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ORIGINAL ARTICLE

The Effect of Water-Based Aerobic Training on the Dynamic Balance and Walking Speed of Obese Elderly Men with Low Back Pain

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ABSTRACT

Background and Objective: Body composition changes such as high body fat percentage, muscle weakening and resulting physical problems such as low back pain and weakness in balance and reduced walking speed are among the problems faced by the elderly. Accordingly, the purpose of this study was to investigate the effect of water-based aerobic training on the dynamic balance and walking speed of obese elderly men withlow back pain.

Materials and Methods: This research was a semi-experimentalstudy with pre-test and post-test design. The subjects were 36 elderly aged persons (62.3±2.6 kg; 163.1±2.1 cm)with low back pain, body fat percentage higher than 35%, waist-hip ratio of over 95% and visceral fat above 100 cm2. In this way, using a systematic non-random sampling technique, the samples were divided into experimental and control groups randomly (each group included 18 subjects).While the control group continued their daily routines,the experimental group performed aerobic exercises for 4 months and three sessions of 60 minutes. All body composition variables were measured using the body composition analysis, walking speed by walking speed test of 10m, and the ability to maintain balance by time up and go test before and after the trainings. Independent and paired t-tests were used to analyze the data via SPSS software at the significant level of $P < 0.050$.

Results: It was suggested that experimental group had a significant decrease in the test time of 10 m walking speed ($p = 0.001$), time up and go test ($p = 0.001$), as well as in obesity variables ($p = 0.001$) and back pain ($p = 0.001$) after four months; however, no significant reduction was observed in any of the test times and variables of obesity and low back pain in the control group.

Conclusion: aerobic exercise seemsto improve walking speed, maintain balance and also reduce obesity and low back pain in obese elderly people and can be used in conjunction with other training programs. However, this research has its own limits and further research is needed.

Keywords: elderly, water-based trainings, abdominal obesity, low back pain

INTRODUCTION

Elderly is a process which all human beings experience in every sex, race, and culture. This is a period that will be very enjoyable if the elderly enjoys a good mental and physical quality (Farsi, Abdoli, & Baraz, 2015). Lower back pain or spinal cord pain is one of the most common musculoskeletal disorders in this age. The high prevalence of low back pain and disability resulting from it will have a very negative effect on the elderly in the daily routine (Nachemson, Waddell, & Norlund, 2000). One of the factors that can cause back pain in middle age and aging is body composition changes, including increased body fat mass, especially in the abdominal region, and muscle weakening of the multifidus.With the increase in abdominal obesity, a compensatory artery is created in the Dimples of Venus, and the increase in upper body

