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Research Article

EIGHT WEEKS AQUATIC MUSCULAR ENDURANCE TRAINING ON SOME KINEMATICS GAIT PARAMETERS IN MALE ELDERLY

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ABSTRACT

Regarding the consequences of aging for the elderly, we can refer to gait speed reduction, functional disorder and power reduction. The current study aimed to investigate the effectiveness of eight weeks of muscular endurance trainings in water on the orderly's gait kinematic parameters (step length, cadence and gait speed). In the current semi-experimental study, two elderly groups consisting of 16 male participants were divided into control group (average and standard deviation age of: 62.33±1.33 years, height: 1.69±5.83 and weight: 80.26±6.41 kilograms) and experimental group (average age deviation: 64.57±2.88, height: 168±4.26 and weight: 73.84±6.17 kilograms). The experimental group took part in training sessions for eight weeks (two sessions a week) while the control group didn't take any treatment. Using Vicon 460, both experimental and control groups were tested based on the parameters before and after the training session. Relatively, the depended and independent sample t tests were used to assess and compare changes within and between groups, at the level of 0.05. There was a significant increase of the step length in the experimental group. However, except for the step length, both experimental and control groups didn't show any significant difference in other parameters. Regarding the obtained results, muscular endurance trainings in water can be used to improve the elderly's step length. Length step improvement maybe is resulted from the muscular tnemevorpmi and balance leading to longer steps and distance.

Keywords: *Gait, Elderly, Muscular Endurance Trainings, Kinematic*

INTRODUCTION

Walking as one of the basic skills, has allocated the most daily locomotor activity to itself (Gordon *et al.*, 2004). The skill which is associated with problems in old age is considered as a measure for determining the achievement of independence in carrying out daily activities of this group of people in the society. The identification of factors and constraints affecting walking in older age, and the methods of delaying the onset of these problems has been of interest for the researchers. Sadeghi *et al.*, (2001) by increasing in age the elder's get changes in muscular performance of the lower extremities and subsequently they confront disturbances in biomechanical model of walking and parameters such as stride length and speed (Sadeghi *et al.*, 2001). They also stated that in elderly, in comparison to younger people, it is the strength of the sagittal muscle that affects the stability and balance phase during walking (Sadeghi *et al.*, 2001). Mac *et al.*, (1992) believe that muscle weakness in his abductors, knee flexors and extensors and dorsiflexion muscles of the ankle are associated with the risk of falling during movement and walking. In fact, the changes in biomechanical capacities of persons in old age can cause falling, injuries and disorders in the elder are walking (Macrae *et al.*, 1992). Including changes in stride length and reducing the reliance surface during stepping. Exercise and physical activity is one of the fundamental strategies to prevent and control disease. In the past, it was believed that only exercise at young ages help to increase endurance during old ages whereas recent researches indicate that exercise is beneficial for anyone of any age (Doherty, 2003). Although the physical ability decreases with age, doing physical activity and regular exercise we can reduce physiological deterioration by 50% (Rajabi and Gaeini, 1999). Exercise also helps to maintain and strengthen the muscular mass, stability and balance which is associated with increased bone density and body harmony to prevent hip fractures resulting from falls (Patricia, 2004).

So far, the effect of different exercises is used on biomechanical parameters such as power walking, yoga, gnihcterts. Sadeghi *et al.*, (2007) have reported the positive effects of strengthening exercises on walking speed and stride length (Sadeghi *et al.*, 2008). Salma *et al.*, (2001) implanted a 10-week exercise program for three days a week including warm-up exercises, aerobic and strengthening exercises on the lower extremity in order to observe its kinematic and kinetic variables of walking through collecting data with cinematography force plate instruments from 30 patients who had a chronic heart attack. Which ultimately increased the function of flexors and plantar flexors of the ankle dorsiflexion and hip extension and improvement of muscle power and walking energy (Teixeira-Salmela *et al.*, 2001). Fabiano *et al.*, (2009) in a study entitled as stretching program to improve walking in older women, concluded that the increase in stride length and walking speed (Andre *et al.*, 2009).

