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ORIGINAL ARTICLE

# The Effects of Aquatic Isometric and Isotonic Resistance Exercises on Fatigue Index of Aged Men

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**ABSTRACT**
**Background:** Fatigue is a common symptom of aging that may be attributed to a decline in normal functioning. Therefore, the aim of the study was to investigate whether aquatic isometric and isotonic resistance exercises improve the fatigue index in aged men.
**Methods:** Forty-elderly men were volunteered to participate in the study and were randomized into two groups of either Exercise (n=20; 70.6$\pm$2.3 years) or control group (n=20; 68.8$\pm$3.8 years). Blood Lactate Acid Concentration (BLC) and maximal tolerance to treadmill walking (MTW) were measured before and after exercise intervention. Exercise group (EG) underwent 10 weeks of exercises (3 days per week), while the control group received no specific exercise program. All exercises were performed 2 Sets of 15 Repetitions at 70 percent of subjects' peak strength. ANCOVA test was used to analyze the data at the significance level of 0.05.
**Results:** The results indicated that EG had Improvement in post-test fatigue index compared to CG [18.82% for BLC (mg/Lit) and 19.18% for MTW (hr.)] while the rate was not sustained by the CG. It was also suggested that a combination of aquatic isometric and isotonic exercises improves the level of elderly fatigue index in both MWT (p= 0.019) and BLC (p= 0.001) compared to the control group.
**Conclusion:** It appears that aquatic isometric and isotonic resistance exercises stimulates improvements in measures of fatigue index in men or aged men.
**Keywords:** Resistance Training, Tolerance, Lactic Acid, Fatigue, aged

## INTRODUCTION

The extended life expectancy among aged population has been reported globally due to medical advances (Amini, Mirmoezzi, Salmanpour, & Khorshidi, 2018; Mohammadi, Allahyari, Darvishpoor Kakhaki, & Saraei, 2018) based on evidences, there is an accelerating rate of aging population by2032 in Iran and the growth rate of the population above age 50 is projected to grow up to 25%–30% of the total population (Mirzaei & Shams, 2007). Given the increased life expectancy among the Iran in an elderly population, reported by WHO, It's necessary to have appropriate plans to mitigate the health related risk factors in the population. The necessity of promoting successful ageing not only assists to improve the physical and mental health, but also, helps to lowering the possible costs of healthcare systems. (Mirmoezzi, Amini, Khaledan, & Khorshidi, 2016). Changes in body composition of aged population, especially muscle atrophy and fatness, contribute seriously to a decline in

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motor control in aged ones. In this regard, Fatigue is a common symptom of aging that may be attributed to loss a decline of in normal functioning which negatively affects the quality of life among the elderly population (Avlund, 2010). Fatigue as an important geriatric syndrome, is accompanied by low physical activity, which leads to anxiety, lethargy, laziness and muscle aches (Sajjadi, Farmahini Farahani, Esmailpoor Zanjani, Dormanesh, & Zare, 2010; Tralongo, Respini, & Ferraù, 2003). Doris et al reported that those aged above 65 and suffering from fatigue, are more likely to have joint problems, urinary incontinence, hearing impairment, depression, and social isolation (Doris, Lee, & Man, 2010). Physical Fatigue along with mental disturbance and abnormal body image posses some challenges in physical, physiological and cognitive performance of people (Irandoust & Taheri, 2017; Lewis & Wessely, 1992; Poluri, Mores, Cook, Findley, & Cristian, 2005; Sayyah, Bigdeli, Mazoochi, & Nikzad, 2012). Thus, the question that rises is how the health authorities will attenuate the negative consequences of fatigue? There are some studies suggesting that exercise increases the energy levels of the elderly and decreases the fatigue by improving the cardiorespiratory functions (Haskell et al., 2007; Mostert & Kesselring, 2002). Although, it has been reported in a study that the aged people are not allowed to do the exercises such as isometric types due to the physical and physiological limitations (Irandoust & Taheri, 2015), Pescatello et al. (2015) argued that isometric exercises increases sustainability and strength in people with joint inflammation, and it improves the range of motion in injured people, also or, and reduce resting blood pressure (Pescatello et al., 2015). Additionally, one of the problems of the elderly is the lack of optimal muscular endurance in anti-gravity or postural muscles causing the general fatigue. Chodzko et al stated that the isometric and isotonic resistance exercises have the advantageous of developing the neuromuscular adaptations leading to reduce the risks for cardiovascular disease. It was postulated in the study that aquatic isometric and isotonic resistance exercises could result in fatigue improvement because of favorable mechanical properties of water on the body (e.g, reducing the pressure on the joints, reducing the heart rate, improving the balance and less occurrence of physical damage in water (Irandoust & Taheri, 2015). The question arises that whether these exercises can be simulated in water to have the advantages of both resistance exercises for the elderly in such a way. Thus, the present study was designed to explore the effects of 10 weeks of aquatic isometric and isotonic resistance exercise on fatigue index of aged men.