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mass also causes a great deal of pressure on the intervertebral discs (Ebenbichler, Oddsson, Kollmitzer, & Erim, 2001).Due to increased lumbar lordosis, the center of gravity moves forward and causes changes in walking, disturbed postural control, and increased risk of falling in the elderly (Wright & Perricelli, 2008). Falling is along with various complications, including pelvic fractures, head fractures, and even death (Tinetti, Speechley, & Ginter, 1988). One of the factors affecting elderly balance is biomechanical factors such as posture (Choi et al., 2011).Increasing age causes biomechanical changes and increased lumbar lordosis of spinal cord (D. Kado, 2009). Some researchers reported an increase in kyphosis by reducing the balance (Antonelli-Incalzi et al., 2007; D. M. Kado et al., 2009), while others rejected the relationship between lumbar lordosis and balance (Ishikawa, Miyakoshi, Kasukawa, Hongo, & Shimada, 2009; Kasukawa et al., 2010). In a study of 1,196 elderly people, the risk of falls was more than 1.5 times more likely to occur in people with an arch behind the Cobb angle of more than 53.1 degrees (D. M. Kado et al., 2009).In another study, 36 percent of people with a history of falling in past years had Hyperkyphosis postures, but this posture was 30 percent in the subjects who had not fallen down. Also, the report for the fall of humans last year was 32.1 times higher for people with Hyperkyphosis posture than those with a natural lumbar lordosis (D. M. Kado et al., 2009). There is a dearth of studies examining the relationship between lumbar lordosis and balance (Ishikawa et al., 2009; Kasukawa et al., 2010). For example, diminished and inverted lumbar lordosis (kyphosis) was more severe in people who fell more than once a month than people who had not a history of falling or fear of falling.Also, there was a significant relationship between the history of falling down with a lumbar lordosis and not with a back lordosis.The researchers concluded that the limitation of compensatory mechanisms to correct the shift of the gravity center in the kyphosis was due to the fact that the ratio of kyphotic changes in the back vertebrae in these cases increased the risk of falling (Kasukawa et al., 2010). However, another common problem that is prevalent among elderly people is the inability to walk properly. One of the aspects of walking that can be affected by the increase in lumbar lordosis is walking speed. Reducing walking speed if it reaches values of less than 1 to 1.2 m/s brings about problems for the elderly (Hoxie & Rubenstein, 1994). The reduction in walking speed in the elderly is also associated with an increased risk of falling for the individual (Josephson, 2005).Despite the wide variety of exercise therapy, there is still not enough evidence of the superiority of one method to the other. Some recommended Williams flexor exercises. After a while, it was indicated that Williams exercises increase the pressure on the inside of the disc. Therefore, the popularity of these exercises was reduced, and isometric exercises were prescribed instead ((Dundar, Solak, Yigit, Evcik, & Kavuncu, 2009).However, some other static enhancements to the central muscle of the body and the public health stabilizers have typically suggested strength development and spinal strengthening programs (Ebenbichler et al., 2001).In this regard, Dundar et al. (2009) reported in a study that water-based exercise reduces functional disability in the elderly who suffers from back pain (Dundar et al., 2009). Avelar et al. (2010) reviewed the effect of six weeks of endurance training in water and land in parameters such as walking speed and elderly balance, and concluded that endurance exercises in both water and land would improve the balance of elderly people. However, it had no significant effect on walking speed (Avelar, Bastone, Alcântara, & Gomes, 2010).In Onestudy, Cao et al. (2007) stated that regular and ongoing physical activity and exercise can effectively reduce risk of falling and promote mobility of the elderly (Cao, Maeda, Shima, Kurata, & Nishizono, 2007). In 2009, Irez also showed that it was possible to slow down the motor performance of these individuals by performing regular lifestyle activities (Irez, 2009). Iwamoto et al. (2009) found that exercise and physical activity improved balance, flexibility, muscle strength and walking ability in older people (Iwamoto et al., 2009).Water-based training is also one of the methods that has been taken into consideration by sports and rehabilitation specialists in recent years (Aidar et al., 2013).This exercise is a series of specialized exercises that involve the body and the brain in a way that it affects power, endurance, and flexibility. Due to the presence of features such as hydrostatic

pressure, floatation and deep sense of sensation, water environment can be an ideal environment for physical exercises (Shiri, Karppinen, Leino-Arjas, Solovieva, & Viikari-Juntura, 2009).According to the research, it has been determined that the elderly suffer from changes in their posture due to age, which increases the lumbar lordosis, reduces the ability to control the posture and their walking speed, and reduces the quality of life and depression and their dependence on others. Therefore, the present study aimed to investigate the effect of water-based aerobic trainings on body composition, back pain and postural control in obese elderly men.

