly men. However, there was no significant difference between the two groups in the HDL index.

Conclusion: Eight weeks of water aerobic exercise can positively reduce cardiovascular risk factors in overweight elderly men. Therefore, these exercises can be recommended by sports and health experts.

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1. Introduction

In the last decade, the population of the elderly has increased due to the decrease in birth rate, health promotion, and increase in life expectancy [1]. Fatigue, lack of motor skills, reduced adaptation to the environment, and increased dependence on others are factors associated with old age [2]. What is certain is that with increasing age, progressive erosion in different body parts causes loss of physical fitness, cognitive function, reaction time, and balance. These changes will increase the chance of physical injuries in the elderly [3, 4]. Besides, being overweight and obese is one of the serious problems of community health and one of the risk factors for chronic diseases such as cardiovascular disease in the elderly [5]. However, the relationship between obesity and overweight and cardiovascular disease is somewhat unknown [6]. Evidence suggests that systemic inflammation and factors such as fat mass and hormones secreted by adipose tissue are effective in developing cardiovascular diseases [7]. Fu Y et al. have shown that high levels of triglycerides (TG), total cholesterol, and low-density lipoprotein (LDL) or decreased levels of high-density lipoprotein (HDL) in the blood increase the risk of cardiovascular disease in the elderly [5, 8].

Furthermore, the prevalence and incidence of heart failure are increasing with the aging population, so most patients are over 60 years old, and the prevalence of heart disease in people over 65 years is about 4% to 8% [2]. Accordingly, physical activity and nutritional control in preventing metabolic syndrome and cardiovascular disease among the elderly are particularly important [9] The results of studies have shown that exercise can improve physical endurance and adaptation of the elderly by increasing cardiac pumping and blood supply to the muscles while reducing heart risks [10].

However, exercise is difficult due to some psychological and physical problems in old age, especially for people who suffer from diseases, such as joint pain and disability or have limitations [11, 12]. One of the best exercise methods to improve balance control is a water exercise that allows the elderly to do exercise or physical activity in a painless environment created in the water [13]. Hydrostatic and buoyancy pressure auxiliaries allow the exercise in the aquatic environment to have several advantages over the outdoor environment. First, the buoyancy force acts against gravity, which provides an auxiliary resistance and support force, and due to the increased flexibility of the spine and hamstring muscles [14], it can provide a suitable environment for comfortable and easy movement for some people who have difficulty moving on the ground. Second, the hydrostatic pressure exerts equal resistance on all active muscle groups when immersed in water, thus creating a resistance exercise condition and providing a strong sense of stability. Since there is no static resting position in the water, the muscles are constantly active to stabilize the body.

Stabilizing positions may allow the practitioner in the water to gain strength and flexibility and, most importantly, a better balance [15]. Rodriguez et al. showed that exercise in water for 12 weeks significantly reduced blood pressure. A change in lipid profile is probably a mechanism by which water sports can have antihypertensive effects [16]. Tasai et al. found that after 12 weeks of water exercise, 60% to 70% of maximal heart rate, triglyceride, total cholesterol, LDL, and systolic and diastolic blood pressure decreased [17]. However, in another study, three months of water exercise did not significantly affect women's quality of life, body mass index, and fat percentage [18]. According to these results, the environmental conditions of water for the elderly may improve the control of the body position and allow them to perform a wide range of movements without increasing the risk of falling or injury. On the other hand, paying attention to the issue of elderly health and preventive care to reduce their problems and even society seems inevitable. Attending to the physical and functional needs of the elderly while reducing treatment costs for countries can decrease premature mortality and maintain the ability and quality of life of the elderly. Accordingly, the present study seeks to answer whether 8 weeks of selected aerobic exercise in water can improve the health of overweight elderly men while reducing lipid profile and blood pressure.

