Effect of aquatic resistance training on blood pressure and physical function of postmenopausal women

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Abstract

BACKGROUND: In postmenopausal women, the risk of having cardiac diseases, especially high blood pressure, is increased due to the decrease in secretion of estrogen. The goal of this study was to evaluate the effect of 8 weeks of aquatic resistance training on blood pressure and physical function of postmenopausal women.

METHODS: In this quasi-experimental study, 24 postmenopausal women (age: 53-60 years, BMI= 29.23 ± 5.27kg/m^2) were randomly divided into experimental (n = 14) and control (n = 10) groups. Women in the experimental group participated in an aquatic exercise program for 8 weeks (3 sessions per week) in the deep parts of the pool. Training included walking and running in water with water dumbbells weighing 250 grams. Before and after the exercise period, the body composition, blood pressure, dynamic balance, and flexibility of the subjects were measured.

RESULTS: According to the T-score, the average systolic blood pressure in the experimental group significantly decreased (9.29%) (P = 0.001). Dynamic balance and flexibility, respectively, significantly increased by 22.02% and 24.4% (P < 0.01). No significant changes were observed in body fat and weight.

CONCLUSION: Due to the positive effect of aquatic resistance training on blood pressure, dynamic balance, and flexibility these exercises are recommended for postmenopausal women.

Keywords: Menopausal Women, Blood Pressure, Flexibility, Aquatic Resistance Training

ARYA Atherosclerosis Journal 2012, 8(Special Issue in National Hypertension Treatment): S178-S182

Date of submission: 12 Feb 2012, ***Date of acceptance:*** 09 Apr 2012

Introduction

Today, most women live long enough to become menopausal.[1] Menopause is not a disease, but rather a normal physiologic event in a woman's life.[2] It is an adaptation process during which women reach a new biological state. This process is accompanied by many biological and psychosocial changes.[1] It can be associated, however, with health complaints, a decrease in quality of life, and an increase in risk of illnesses, such as osteoporosis and coronary heart disease (CHD).[1,2] Thus, menopause is linked to increase in several risk factors of cardiovascular disease (CVD), including abnormalities in blood pressure, lipids, body composition, and insulin sensitivity.[3] In addition, premenopausal women are at a lower risk of developing hypertension and coronary heart disease than men of the same age, and cardiovascular risk increases only after the cessation of ovarian function.[4] Despite the protection apparently offered by endogenous sex hormones in their premenopausal years, the longevity of women exposes them to a lifetime risk of coronary and other vascular diseases similar to that of men.[2] Menopause is associated with a natural decline in estrogen that increases visceral fat mass, decreases bone mass density, muscle mass, and strength.[5] Moreover, muscle mass in women tends to decrease gradually after the 3rd decade of age, and shows an accelerated decline after the 5th decade.[5] Decline in muscle mass, called sarcopenia, is related to limited functional performance and physical disability, and women are more susceptible to these health problems, as compared to men, because they live longer.[5] Balance ability is an important function that prevents individuals from falling, because it is associated with postural control.[6] In addition, the fear of falling limits daily activities, which in turn further decreases physical function.[6] Therefore, exercises to improve balance ability are important in preventing, or at least forestalling, the decline in physical function and consequential falls.[6]

Due to the complexity of menopausal symptoms,

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many different alternatives to hormone replacement therapy have been developed to control menopausal symptoms. They include the use of herbal drugs, diet/nourishment, exercise programs, and lifestyle modification programs.[1] It is evident that exercise is becoming one of the most important alternative treatment procedures, and there is good evidence that regular physical activity reduces the risk of cardiovascular diseases.[7,8] Moreover, Physical exercise prevents bone loss in postmenopausal women.[9]

Physical activity, especially resistance training, is a major determinant in maintaining muscle mass and reducing the accumulation of intramuscular fat.[5] Selection of the appropriate physical activity is essential in order to avoid injuries and ensure exercise adherence. Recently, aquatic exercise has been proposed as an alternative mode of exercise for improving overall fitness, especially in individuals with low levels of physical fitness.[10] The rationale for using aquatic balance training is seen in the various properties of water, the most important of which include buoyancy, hydrostatic pressure, and viscosity.[11] Water acts as a variable 'accommodating' resistance.[12] This resistance promotes strengthening of muscles. It has been hypothesized that viscosity and buoyancy may improve balance by the stimulation of muscle proprioception and deep muscles in water.[13] Although water reduces the effects of weight on skeletal joints at rest, thus imposing little strain on low-joint extremities, the resistive effect of water provides exercise loading during limb movements, which enhances muscular tension and increases energy expenditure beyond that achieved with land exercise.[10]