METHODOLOGY

This research was a semi-experimental study with pre-test and post-test design. The statistical population consisted of elderly obese men who were referred to the consulting and nutrition clinic for dietary program. Of these, 46 subjects were selected, of which 6 ones were not eligible for inclusion, and 4 were not willing to cooperate. Subsequently, 36 subjects were randomly divided into experimental and control groups.The subjects were asked to refer to the clinic on a specific day in order to measure their height, weight, BMI and familiarity with the research procedure.Before the beginning of the training period, Medical History Questionnaire and Physical Activity Readiness Questionnaire(PAR-Q)(Thomas, Reading, & Shephard, 1992) were respectively used to determine the health status and level of physical readiness of the subjects.The Physical Activity Readiness Questionnaire (PAR-Q) is aquestionnaire with seven "Yes and No" and is designed to select individuals when engaging in physical activity that may be intense to them.PAR-Q is recommended as a standard for introducing moderate intensity exercise programs. The questions in this questionnaire are in the area of cardiovascular health, joint discomfort and hypertension (Thomas et al., 1992).Given that the PAR-Q was used in the pre-test and in order to qualitatively examine the participants' ability to participate in the training program as a criterion for selection, all the participants had selected the response "No", and the individuals who answered even one question Yes, were excluded in the training program.

Inclusion criteria

The inclusion criteria included: the age range of 60 and over, with the history of back pain, body fat percentage of 35%, waist to hip ratio of over 95%, and visceral fat of over 100 cm, a functional autonomy in daily activities, ability to travel at a distance of 12 meters or without auxiliary equipment, ability to follow the instructions and give proper answers to questions without any help (to examine the cognitive level of the subjects), the willingness to participate in the research, the use of psychiatric medication affecting the balance, the absence of a history of lower limb injury along the past six months, or neuromuscular problems, lack of visual impairment, no abnormality effective in the process of research (in the upper and lower limbs), no history of surgery in the past year, and lack of fractures in the upper and lower limbs to a year before the survey.

Exclusion criteria

Exclusion criteria were: having insulin dependent diabetes mellitus, arthritis rheumatism, people with heart and hearing problems, cerebrovascular disease or any environmental and central disease that may interfere with sensory input, having a compartment syndrome or any previous vascular status in the lower limbs, pain with maximum muscle contraction, scratching or rubbing skin, or any adhesion sensitivity, central or environmental system diseases, Varicose veins and other vascular diseases.

Ethical considerations

This study was referred to the Ethics and Research Council of Imam Khomeini International University for ethical review, and carried out after obtaining permission from this committee (No. 17682). Before the onset of the study, the research process (research objectives, how the variables were measured, how the exercise program was conducted, and the length of the research period) was explained to the subjects. All the participants participated voluntarily in the research and with the completion of the consent form.

Measuring the rate of back pain in the elderly

In order to assess the back pain, a 9-item questionnaire (the Keele STarT Back) was used to categorize the pain that determined both physical and psychological factors of pain. The reliability of this test had been reported as 0.79 (Hill, Dunn, Main, & Hay, 2010). To measure pain, visual analogue scale was used as percentage of pain. This horizontal bar scale is 100 mm or 10 cm long, with a zero end point, no pain, and another end point 10, that is, the most severe pain possible. The patient was asked to look at the continuum while measuring the pain he felt at that moment. The internal consistency of this scale, according to previous studies, is ICC = 0.91 (Karimi, 2004).

Body composition measurement

The obesity variables including total body obesity: percentage of body fat (PBF) and visceral obesity: waist hip ratio (WHR), visceral fat intake using a body composition analyzer (South Korean manufacturing model ZENUS 9.9) were measured.

Measuring 10 meters of walking speed

To measure the speed of the elderly, the subjects were asked to travel 10 metersat a maximum speed. In this research, each subject performed the test twice, with his best score calculated. Dividing this number by the desired distance, the speed of the person's walking was obtained in meters per second.

Time up and go

Before the onset of the training, the TUG test (with the reliability of 99%) was used to predict the risk of falling, so that the dynamic balance of the participants in the experimental and control groups was measured (Lopopolo, Greco, Sullivan, Craik, & Mangione, 2006). The test was executed in such a way that the participant, without using his hands, rises from a non-armchair chair, after returning to a three-meter course, he would sit again in the chair (Buchner et al., 1997).