2. Materials and Methods

The present study is quasi-experimental, and its statistical population consisted of all overweight and sedentary elderly men living in Arak City, Iran. The present study was conducted in full compliance with the provisions of research ethics and the principles of the Helsinki Declaration. The ethical code (IR.Qom.REC.1400.003) was obtained from the Ethics Committee of the Research Project of Qom University, Qom City, Iran. Among the volunteers, 34 were selected to participate in the study and were randomly divided into water exercise (17 people) and control group (17 people). The inclusion criteria were regular inactivity and body mass index (BMI) above 25 kg/m^2. Before selecting the sub-

jects, individuals with known physical illnesses such as cardiovascular disease, hypertension, diabetes, occupational exercise, smoking, or under diet to lose weight were excluded from the study. To evaluate the research variables, blood samples were taken after 12 hours of fasting in the pretest stage and 48 hours after the last exercise session, and the total cholesterol (TC) and triglyceride (TG) were tested using a Pars Azmoon Iran kit with a sensitivity of 5 mg/dL. Also, the HDL and LDL were measured using a Pars Azmoun Iran kit with a sensitivity of 1 mg/dL. Also, systolic and diastolic blood pressure using a mercury sphygmomanometer and their fat percentage using a Harpenden (caliper) fat meter and Jackson-Pollack equation of three points in the baseline stage after 8 weeks were measured in both groups, and their BMI values were calculated.

Exercise protocol

In the present study, all exercise steps were performed in the pool and a shallow water area for the experimental group. The duration of the exercise program was one hour per session. Each water exercise session had three stages: the first stage, adapting to the water environment and warming up (15 minutes), including stretching movements in all joints and major muscle groups, walking forward, backward, sideways, on heels and toes, and jogging in the water. The second stage, the exercise phase (30 minutes), included weight transfer from front to back, brisk walking in the water, walking sideways, imitating the movement of a soccer ball shot, imitating throwing the ball with the hand in front of the body, away and approaching the legs and hands from the middle axis of the body in standing and squatting. The third stage was 15 minutes of stretching, deep breathing, and swimming exercises. These exercises were conducted in an indoor pool with a water temperature between 26°C and 28°C.

The water exercise protocol comprised a gradual increase in exercise intensity during the 8-week exercise period to the end of it [13]. To control the variable of exercise intensity, the maximum heart rate was used, and to obtain the maximum heart rate of the subjects, the equation (age-220) was used. The heart rate started at 45% of the maximum heart rate during exercise. It increased to 65% of maximum heart rate at the end of the exercise, so the number of exercise sessions in the first three weeks was 3 sessions per week with an intensity of 45% maximum heart rate. In the second three weeks, it increased to 4 sessions with an intensity of 55% maximum heart rate, and in the third two weeks to 5 sessions per week with a 65% maximum heart rate [13]. This exercise protocol was also implemented in accordance with the specific recommendations of the American College of Sports Medicine (ACSM) for the elderly [19]. To control the intensity of exercise, participants' heart rate was measured during each exercise session and in several stages before, in the middle, and after aerobic exercise, and once during cooling from the carotid pulse path.

Statistical analysis

The study data were analyzed using SPSS software version 22, and the Shapiro-Wilk test was used to check the normality of data distribution. Moreover, after confirming the hypothesis of data distribution, a correlated t test was used to compare the within-group and independent t test to examine the between-group results.

3. Results

The characteristics of the participants (Mean±SD age, 64.84±5.56 years; Mean±SD height, 171.6±4.4 cm; Mean±SD weight, 85.8±9.19 kg; and Mean±SD body mass index [BMI], 27.95±2.37 kg/m^2) were presented in Table 1. The results showed that eight weeks of selected aerobic exercise in water significantly reduced the TC ($P\leq0.01$), TG ($P\leq0.00$), and LDL ($P\leq0.02$) of the subjects after the exercise period. Also, there was a slight increase in blood HDL levels compared to baseline. However, these changes were not statistically significant ($P\geq0.05$) (Table 2). In addition, after water exercise, the mean blood pressure ($P\leq0.001$) and systolic blood pressure ($P\leq0.000$) were significantly reduced (Table 3).