While it is accepted that resistance training programs can improve muscle mass, strength, power, and local muscular endurance less is known about the effects of different modes of resistance training, such as aquatic resistance on these parameters or other indicators of health.[14]

There was limited information on aquatic resistance exercise training and its effect on both blood pressure and physical capacity in postmenopausal women. Therefore, the main purpose of this study was to determine the effects of 8 weeks of aquatic resistance training on blood pressure, and flexibility and dynamic balance, which are possible contributors to mobility loss and fall risk, in postmenopausal women..

Materials and Methods

Subjects

Twenty-four healthy postmenopausal women (52-60 years of age) who did not exercise regularly were recruited in this study. They were not taking medication or hormone therapy; they were all functionally independent and had no neurological, cardiovascular, metabolic, inflammatory, or musculoskeletal conditions that would stop them from participating in a physical exercise program. None of them had ever participated in resistance training exercises or aerobic exercises. Participants were randomly divided into aquatic resistance training group, who exercised in water using the resistance equipment (n = 14), and the control group (n = 10). In anticipation of potential drop-outs, which often occurs during the administration of unpaid research studies, many women were placed into the exercise group. Two subjects were excluded due to surgery (n = 1) and infectious disease (n = 1). All participants had a natural menopause, with amenorrhea at least 1 year prior to the start of the study (average time of amenorrhea: 5.2 ± 0.8 year). All subjects were instructed not to modify their behavior or diet, nor to do any other type of physical exercise for the duration of the study. Subject characteristics are presented in Table 1.

Table 1. Subject characteristics (mean ± SD)

Group	Aquatic (n = 14)	Control (n = 7)
Age (year)	55.2 ± 3.7	54.4 ± 4.6
Height (cm)	155.2 ± 6.3	156.6 ± 5.5
Weight (kg)	68.6 ± 10.6	68.5 ± 10.2
BMI (kg/m^2)	28.5 ± 3.4	27.9 ± 3.9

Testing procedures

All subjects underwent anthropometric measurements (height, weight, BMI); Weight and height values were then used for the calculation of BMI. Blood pressure and physical performance tests before and after the training period were performed by the same examiner. Blood pressure was measured before other measurements in sitting position after resting for 10 min. It was measured once again after resting for 5 min. Two physical capacity tests were chosen for this investigation. Physical performance testing consisted of sit-and-reach and timed up and go test (TUG).

The subjects carried out a specific warm-up protocol prior to the tests and had a minimum recovery period of 10 min between the tests. The subjects were tested at the same time of day, and tests were performed in the same order for pre- and post-testing. The sit-and-reach test was chosen for lower body flexibility (ACSM 1999 (14)) and was performed first, with a slight modification in the starting position such that the subject began the test with the back flat against the wall and reached forward from that position.[14] A test of TUG, evaluating balance function,

was performed to measure the time required for the subject to stand up from a chair, walk a distance of 3 meters, walk back to the chair, and sit down. This simple test provides a comprehensive evaluation of the subject's balance, gait, speed, and functional ability in seconds.[15]

Training protocol

The aquatic exercises were performed three times per week for 8 weeks in the deep parts of the pool in the Shohada swimming pool of Borojen, Iran. The water temperature was 28–30°C. The training protocol consisted of 60 min with a 10-min light warm-up of walking, 30-40 min resistance exercises and a 5-10 min cool-down. The resistance exercises consisted of movements which included the major joints of the body, such as shoulder horizontal add-abduction with elbow extension–flexion, shoulder ab-adduction, elbow flexion–extension, hip flexion–extension, hip ab-adduction, abdominal flexion and torsion, and jumping. Exercises rotated between different muscle groups in such a way that, for example, a lower body exercise always followed an upper body exercise. A cool-down of 1 min of light cardiovascular exercise followed by 4 min of light stretching was always performed after the training sessions. The total duration of the training session for the mesocycles was: 45 min during weeks 1–3, 50 min during weeks 4–6, and 60 min during weeks 7–8.