Training program

The water-based training program lasted for four months, 3 sessions per week and 60 minutes per session with vo2max intensity of 40% -50%, including warm-up stages (15 minutes; stretching in all joints and major muscle groups; walking forwards, backwards, sides, on heels and paws, and jogging in water), training (30 minutes; weight transfer from front to back, rotation around a square, feet balance training, standing on one foot (pauses every 20 seconds) , weight transfer from side to side, step by side, scott, back hamstring, hip opening, single bicycle foot, pendulum training, reaching the elbow Eating, exercising the pendulum, moving the palm resting elbow in a standing position, practicing the pendulum of the hands) and returning to the initial state (15 minutes; stretching training, deep breathing, and floating exercises) (Dundar et al., 2009).Subjects' diets were adjusted according to the data extracted from their body composition based on the amount of calories recommended daily by the nutritionist.In this study, Shapiro Wilk teststatistical test was used to evaluate the normality of the data and then independent t-test and paired t-test were run for their analyses. Finally, the data were analyzed in SPSS version 21 software. Furthermore, $P \leq 0.05$ was considered as a significant level.

Findings

The results of t-test showed that the muscle volume of

Table 1. General and anthropometric characteristics of the subjects in the experimental and control groups

Variable	Group	Control		Training in Water		p
		Pre test	Post test	Pre test	Post test	
	Age	63.3±1.4		63.1±2.4		-
	Height (cm)	168.7±1.4		167.4±2.8		-
	Weight (kg)	80.9	79.5	83.5	79.2	*0.0001
	Percentage of body fat (%)	37.3	36.8	37.6	32.6	*0.001
	Muscle tissue (kg)	28.2±0.8	27.9±1.2	28.4±1.2	31.9±1.1	*0.003
	WHR (Waist hip ratio)	0.95	0.94	0.96	0.88	*0.001
Abdominal fat	Visceral Fat (cm^2)	107	106	106	94	*0.001

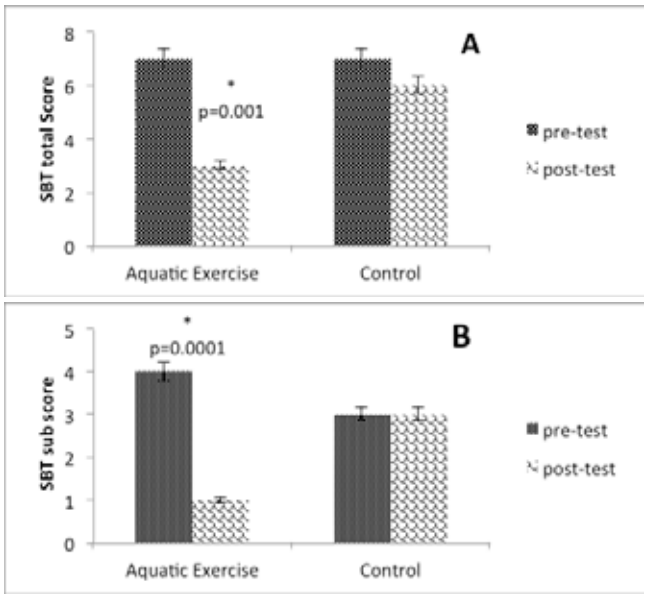

Figure 1. Assessment of back pain in the study groups A: Comparison of physical pain symptoms in experimental and control groups B: Comparison of psychological symptoms in experimental and control groups

the subjects with physical activity was significantly increased compared to the control group (p = 0.03). On the other hand, water-based training group had a significant improvement in abdominal obesity in two variables: waist-hip ratio and visceral fat (p = 0.001) (Table 1).

As shown in Figure 1, (a) physical symptoms and (b) psychological symptoms of pain following water-based training were significantly reduced (p = 0.001)

As shown in Fig. 2, both abdominal obesities (waist hip ratio and visceral fat) ws decreased significantly after water-based training (p= 0.001).

As shown in Table 2, the results of paired t-test in time up and go test suggested that the experimental grouphad a significant improvement after the exercise intervention (t=0.511; p= 0.001), whereas the difference for the control group was not significant (t=0.511, p = 0.616). The results showed that there was not a significant difference between the experimental and control groups at the time and go in pre-test. However, there was a significant difference between the experimental and control groups in post-test scores.