In recent years, the practice of water exercise programs for the elderly has been added to the collection. As the water environment has features such as hydrostatic pressure (Genuario and Vegaso, 1990), float (Genuario and Vegaso, 1990; Thein and Brody, 1998) and also for increased sensory feedback (Balogun *et al.*, 1992) and noitpecoirporp (Geigle *et al.*, 1997), it could be a suitable environment for physical exercises. Since many of the actions that take place on land, can be easily achieved in water and patients could do these exercises with less intensity than on the land and, regarding the therapeutic value of exercise in the water, this method has received interest in the elderly population. The effect of this exercise method has further been on health-related factors and has been used on individuals with balance or physical diagnosis such as heart disease and osteoarthritis (Suomi and Koceja, 2000; Candeloro and Caromano, 2008; Chu *et al.*, 2004; Lord *et al.*, 1993). Although endurance exercises are considered as the needs of the elderly, few researches have investigated the effect of muscular endurance and aerobic exercises on biomechanical parameters of walking. But recently, Ovelar *et al.*, (2010) have reported the effect of endurance exercises on the muscles of the lower extremities in water and on the lane on static and dynamic balance in older people and have reported balance as a result of these exercises. In a study conducted by Chu *et al.*, (2004) the results indicated that eight weeks of exercise in the water had no effect on patients with heart disease, but significantly improved cardiovascular fitness, walking speed and lower extremity strength. However, the effectiveness of exercise in water on biomechanical parameters of walking in healthy older people is of little attention (Booth, 2004). There are few researches which have investigated the effect of water exercise on walking in the elderly, also there was no research investigating the effects of muscular endurance exercises on biomechanical parameters of walking in the elderly. Hence, regarding the influence of muscular exercise in water on some kinematic parameters of walking was the purpose of the study.

MATERIALS AND METHODS

Methodology

This study was a prospective and quasi-experimental where the variables were assessed in both the exercise and control groups using pretest-posttest design. The exercise program is reviewed and approved by the Ethics Committee of the Faculty of Physical Education and Sports Science, composed of experts in physiology, motor behavior, sport biomechanics and pathology. The study population is comprised of all 60 to 70 year retired members of the Retirement Education in Karaj city who were informed to participate in the study through recalls and notifications installed in the center. After registering all volunteers interested in participating in the study, only 20% of the patients who fulfilled inclusion criteria were investigated, and were selected as the sample (Table 1). In addition to cultural considerations and also because the separate practice of men and women can be different in the exercise providers and heterogeneity of exercising participants is not restored, it was not possible to train men and women together, so only males entered the study.

Table 1: Inclusion and exclusion criteria

The exclusion criteria	The inclusion criteria
The elderly people who have been treated with physical therapy or respiratory diseases, metabolic diseases; infectious skin disorders; neurological disease, or severe vision or hearing impairment	Age between 60 to 70 years and having the physical activity readiness questionnaire obligations

In order to ensure the health of the subjects and their ability to attend and complete the exercise period, a medical questionnaire and physical activity readiness questionnaire was used. The blood pressure was recorded before the beginning of the exercise.

Methods and aims of the study were explained to the volunteers and they were informed to complete the consent forms.

The participants were assured that their personal information and their health will be safe and each subject was also able to leave the study anytime he wanted. After filling the consent form by the examinees, they were placed in two groups of exercise in water (n = 10) and control group (n = 9).

It should be noted that during practice, two members of the exercise group, one in the second week (due to personal problems) and another in the third week (due to cold and lack of ability to participate in the exercise) avoided to participate in the exercises, so that the number of the subjects in this group was reduced from 10 to 8. Also one of the subjects from the control group left the group (due to travel) in the posttest and this group was reduced to 8.

To collect data, the Vicon 460 set at the University of Science and Rehabilitation was used. Foot markers were placed on the outer ankle, heel and outer edge of the foot joint – the fifth finger.

The participants were asked to walk at a normal speed of 10 m while raising their head up and looking straight. Before the exercise, to ensure that all participants walk in their normal pace, they were allowed to practice walking for several times in vitro.