## MATERIALS AND METHODS

The present study was semi-experimental with pre-test and post-test design with control group. The population of the study was elderly in Karaj, of whom 40 were volunteered and randomly divided into training and control groups with 20 subjects in each. All of them kept on the study up to the end. The sample size was selected based on 95% confidence level and 80% test power. Inclusion criteria were being over 65 years old, not having history of acute injury, non-use of wheelchairs, walkers or any other auxiliary equipment for walking, not having regular resistance exercise or specific exercise in the past six months. Moreover, these criteria were not suffering from other acute abnormalities or chronic physical and mental and psychological problems such as severe depression (was done using Beck Depression Inventory with scores above 30 excluded).

For observing the ethics, besides getting consent from all subjects, it was explained that the results of the study were purely for research purposes and would be published collectively without mentioning the names of the individuals. Their participation in the study was also optional, and they could leave it at any stage. The objectives, the stages, and conducting the research were described for the subjects. In order to determine the readiness of the subjects in the training period, we used Physical Activity Readiness Questionnaire (PAR-Q) with the subjects responding before participating in the training period. If they answered questionnaire questions positively, they were excluded. PAR-Q questionnaire is a tool for screening and evaluating the quality of participation in physical activity (Martins et al., 2015). Subjects also conducted Short Physical Performance

Battery Protocol (SPPB) and those who scored a score of less than nine (SPPB≤9) were excluded from the study (Martins et al., 2015). A sports specialist, with a lifeguard on alert outside the water to watch the subjects, conducted the training course in water. All subjects were allowed to perform exercises in water.

A week prior to the main test, the anthropometric characteristics of subjects such as age, height, weight and body mass index (BMI) were measured and recorded. The height and weight of the subjects were measured and recorded using BSR 85 model, including electronic scale and mechanical stroke. T-940 treadmill manufacturing Taiwan's Power Sir St plant was used to take the time to walk and to deliver patients to get exhaustion. Moreover, lactometer model Lactate Scout was used for lactic test. The exercise protocol was a combination of isometric and isotonic resistance exercises, conducted in a water exercise program (water temperature ranging from 29 to 30 ° C) for the training group for 10 weeks and 3 sessions per week (even days), the control group was only followed (Table 1). It should be noted that Water Sports Association (Association, 2010) designs this protocol based on the book.

To start after obtaining personal information and consent, the patients walked on the treadmill to get exhausted. The time of walking on treadmill and blood lactate was measured using a hand-held lactate analyzer (EKF Diagnostics lactometer) and recorded in each person's table. All patients first walked for one minute at a speed of one meter per second, and then a proper pace was considered for every patient according to his physical condition. A harness was used for all subjects while walking on treadmill. Afterwards, a 10-week training protocol was done for the experimental group according to Table 1. After 10 weeks, all subjects (experimental and control) were checked and recorded for weight, height, BMI, treadmill walking until complete fatigue again. It should be noted that pre-test conditions (both environmental and walking speed) were considered in the post-test. In addition, the post-test was given in two days with two days. In the first session, only one test was performed based on the duration of walking to the extinction limit of each subject and then the lactate test was performed. At the next test session, the distance the subject could travel until stall was recorded. Independent and independent t-test was used for data analysis (P≤0.05).

## RESULTS

The Kolmogorov–Smirnov test showed that the distribution of data is normal. Therefore, parametric methods were used to analyze the data. The individual characteristics of the participants in the practice and

**Table 1: Water exercise protocol in summary**

| Stage (time) | Summary of protocol content |
|---|---|
| Warm up (10-15 min) | Walk in the pool and stretching |
| The main program, which was a combination of isometric and isotonic resistance exercises (35-40 min) | Isometric exercises: Used Aqua noodles and resistance band that installed in Swimming Pool Ladders (3 reps for 20 seconds).<br>Upper Body: In Lunge position pull, rowing and bench press with resistance elastic band.<br>Core Body: Abdominal, sitting in a leaning position with straight and bend legs (do not swing), V position.<br>Lower Body: Knee flexion, Hip flexion, Hip abduction and Hip extension. |
| | Isotonic Exercises: For these movements, Aqua dumbbells and noodles were used<br>Upper Body: Press, Reverse Curl, Hammer Curl, Lateral Raise, Fly<br>Core Body: Leg extension with noodle, turn with straight arm and dumbbells in the hand, Scoop with dumbbells.<br>Lower Body: Knee flexion, Hip flexion, Hip abduction and Hip hyper extension (With noodle). |
| Cool down (5-10 min) | Walking, breathing exercises and flexibility |