As shown in Table 3, there is a significant difference between the walking speed in the experimental group (t=5.801; p= 0.001) while this difference was not significant for the control group (t=0.054; p= 0.958). The results showed that there was not a significant difference

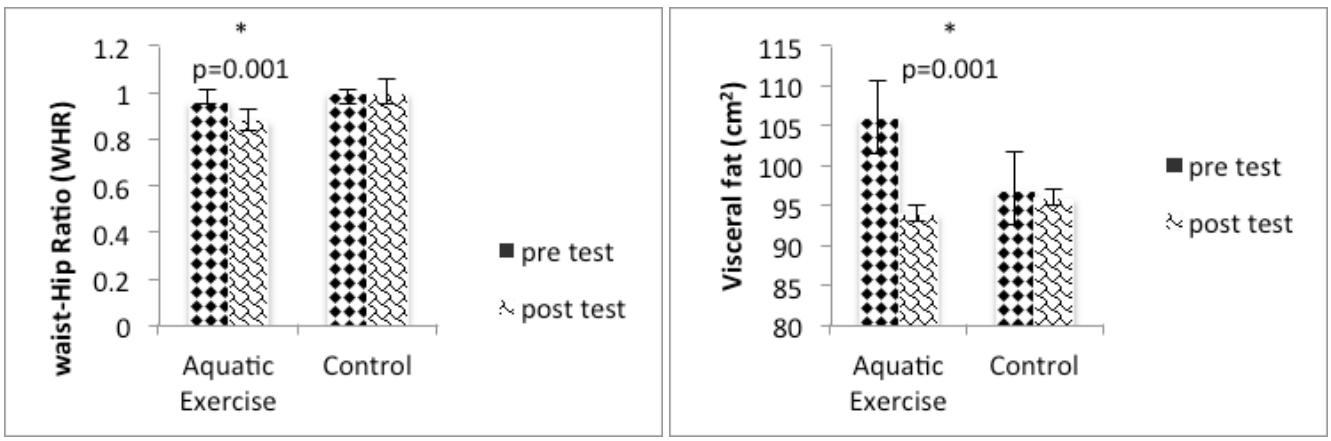

Figure 2. The effect of water-based training on abdominal obesity A: Waist hip ratio. B: Visceral Fat

Table 2. the effect of water-based exercise on time up and go inthe control and experimental groups

Group	Pre-test Mean ± SD	Post-test Mean ± SD	t statistic	Significance level*
Control	8.05 ± 0.45	7.98 ± 0.33	0.511	0.616
Experimental	8.28 ± 0.38	7.53 ± 0.38	6.55	0.001*

The * Significance level is P≤0. 05

Table 3. the effect of water-based exercise on time up and go in the control and experimental groups

Group	Pre-test Mean ± SD	Post-test Mean ± SD	t statistic	Significance level*
Control	1.91 ± 0.04	1.92 ± 0.03	0.054	0.958
Experimental	1.90 ± 0.03	1.85 ± 0.04	5.801	0.001*

The * Significance level is P≤0. 05

in the pre-test in walking speed of two groups, but there was a significant difference in the post-test scores between the experimental and control groups.

As shown in Table 3, the results of paired t-test for between group mean of the pre-test and post-test of walking speed of 10 m in the experimental group were significantly different (p = 0.001), while the difference for the control group was not significant (p= 0.958). The results showed that there was not a significant difference between the experimental and control groups in the pre-test walking distance of 10 meters. However, there was a significant difference between the experimental and control groups in post-test scores.