Statistical analyses

All statistical analyses were performed using SPSS for Windows version 16.0. All data were normally distributed, and presented as mean ± SD. Independent t-test was used to compare the mean differences between-groups before and after training. Differences of $P \leq 0.01$ were considered significant for all statistical analyses.

Results

Fourteen postmenopausal women in the aquatic resistance training group and ten postmenopausal women in the control group conducted the test procedures of this study.

No significant changes were observed in weight and BMI of subjects after the exercise period. Changes in systolic blood pressure, dynamic balance and flexibility were shown in table 2. Systolic blood pressure decreased significantly after training in the experimental group (9.29%) compared with the control group ($P < 0.001$) (Figure 1).

Dynamic balance score (TUG) was significantly improved (22.02%) in the training group (from 7.71 ± 2.05 to 5.78 ± 1.31 seconds) compared with the control group ($P < 0.001$) (Figure 2). A significant increase was observed in flexibility in the training group (from 23.07 ± 6.66 to 27.78 ± 5.92 cm) by 24.44% after aquatic training ($P < 0.001$) (Figure 3).

Table 2. Changes in blood pressure and physical capacity

Variable	Aquatic Group (n = 14)		Control Group (n = 10)			
	Pre-test	Post-test	Pre-test	Post-test	t	P value
††SBP (mmHg)	125.16 ± 20.22	113.53 ± 17.69	126.44 ± 11.38	127.87 ± 12.58	-4.426	0.001 *
Timed Up and Go (sec)	7.709 ± 2.004	5.780 ± 1.314	6.866 ± 1.024	7.141 ± 1.204	-5.281	0.001 *
Sit-and-reach (cm)	23.07 ± 6.66	27.78 ± 5.92	28.14 ± 9.84	26.14 ± 8.80	3.288	0.004 *

*significant difference between groups

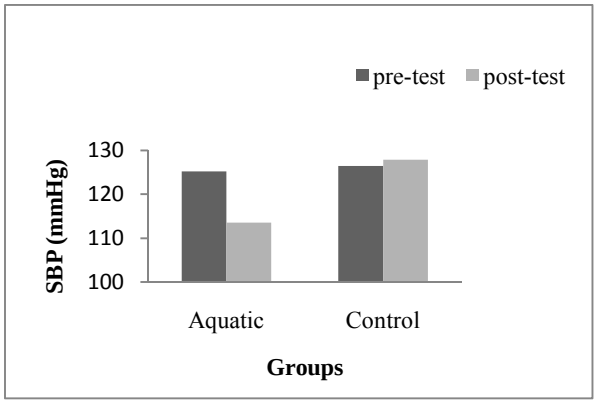

Figure1. Systolic blood pressure before and after aquatic training between aquatic and control groups

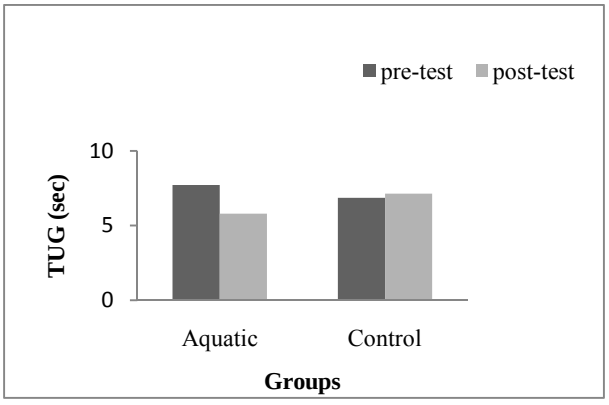

Figure2. Dynamic balance before and after aquatic training between aquatic and control groups

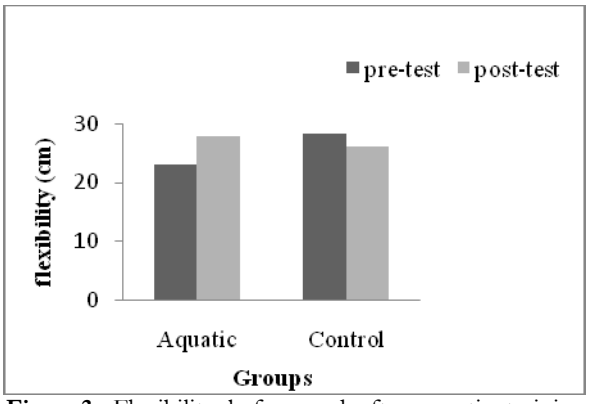

Figure3. Flexibility before and after aquatic training between aquatic and control groups

