Evidence Based Care Journal

http://ebcj.mums.ac.ir/

Comparing the Effects of Aquatic and Land-based Exercises on the Bio-motor Abilities of Elderly Men

Mojtaba Askari, Seyed Reza Mazlom, Samira Mohajer, Amin Azhari

The online version of this article can be found at
http://ebcj.mums.ac.ir/article_10534.html

Evidence Based Care Journal 2018 8:7 originally published online 01 July 2018

DOI: 10.22038/ebcj.2018.27934.1668

Online ISSN: 2008-370X

Address: Mashhad Nursing and Midwifery School, Ebn-e-Sina St., Mashhad, Iran
P.O.Box: 9137913199
Tel.: (098 51) 38591511-294
Fax: (098 51) 38539775
Email: EBCJ@mums.ac.ir

Evidence Based Care Journal

Original Article

OPEN ACCESS JOURNALS

Comparing the Effects of Aquatic and Land-based Exercises on the Bio-motor Abilities of Elderly Men

Mojtaba Askari[1], Seyed Reza Mazlom[2], Samira Mohajer[3*], Amin Azhari[4]

Received: 02/12/2017
Accepted: 19/03/2018

Evidence Based Care Journal, 8 (2): 7-17

Abstract

Background: Physical activity, whether in water or on land, can improve motor disorders in the elderly. However, the more effective type of exercise remains inconspicuous.

Aim: To compare the effects of aquatic and land-based exercises on the bio-motor abilities of elderly men.

Method: This clinical trial was performed on 60 elderly men visiting Imamat and Daneshamuz health centers in Mashhad, Iran, in 2016. The eligible volunteers were randomly assigned to two groups (n=30 each). In one group, the subjects attended aquatic exercise sessions for six weeks, while the other group participated a land-based exercise program. Bio-motor abilities of the subjects including motor ability, flexibility, and general endurance were evaluated before and immediately after the intervention and recorded in a researcher-made checklist. Data were analyzed in SPSS, version 16, using the independent t-test, paired t-test, Chi-square test, Fisher's exact test, and exact Chi-square test.

Results: The mean ages of the aquatic exercise and land-based exercise groups were respectively 69.9±5.1 and 68.0±5.0 years. Post-intervention, the aquatic exercise group showed significantly higher motor ability (P=0.01) and general endurance (P=0.02) than did the other group. However, the difference in final flexibility of the groups was not significant (P=0.252). Paired t-test showed a significant improvement in bio-motor abilities of both groups post-intervention (P<0.001).

Implications for Practice: Since the aquatic exercise program had a greater impact on bio-motor abilities than did the land-based program, it is recommended for achieving better results among elderly men.

Keywords: Aquatic exercise, Bio-motor abilities, Elderly, Land-based exercise

1. MSc in Nursing, School of Nursing and Midwifery, Mashhad University of Medical Sciences, Mashhad, Iran
2. Instructor of Medical-Surgical Nursing, Evidence-Based Care Research Centre, School of Nursing and Midwifery, Mashhad University of Medical Sciences, Mashhad, Iran
3. Instructor of Gerontological Nursing, Evidence-based Care Research Center, School of Nursing and Midwifery, Mashhad University of Medical Sciences, Mashhad, Iran
4. Assistant Professor of Rehabilitation Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

* Corresponding author, Email: mohajerm@mums.ac.ir

Introduction

Increased life expectancy is a human achievement worth celebrating, but the resulting population aging poses serious challenges to human societies (1). According to the United Nations, the world's geriatric population was about 740 million in 2009, which will reach two billion by 2050 (2). Population of the Iranian elderly is expected to grow at the same rate and reach 25 million by 2050, that is, about a quarter of the Iranian population will be elderlies by that time. According to the latest national census, the Iranian elderly population has grown by 12% from 8.5 million in 2011 to 9.6 million in 2016 (1, 3). The developing Asian countries are growing old faster than the other countries. As people age, their health problems progressively increment (3). When people age past the middle-age years, they lose about 1.5% of their physical and mental functioning every year. This means that people reaching the age of seventy have lost, on average, about 26% of their abilities. Thus, most people who reach an old age struggle with many disabilities (4). Balance issues are known as the main cause of falling among the elderly; an event that frequently leads to impaired performance, dependence, and disability (5). Hence, it is imperative to develop and implement prevention and rehabilitation programs and interventions to reduce these problems among this portion of the population.