DISCUSSION AND CONCLUSION

The purpose of this study was to investigate the effect of water-based aerobic training on body composition, back pain and postural control and walk in elderly obese men. The results showed that water-based training reduces the physical and psychological symptoms of back pain, decreases the abdominal obesity, WHR and visceral fat, and improves the balance and walking speed.As stated in the theoretical framework of the research, there was a direct relationship between abdominal obesity and back pain; therefore, one of the main causes of back pain in the water-based aerobic training group could be attributed to the reduction of abdominal obesity. The findings of the study are consistent with the results of the study by Taheri et al. (2014) who postulated that water therapy in retired professional soccer players could reduce back pain. As indicated in the results of the study, in addition to decreasing the fat mass of the experimental group, there was a significant increase in the muscle tissue of the water-based training group, which in turn could increase the strength of the spine and reduce the pain of the waist.According to Archimedes law, weightlessness in water causes pressure on the muscles of the body in water to be seven times less than that in the dry, which increases the tolerance and endurance in water (Kotzampassi, 2013; Taheri & Irandoust, 2014). The floating property in water acts in unlike gravity and makes the patient slim and reduces pressure forces on the joints.Water protects the damaged members and enables the patient to take a comfortable position so that it does not increase pain. As a result, the cycle of pain is broken. The stimulatory effects of water cause the relaxation of the spastic muscles and reduce the protective effect of the muscles. Hot water by blocking the nervous system distorts the patient's attention to pain, so that the blocking of sensory stimuli through thicker, faster, and more conductive fibers transmitted pain and competes with the transfer of pain. As a result, the patient's sense of pain is blocked (Burke et al., 2001); and it allows the patient to strengthen the postural muscles; therefore, given the effectiveness of the exercises applied in the present research, as well as considering that the therapies should be effective and have no side effects, it is suggested that patients with chronic nonsteroidal back pain who suffer from reduced endurance of the postural extensor muscles use a water-based training program to strengthen these muscles. Along with the results of this study, other studies have shown that water therapy improves pain and disability in patients with chronic back pain (Maul, Läubli, Oliveri, & Krueger, 2005).On the other hand, reduction of abdominal obesity, which is essential for lower back pain, was mentioned in this study, which is in line with the results of Giannopoulos et al., Slentz and colleagues (Giannopoulou et al., 2005; Slentz et al., 2004). Also, improvement in balance and walking speed is consistent with the results of the studies conducted by Dundar et al. (2009), Genobu et al. (2007), Bijet (2009), and Suzuki et

al. (2009); however, they were inconsistent with part of the results of Oular et al. (2010), who stated that endurance training in water and land did not have a significant effect on road speed.Although the nature of the training program used in the studies is similar, the difference in the results pertains to ignoring the factors such as the level of fitness, physical activity, motivation, gender, age, height, and weight of the subjects. Also, the observed difference in the studies can be attributed to the research methods as well as other variables. Although muscle strength decreases with age (Md et al., 2002), it can be adjusted in the elderly (Rogers, Rogers, Takeshima, & Islam, 2003).Conducting sports exercises compensates for age-related functional changes, and maintains independence in aging for a longer period of time. Research findings suggest that regular physical activity reduces body fat stores and increases strength and muscle endurance and the ability to do daily activities. Muscular atrophy, also associated with age, can be delayed or reversed through aerobic and strength training (Md et al., 2002). Since the training program of this research goes under the rubric of aerobic training, the process of fat tissue decolonization seems logical. In general, the pleasure of the water environment compared to other exercise environments makes it more relaxing in humans and can provide a basis for reducing visceral fats. It is worth mentioning that the elderly's physical limitations limit the opportunity to apply different training programs. Therefore, exercise in water is an innovative approach to preventing many physical disorders such as back pain and, on the other hand, a novel way of relaxing people both physically and mentally.

CONCLUSION

Given the results of this study, it can be said that water-based aerobic training can reduce the percentage of visceral fat and lower back pain and improve the balance and walking speed of the elderly. Research has shown that a regular attendance in sports activities may reduce the amount of abdominal fat and improve musculoskeletal control, reducing lower back pain and improving the quality of maintaining balance and walking speed in the elderly. These exercises, with the strengthening of the central muscles of the body, and the neuromuscular strengthening of the gravity line, are normal and cause the body to balance in a favorable state. As a result, exercises can be used alongside other elderly rehabilitation programs.

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