Discussion

The aim of this research was to investigate the effect of aquatic resistance training on blood pressure in postmenopausal women. Our data suggest that 8-weeks of water resistance training reduce the blood pressure of the participants from 125.6 to 113.36 mmHg. Based on this study, an 8-week aquatic resistance training exercise has an impressive effect on the resting systolic blood pressure in postmenopausal women. The results of the present study are in accordance with the findings of Colado et al.,[14] Zaros et al.,[9] Piotrowska-Calka,[16] and Karacan,[17] and indicate the significant effect of aquatic training on improving blood pressure. Numerous studies have investigated the mechanism of blood pressure reduction after dynamic and aerobic exercise. Based on these studies decreased total peripheral resistance appears to be the primary mechanism by which resting blood pressure is reduced after exercise training. Reductions in vascular resistance after training are mediated by changes in sympathetic nervous activity, altered vascular responsiveness and changes in vascular structure. Moreover, psychological and stress-reducing effects of aquatic environment may have an additional role in this.[18] Increased shear stress, due to enhanced blood flow, has been proposed as a major mechanism for the blood pressure lowering effect of exercise training.[19]

The results of the present research are in accordance with the findings of Avelar et al.,[20] Katsura et al.,[15] Littrell,[21] and Tsourlou et al.,[3] and Gunendi et al.[22] in indicating the significant effects of applying aquatic training on improving dynamic balance of postmenopausal women. Potential reasons for the increase in balance due to training include the increase in strength of subjects' lower limbs after participating in exercise programs, facilitation of the optimal functioning of muscles, quick contraction movement of organs, increasing adaptation of the muscles, and applying pressure on neuromuscular systems.[23] Moreover, hydrostatic pressure of water provides compression to the body surfaces which will aid in decreasing edema for rehabilitative cases and increasing balance by increasing joint mechanoreceptor activity.[11,24] With respect to obtained results we can say that aquatic resistance training is a pragmatic and effective method to improve the balance of people; we can apply this method to improve balance and enhance people's movement skills especially in aged people.

The results from the present investigation showed the effectiveness of aquatic resistance training in improving the flexibility of postmenopausal women. Likewise, other studies by Colado et al.,[14] Tsourlou et al.,[3] Littrell,[21] and Karacan[17] have shown that aquatic training has a positive impact on flexibility among postmenopausal women. Postmenopausal women find it challenging to find exercise activities that are safe, rewarding, and beneficial to their overall health. These women are drawn to water exercise programs for many psychological and physical reasons, including the supportive environment that provides freedom of movement, which may be lost on land.[21] Hence, water provides an environment for postmenopausal women to maintain cardiovascular health, muscle fitness, and flexibility.[21] Current studies although small in number support the improvement of flexibility through shallow and deep water training. Participants are able to use the buoyant properties of water to decrease joint stress while gaining flexibility.[11,25]

Conclusion

The present study suggests that an 8-week aquatic resistance training (supervised by a trainer) has an impressive effect on resting systolic blood pressure and also on dynamic balance and flexibility of postmenopausal women between 50-60 years of age. Thus, training with aquatic resistance exercises is a viable alternative to traditional resistance trainings, and may provide more benefits to individuals who are more sensitive to heavier loading or to impact, which may occur when training on dry land with certain devices and exercises. This mode of exercise can be particularly beneficial for individuals with orthopedic problems, overweight individuals, and those who have not learned how to swim

Acknowledgments

We would like to thank the subjects who participated in the present study and the mayor of Borojen for the grant to use the Shohada pool of Borojen.

Conflict of Interests

Authors have no conflict of interests.

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How to cite this article: Sattar M, Esfarjani F, Nezakat-Alhosseini M, Kordavani L. **Effect of aquatic resistance training on blood pressure and physical function of postmenopausal women.** ARYA Atherosclerosis Journal 2012; 8(Special Issue in National Hypertension Treatment): S178-S182.