After this process, the phase of testing began and well continued for two tests and two good tests were selected for further calculations. All the procedures were repeated for the post-test. Video data were filtered using a fourth order in Batrors filter. The position of the markers used in this study was used to calculate the parameters and the variables of interest were calculated using Matlab software 2010.

The exercise group was exercising in water intermittently over a week (2 sessions per week), (pool of Khwarizmi University). The exercising place of these elder people was safe and had an appropriate environment. Lifeguards were present in the water during the workout.

In addition, the trainer was completely familiar with first aid. In the exercising program also the approved and appropriate exercises that are not harmful to people.

Table 2: Exercising Protocol

10-15-minute warm-up, aerobic exercises (18-25 minute walk with the severity of MHR60-50%), muscle endurance exercises (20-30 minutes) and 5 minute cooling down exercises. In general a practice session lasted about 70 -60 minutes.	Exercising Protocol
Walking forward, walking backward and sideways walking (on both the left and right) were considered. Two-thirds of total aerobic exercise time was allocated to walking forward. About 10 minutes of walk forward walking was done and then the alternates of walking forward, backward and sideways were done.	Aerobic exercises
In the first to the third weeks, the muscular endurance exercises include: 1.Abduction of the hip 2.Hip flexion (knee in extension mode) 3. Hip abduction 4. Hip extension 5.Triple flexion of the lower extremities (simultaneous hip, knee and ankle flexion) 6. Strengthening anterior and posterior leg muscles (standing on tiptoes and heels and tiptoe or heel walking) 7.Rotating torso (to strengthen the abdominal muscles and the para-spinal muscles, respectively). In the fourth and fifth weeks, half sitting squat instead of triple flexion exercises were added and in the sixth week single-leg squat, standing on single leg replaced half sitting squat. Number of the muscular endurance repetitions was equal to 50-60% of the average of the maximum where the subjects could move close to exhaustion.	Muscular endurance exercises

In the first week of the exercise, by taking the test, the maximum number of participants (up to exhaustion) would perform the desired action and the average was considered as the maximum number of iterations. The test was repeated in the fourth week so that the development of the subjects is considered for overloading practices. The desired movements for each exercise session were 2 to 3 sets (2 sets from the first week to the forth week, and 3 sets from the fifth week on) was performed. Every week, 5 to 10 percent was added to the number of movements per set and walking was increased.
It should be noted that in the first to fourth weeks, the subjects were standing next to the walls and were attempting to balance themselves during muscular endurance exercises in water. But during the fifth to eight weeks the above mentioned exercises were performed without any aid in order to increase the overload and challenge the systems involved in balance control.
Descriptive statistics were used to describe the data and determine the measures of central tendency of each group (mean, standard deviation). To examine the distribution of quantitative data of variables, the Shapiro-Willkie (SW) test was used. To assess within-group variation in measurements before and after the period, dependent t-test (t) and to compare the results of 2 groups independent t-test at a significance level of 0.05 was used.

Research Findings

Physical characteristics of the subjects are presented in Table 3.

Table 3: Mean, standard deviation, minimum and maximum physical characteristics of the control and experimental groups

Variable	Group	Average	SD	Minimum	Maximum
Age	Control	63.33	1.66	60	65
	Experimental	64.57	2.88	61	70
Height (m)	Control	1.69	5.83	1.61	1.80
	Experimental	1.68	4.26	165	1.76
Weight (Kg)	Control	80.26	6.41	70	89
	Experimental	77.84	6.17	61.80	80.50

In Table 4, the mean and standard deviation of the parameters such as walking speed, stride length and the number of steps per minute are presented along with a significance level of intergroup and within the group differences. The information of the table indicates that from among the parameters studied; only the stride length has increased.