**Table 2: Individual characteristics of subjects and fatigue indices in pre-test (mean±SD)**

| group | practice | control | P-value |
|---|---|---|---|
| Age (yr) | 2.34±70.61 | 3.87±68.82 | 0.079 |
| Height (cm) | 7.52±167.75 | 8.07±169.23 | 0.554 |
| Weight (kg) | 3.35±66.14 | 4.55±68.10 | 0.129 |
| BMI (kg/m²) | 1.64±23.40 | 3.35±23.52 | 0.144 |
| Walking time (hr) | 2.19±2.76 | 2.78±2.82 | 0.940 |
| Blood lactate (Mg/L) | 7.74±22.44 | 7.88±21.31 | 0.645 |

**Table 3: Covariance analysis results to compare fatigue indices in practice and control groups**

| Sub-scales | | SS | df | MS | F | Sig. | effect size |
|---|---|---|---|---|---|---|---|
| Weight (kg) | Pre-test | 1529.19 | 1 | 1529.19 | 1127.47 | 0.000 | 0.99 |
| | group | 4.74 | 1 | 4.74 | 3.49 | 0.084 | 0.21 |
| | error | 1.36 | 17 | 1.36 | | | |
| BMI (kg/m²) | Pre-test | 95.29 | 1 | 95.29 | 482.11 | 0.000 | 0.97 |
| | group | 0.72 | 1 | 0.72 | 3.64 | 0.079 | 0.22 |
| | error | 0.20 | 17 | 0.20 | | | |
| Walking time (hr) | Pre-test | 326.99 | 1 | 326.99 | 53.55 | 0.000 | 0.80 |
| | group | 151.86 | 1 | 151.86 | 24.87 | 0.019 | 0.66 |
| | error | 6.11 | 17 | 6.11 | | | |
| Blood lactate (Mg / L) | Pre-test | 478.05 | 1 | 478.05 | 44.06 | 0.000 | 0.77 |
| | group | 411.57 | 1 | 411.57 | 37.93 | 0.001 | 0.74 |
| | error | 10.85 | 17 | 10.85 | | | |

control groups are presented in Table 2. The results of independent t-test before intervention did not show a significant difference (P>0.05), which indicates homogeneity of subjects in terms of individual characteristics and pre-test (Table 2).

The results of covariance analysis showed a significant difference between the two groups of resistance training and control in walking time (P = 0.019 and $F_{1,17}$=24.87). Also levels of blood lactate after walking, showed a significant difference between the two groups of resistance training and control (P = 0.001 and $F_{1,17}$=37.93).

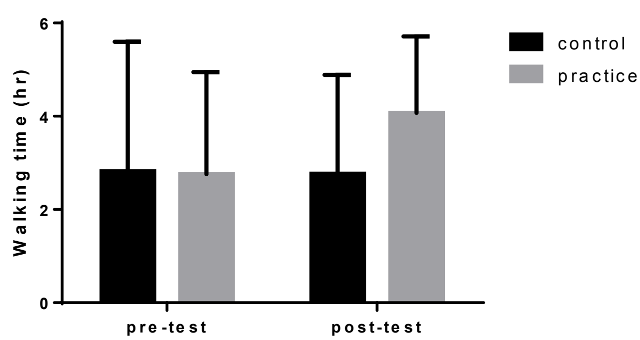


**Figure 1: Comparison of pre-test and post-test for walking time**

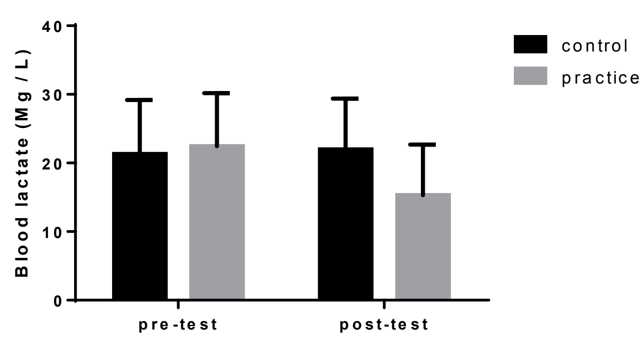


**Figure 2: Comparison of pre-test and post-test for blood lactate**

## DISCUSSION

Increasing motor readiness of the elderly is among the issues always considered by health researchers. In this regard, exercise therapy in aquatic environment is an appropriate solution. Increased muscular fitness is a result of muscle strength and muscular endurance that can affect cardiorespiratory function, flexibility and increased range of motion, balance and avoidance and early fatigue