4. Discussion

Most studies have associated lipid indices such as TC, TG, HDL, and LDL with cardiovascular disease, obesity, and metabolic syndrome [5, 7]. Also, recently due to changes in lifestyle and diet, the prevalence of cardiovascular disease has increased [9]. Accordingly, we postulate that reducing lipid indexes through practical exercise may prevent cardiovascular diseases, especially in the elderly. The present study results showed that after 8 weeks of selected aerobic exercise in water, TC, TG, and LDL in elderly men decreased significantly. Zanetti et al. also reported that after 12 weeks of nonlinear resistance exercise, TC, TG, and LDL levels decreased in the exercise group while HDL levels increased in this group [20]. In another study, Tartibian et al. reported that after 12 weeks of aerobic exercise, TG levels and fat percentage of overweight girls decreased significantly [21], but this exercise had no effect on their cholesterol levels and body mass index [22].

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Table 1. Individual and physiological characteristics of the participants in the study groups (n=17)

Variables	Mean±SD	
	Water Exercise Group	Control Group
Age (y)	65.85±6.36	63.82±4.20
Height (cm)	170.62±4.4	171.50±4.4
Weight (kg)	85.58±8.24	86.02±10.14
BMI (kg/m^2)	27.91±2.58	28.00±2.17

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One possible mechanism for lowering triglyceride levels is to increase the activity of the enzyme lipase, which breaks down triglycerides into free fatty acids. Endurance exercise has been shown to increase fat metabolism by increasing the number of mitochondria and lipase activity [23].

On the other hand, exercise has been shown to further reduce fat plasma levels by increasing the ability of the skeletal muscle to use lipids compared to glycogen as a fuel. Following endurance exercise, serum levels of lecithin cholesterol acyltransferase, the enzyme responsible for transporting ester to HDL cholesterol, increase. In contrast, serum levels of cholesterol ester protein transporter, the enzyme responsible for transporting HDL cholesterol to other lipoproteins reduce. Thus, this increased enzymatic activity increases the muscle's ability to oxidize fatty acids induced by plasma, LDL cholesterol, or triglycerides [24].

However, there was a significant increase in HDL levels after exercise in the present study, but the changes in this index were not significant. Researchers believe that HDL is severely affected by exercise and the intensity of physical activity is one of the most important factors affecting HDL levels [8]. Therefore, some findings contrary to this study can be attributed to the difference in the type of exercise protocol and the intensity of the exercises performed or the duration of the exercises. Although the intensity of exercise in the present study is similar to other studies (45% to 65% of maximum heart rate) and despite a significant increase in HDL after 8 weeks of aerobic exercise in water, this increase was not significant. Therefore, longer exercise sessions can be more effective on HDL. Studies with exercise periods of more than 9 weeks (10 weeks, 12, or 24 weeks) have reported more changes in HDL and other lipid profile indices [25]. The effect or lack of exercise on lipid profile indices depends on the duration, intensity, type of exercise, calorie restriction or non-restriction, and diet control.

Table 2. Comparing lipid profiles in the studied groups

Indicator	Variables	Groups	Stages		Sig.
			Before Exercise	After Exercise	
Lipid Profile	Cholesterol (mg/dL)	exercise in water	179.91±13.96	171.75±11.32	0.010*
		control	181.08±14.24	182.00±12.22	0.203
	Triglyceride (mg/dL)	exercise in water	144.55±10.96	132.25±12.15	0.000*
		control	145.33±11.19	147.75±9.56	0.114
	Low-density lipoprotein (mg/dL)	exercise in water	109.41±7.18	102.7±9.27	0.020*
		control	111.40±10.21	112.83±8.07	0.249
	High-density lipoprotein mg/dL))	exercise in water	49.23±3.18	51.00±3.23	0.105
		control	49.75±4.07	50.08±5.45	0.559

* Indicates a significant difference (P≤0.05).

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Table 3. Comparing blood pressure in the studied groups

Indicator	Variables	Groups	Stages		Sig.
			Before Exercise	After Exercise	
Blood pressure	Mean blood pressure, mm Hg	Exercise in water	104.58±5.01	99.58±2.96	0.001*
		Control	105.33±4.07	106.04±3.12	0.305
	Systolic blood pressure, mm Hg	Exercise in water	133.61±3.38	127.89±3.17	0.000*
		Control	133.21±4.36	134.07±2.79	0.084
	Diastolic blood pressure, mm Hg	Exercise in water	90.23±4.23	87.64±4.30	0.197
		Control	91.15±2.09	91.82±4.50	0.174

* Indicates a significant difference (P≤0.05).