Exercise is one of the most effective ways to maintain and enhance physical abilities (6, 7). Exercise is even more important for the elderly because of physiological, pathological, and psychological changes associated with aging. In addition, appropriate exercise interventions may somewhat restore the physical abilities of older adults (6). However, the type of exercise is also very important as it needs to be relatively simple and appealing to the elderly. Complex exercise programs are likely to undermine their self-esteem, reduce output and participation, and ultimately, discourage the elderly from committing to the program (7).

The typical physical exercises and activities recommended for the elderly include resistance exercise, tai chi, yoga, and balance exercises (8). Nonetheless, as people grow older, physiological effects of aging and development of diseases such as arthritis and motor disabilities may cause them to find these exercises more challenging and less interesting (9, 10).

One of the important tasks of geriatric nursing is to promote the physical health of the elderly and one of the best ways to do so is the use of well-tested physical activities such as aquatic exercises (11). Thanks to its physical characteristics, water is the perfect environment for the physical activity of the elderly (12). Because of the water's buoyancy effect, exercising in water, which has proven health benefits, has long been a popular way of physical and mental relaxation (13, 14). Besides its well-known soothing effects, exercising in water has a wide range of physical advantages such as improved endurance, fitness, and respiratory health (15, 16). Aquatic exercises also provide a pleasant environment and an opportunity for the elderly to interact and sympathize with their peers (16). Despite the undeniable benefits of aquatic exercises for the elderly, they are also associated with the risk of musculoskeletal injuries, falling, getting cold, chlorine poisoning, and drowning. Of course, these risks can be mitigated by taking approximate measures such as provision of pools with proper safety and heating equipment and flooring, proper measurement and control of chlorine level in pool water, and recruitment of well-trained and experienced lifeguards (14, 15).

Another recommended method for the elderly to engage in physical activity is land-based exercises (17). Regular physical activity during youth and adulthood is known to prevent cardiovascular illnesses, diabetes, and other systemic diseases (18). Land-based exercises can be performed in any safe environment and provide benefits such as better nocturnal sleep, weight loss, improved mood, and enhanced flexibility (19). Cromwell et al. (2007) and Lin et al. (2006) have shown that land-based balance and functional exercises can promote walking ability (20, 21). Since the elderly may gradually lose motivation to participate in this type of exercise, the exercise program needs to be sufficiently diverse and the exercise environment must be changed before becoming repetitious to prevent disinterest and demotivation among participants (10, 22).

Only few studies have compared the outcomes of land-based and aquatic exercises. For example, the study of Noh et al. (2008) on the effects of exercise in water and on land on the balance and muscle strength of stroke survivors showed a significant improvement in balance and muscle strength of an aquatic exercise group as compared to a land-based group (23). However, the study of Rezazadeh and Baluchi (2015) revealed that aquatic and land-based exercises have the same effects on static and dynamic balance and the risk of falling among the elderly (24). Kaneda et al.

(2008) also presented that aquatic and land-based exercises both improved balance ability among the elderly (25). A study by Colado et al. (2005) reported no significant difference in physiological response, heart rate, and blood lactate among the elderly after performing resistance exercise on land and in water until muscular fatigue (26).

There is a clear association between psychological traits and lifestyles of the elderly and their performance and independence (18), and thus, their ability to control the outcomes of aging and therapies. Despite the benefits of aquatic and land-based exercises for the elderly, a review of the related literature showed that only few researchers have studied the effects of these exercises on the biomotor abilities of the elderly, and even those few have mostly addressed the effects of these two methods separately. Studies that have investigated both methods in conjunction have mostly reported contradictory results and could not draw a conclusion as to which method is more effective. In view of the above gaps in the literature, this study aimed to compare the effects of aquatic and land-based exercises on the biomotor abilities of elderly men in Mashhad, Iran.

Methods

The present randomized clinical trial with two groups (aquatic exercise and land-based exercise) and a pretest-posttest design was performed from April 4 to June 4, 2017. The research population included the elderly who visited Imamat and Daneshamuz health centers in Mashhad, Iran. These health centers were chosen because of their high involvement with the elderly and better access to subjects. The study population was formed by 60 elderlies who met the inclusion criteria. The subjects were randomly selected by using the lottery method at a meeting with all candidates. The selected subjects were divided into two groups of aquatic exercise and land-based exercise. Before the study, the minimum sample size was calculated using the formula for comparing the means of two populations. To obtain the mean value of motor ability (one of the dimensions of biomotor ability), a preliminary study was conducted on 20 elderlies (10 elderlies in each group). The largest sample size was calculated for motor ability index (mean: 61.0±15.6 and 50.5±11.0 for the land-based and aquatic groups, respectively). Thus, to achieve 95% confidence level and 80% test power, the sample size was estimated at 26 (per group). Considering the possibility of sample attrition, the sample size was increased to 30 subjects per group. Nevertheless, all the subjects managed to complete the study.