(Association, 2010; Taheri & Irandoust, 2017). The results suggested that resistance training had a significant effect on the improvement of walking time and the amount of blood lactate after walking to get exhaustion. There have been no studies on the effectiveness of resistance exercises on individual indices, but several studies have shown that the use of various exercises have been shown to improve fatigue. For example, Pollock et al. (2000) studied the effect of resistance exercises on individuals with and without cardiovascular disease. They stated that resistance exercises lead to increased health, physical fitness, physiological indices and fatigue delay in the two groups (Pollock et al., 2000). Gappmaier et al. (2006) stated that aerobic exercise in water has the same benefits of metabolism, reduced fat and weight, such as aerobic exercise in land (Gappmaier, Lake, Nelson, & Fisher, 2006).

It was also shown that there was a significant reduction in blood lactate levels after walking to get exhaustion. During exercise, lactate is contracted out of muscle and is consumed by different oxidative heart and muscles. Membrane-bearing proteins, known as monocarboxylic carriers, facilitate the release of monocarboxylate, such as lactate and pyruvate throughout the membrane of the mammalian plasmid. As age increases, morphological and metabolic changes in the skeletal muscle occur in the form of a decrease in the transverse area of the muscle, which reduces the ability and weaken the muscles (Mohebbi, Rahmani-Nia, Arabmomeni, Riasi, & Marandi, 2014). The normal amount of blood lactate is from 0.5 to 2.2 millimoles per liter. It is assumed to increase in the range of 20 to 25 millimoles per liter in the extinction. The peak in blood lactate occurs about 5 minutes after severe withdrawal (Mohebbi et al., 2014). Moreover, it is stated that with increasing age, lactate accumulation decreases, so fatigue resistance increases in elderly musculoskeletal system. it seems that lactate reduction in the elderly is related to factors like as muscle mass and plasma volume decreasing with age (Kaczor et al., 2006). In the present study, resistance training had a significant effect on improvement of walking time to get exhaustion. The factors that can improve the function of walking and delay in fatigue are improving dynamic balance, body composition and optimal weight, improving flexibility, and increasing the range of motion and muscular fitness (Tinetti, 2003). As the isometric exercise is performed, only the muscle in that situation is strengthened. However, it also has a positive effect on the muscle and improves muscular endurance, especially in dynamic balance. On the other hand, isotonic exercise, such as lifting a weight at a range of motion, strengthens the muscles, but does not strengthen the elderly much more than strength and endurance. Combining both types of exercises leading to weight loss also increase the force that muscles produce (Yousef Abadi, Mirzaei, Habibi, & Barbas, 2017). Increase in strength and endurance in muscles, especially muscles such as quadriceps and Suez, lead to improved balance and walking time in the elderly (Irandoost, Taheri, & Seghatoleslami, 2015). Resistive exercises can have a good effect on flexibility and range of motion, leading to better and optimal steps and increased travel time with less energy (Pollock et al., 2000). Generally, physical activity reduces the aging process. Proper aqua fitness programs can help older people achieve higher physical and physiological performance. Water exercises are attractive for adults for some reasons. The water is a relaxing interface that reduces joint compression and gravity pulling. Participants unable to exercise on the ground can easily be active in water (Hanai et al., 2006). Water pressure helps reduce swelling of inflamed joints. Water provides touch feedback and enhances sensory function. The classroom environment helps reduce loneliness, depression and anxiety, whereas, at the same time, providing physical feedback, social relationships with peer groups (Irandoust, Taheri, Neto, & Lotfi, 2017). Water fitness can be fun and exciting (Association, 2010). Resistance training programs for the elderly increase physical activity (Sohbatiha, Aslankhani, & Farsi, 2011). Based on the results of this study, a combination of isometric and isotonic exercises, which can be easily designed in water, besides reducing gravity and weight loss in water, can also increase heart rate and blood pressure in the activity. This is due to lower water temperature than the body and the response of the body's neurology to flotation in water (Association, 2010). This can reduce the risk of high-pressure exercises and injuries in the elderly, along with the benefits of resistance training. Considering the mental characteristics of elderly especially depression and micro nutrients deficiency (Irandoust & Taheri, 2017) with a larger population besides the more physiological parameters in both aged men and women are proposed for future research. Since mental fatigue is a key reason for physical fatigue, more research is needed to consider it by researchers. Thus; it is a useful tool for explaining the comprehensive plans for participation of the elderly in sport. As the mechanism of fatigue in the body, has a psychological origin, more research is needed.

## CONCLUSION

Given the important effects of resistance training on fatigue indexes among aged population, considering the isometric and isotonic water exercises is highly recommended for improving quality of life caused by lowering the elderly fatigue.

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