Table 4: The mean and standard deviation of pre-test and post-test records for both control and experimental groups with a significance level of independent (intergroup comparison) and dependent t-test (within group comparison)

Variables	**Training stages**	**Standard Deviation**		**Intergroup significance (independent t test)**	**Intragroup significance level (dependent t test)**	
		Control (n = 9)	**Experimental (n = 8)**	**Control and experimental**	**Control (pretest and posttest)**	**Experimental (pretest and posttest)**
Stepping speed (m/s)	Pretest	1.13 (0.20)	1.24 (0.13)	0.245	0.999	0.866
	Posttest	1.13 (0.20)	1.23 (0.10)	0.244		
	The extent of progress	0.00 (0.00)	-0.009 (0.14)	0.866	-	-
Stride length (m)	Pretest	1.31 (85.03)	1.31 (84.59)	0.887	0.321	0.010
	Posttest	1.28 (79.16)	1.38 (41.67)	0.008		
	The extent of progress	-33.03 (80.78)	72.56 (59.14)	0.012	-	-
Stepping rhythm (the number of steps per minute)	Pretest	51.67 (7.75)	56.34 (4.28)	0.174	0.326	0.629
	Posttest	52.70 (8.02)	55.11 (4.30)	0.475		
	The extent of progress	1.03 (2.56)	-1.12 (6.30)	0.414	-	-

- *= significance at the level of 0.05*

Discussion and Conclusions

The purpose of the present study was to investigate the effect of an eight-week exercising program on muscle strength in water on some of the kinematics parameters of gait (stride length, walking speed and rhythm) in men aged 60 to 70 years. The results showed that this training program resulted in only significant improvement in step length of participants in the exercise. To take a step rather than only aspects of balance, the cooperation of different groups of muscles is required, too and the amount of moving, bending, and opening, closing and getting close to take a step depends on the strength and muscular endurance in successive steps. Enough muscular strength and endurance allows steps to be taken in proportion to the body size. For this reason, it seems natural that to compensate the depletion in strength and endurance of essential muscles in walking, one can increase the stride length of the elderly in successive steps. In the literature review there was no research that investigates the effect of endurance muscle training in water on stride length. From among the reasons for the improvement in stride length by exercising muscular endurance in the water, the increased strength of muscles can be noted that endurance training affects the stride length of elderly people. The results of this investigation is consistent with the findings of Judge *et al.,* (1993), Kerrigan *et al.,* (2001), Dibenedetto *et al.,* (2005) and Sadeghi *et al.,* (2008) who reported the effectiveness of exercise on stride length, but it is inconsistent with gene Coa *et al.,* (2007) and Sadeghi *et al.,* (2009) researches.

Lack of change in the rhythm of taking steps in this study indicates that the stepping rhythm is not only influenced by the increasing strength in the lower extremity. Reviewing the previous researches, no study was found to investigate the effect of muscular exercise on stepping rhythm in water or on land. Although some studies have been conducted on the effect of exercise on stepping rhythm (Coa *et al.,* 2007, Sadeghi *et al.,* 2009, Sadeghi *et al.,* 2008) all the researches indicate the ineffectiveness ofthe effect of exercise on stepping rhythm. Effects of muscular endurance exercising in water on walking speed of old men, was another component of the present study. Since walking speed is dependent on stride length and stride rhythm (Faghihy, 1996), increasing stride length and higher rhythm both can lead to an increase in walking speed. The results of this study, showed no significant effect of exercising muscle strength in water on walking speed in old men. Investigating the previous studies, this study is consistent with the research conducted by of Oular *et al.,* (2010), Bachner *et al.,* (1997), and the present study is consistent with other studies in that exercise has no effect on the walking speed of elderly people as Sauvage *et al.,* (1992), Buchner *et al.,* (1997) Sadeghi *et al.,* (2009), and is also consistent with other studies in that exercise has an effect on the walking speed like Lord *et al.,* (1996), Lopopolo *et al.,* (2006), Sadeghi *et al.,* (2008). The reason may be noted that muscular endurance exercises in the water have no effect on walking speed and the exercises are not performed with maximum speed and it seems that subjects' speed in the pre-test was normal. Therefore the performed exercises have not shown any change in their walking speed in the posttest.

Conclusion

According to research findings, practicing muscular endurance in water can improve the stride length of elderly men, and this increase is probably due to the strengthening of the muscles involved in walking, which consequently influence the balance performance, which has improved the stride length.

Limitations of the Study

Age and Sex of the participants (healthy elderly males 60 to 70 years old) are within the control area of the researcher, but the limited number of subjects and their individual differences were among the uncontrolled limitations of the present study.

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