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In general, and based on previous research findings, the possible mechanisms of the effect of physical activity on reducing lipid profile are physical activity by increasing the activity of two enzymes, lipase lipoprotein and lecithin cholesterol acyltransferase reduces LDL, TG, TC, and increases HDL. On the other hand, lipase lipoprotein can increase very low-density lipoprotein and LDL catabolism after endurance activity [26]. Exercise also appears to increase lipolysis and decrease fatty acids in the muscles so that increased lipase lipoprotein activity accelerates the breakdown of glycerol in VLDL and removes lipoprotein particles [13]. On the other hand, some researchers believe that there is a significant relationship between anthropometric indices (fat percentage, body mass index, etc.) and lipid profile of individuals [22], and weight loss and body fat percentage due to exercise can directly cause decreased lipid profile [21]. Also, exercise significantly reduces these factors in people whose basal lipid profiles are higher than normal [27]. However, in the present study, the elderly participants were all overweight, and their body fat percentage and body mass index decreased significantly after 8 weeks of selected aerobic exercise in water.

In addition, the present study's findings showed that eight weeks of aerobic exercise in water significantly reduces blood pressure in older men. This finding is consistent with Abbasi et al.'s study, which examined the effect of 8 weeks of water exercise on quality of life, body mass, and heart rate in middle-aged women [28]. Also, Rodriguez et al. reported that exercise in water for 12 weeks significantly reduced participants' blood pressure [16]. Activity and immersion in hot water, especially in the elderly and people with heart problems, can reduce ventricular post-load pressure due to dilation of peripheral arteries in hot water. On the other hand, hydrostatic pressure and water temperature improve blood flow and alters hemodynamic responses at rest and during exercise in a favorable manner. However, Amooali et al. examined the effect of 12 weeks of aerobic exercise on blood pressure levels in elderly women with hypertension. The results showed that aerobic exercise caused no significant change in blood pressure in elderly women [29]. The exercise environment and the gender of the participants can be one of the factors influencing these contradictory findings, as studies have shown that reducing the elasticity of arteries with increasing age reduces vascular function, especially during onshore exercise [30].

Accordingly, the decrease in blood pressure may also be related to the decrease in the activity of the sympathetic nervous system due to exercise in hot water. As immersion in water due to relaxation in the body's peripheral receptors can reduce the sympathetic effects, vascular resistance is reduced by reducing the sympathetic tone. Muscle blood flow is improved by affecting the cardiac output and vasodilation, especially in the elderly, where the vessel wall becomes stiff. Reducing peripheral resistance can play an important role in improving blood pressure [31]. In addition to this change in lipid profile, there is another mechanism by which sports can have antihypertensive effects [32].

Prolonged exercise may play a protective role in endothelial function by increasing HDL levels. It has been reported that HDL cholesterol can release prostacyclin (PGL-2) into the walls of arteries and smooth muscle cells and that re-provision of HDL can prevent platelet aggregation in animal and tissue samples [33]. In the present study, HDL levels in the exercise group increased, although insignificantly.

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5. Conclusion

In short, one of the most important ways to achieve the desired physical condition and reduce cardiovascular risk factors in the elderly is to do regular water exercises. According to the variables measured in the present study, performing a selected course of aerobic exercise in water has improved metabolic indicators and lipid profile in the elderly, which is associated with lower blood pressure levels and cardiovascular risk factors. Therefore, aerobic water exercise can be suggested as a safe alternative to exercising on land.

Ethical Considerations

Compliance with ethical guidelines

To observe ethical considerations in this study, all subjects participated in the study voluntarily and after presenting their written consent. They were assured that their data would be analyzed as a group and would not be shared with any third party and that no exercise program fees would be charged.

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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