The inclusion criteria were: male gender, 60 years of age or older, visual and cognitive health, and lack of osteoporosis (self-reported or recorded in the health center), skeletal, muscular, and nerve disorders (e.g., fractures, amputations, and scoliosis), any maiming or paralysis, visible inability to walk, and acute or chronic disabling diseases (e.g., myocardial infarction and cerebrovascular accident [CVA]) based on examination and health center records.

The exclusion criteria comprised of acute musculoskeletal, bone, or disabling diseases (e.g., cold) during the study, withdrawal for any reason, additional exercises (including swimming), severe physical activities during the study (directly asked at each session), absence for more than three sessions, and inability to perform exercises in more than three sessions.

The data collection instruments used in this study were a standard demographic information questionnaire and a researcher-made questionnaire entitled as “elderly biomotor ability checklist”. The demographic information questionnaire consisted of nine open-ended and multiple-choice questions about age, height, weight, body mass index, level of education, marital status, smoking, and history of previous illnesses. The elderly biomotor ability checklist consisted of three sections for recording motor abilities, flexibility, and general endurance of the elderly. This checklist was developed based on previous studies and after consultation with members of the Faculty of Nursing and Midwifery at Mashhad University of Medical Sciences (MUMS). Biomotor abilities (i.e., motor ability, flexibility, and endurance) of the subjects were evaluated using the standard and well-established methods described below. Motor abilities were measured using the Timed Up and Go (TUG) test, which relies on the time needed for the person to rise from a chair (without the help of hands), walk 3 meters, and then return to sit back on the chair (27). Flexibility was gauged using the Wells test, which involves stretching the legs in sitting position and then stretching the hands to touch the tip of the toes (28). General endurance was determined using the six-minute walk test (6MWT), which involves measuring the distance that a person can walk on a flat surface in 6 minutes (29).

The content validity of the data collection instruments was confirmed with the help of 10 members of the Faculty of Nursing and Midwifery (including gerontological specialists) at MUMS. The reliability of the tests of motor ability, flexibility, and general endurance was confirmed by the inter-rater agreement method. For this purpose, the results of 10 subjects were evaluated independently by two raters (researcher and a research assistant trained and approved by supervising and advising professors) and then compared with one another. The Pearson correlation coefficients were calculated at r=0.86 for motor ability, r=0.89 for flexibility, and r=0.83 for general endurance, which demonstrated the reliability of the instrument.

Prior to the intervention, the biomotor abilities of the subjects including motor ability (TUG test), flexibility (Wells test or stretching hand to touch the toes), and general endurance (6MWT) were measured by the researcher under the supervision of a rehabilitation medicine specialist and were recorded in the elderly biomotor ability checklist. In the TUG test, the subject was asked to rise from a chair without using hands, walk 3 meters, and return to sit back on the chair. The subject was also asked to do this as fast as possible without running. The total time of the test was recorded in the checklist. All the tests were conducted in Kazemian sports hall of Mashhad Department of Education.

After obtaining the permission of the Regional Medical Ethics committee of MUMS and presenting an introduction letter to the authorities of the health centers chosen for the study, the necessary coordinations for starting the research were made. The researcher invited the elderly who visited the health centers to attend a briefing session at a later date at the same site. In this session, after explaining the research objectives and procedure for about 15 minutes, the attendees who were eligible and willing to participate in the study were identified and asked to complete an informed consent form.

The enrolled people were randomly divided into two groups of aquatic exercise and land-based exercise based on the draw. The participants were asked to refrain from exercising, performing intensive activities, swimming, or going to a pool outside the scheduled exercise sessions. The subjects of both groups were also asked to complete a demographic-medical information questionnaire in advance. For the pre-test, the subjects of both groups were invited to Kazemian sports hall and indoor pool. The individual tests were performed by the researcher under the supervision of a rehabilitation medicine specialist.

The group sessions of aquatic exercise were held in the Kazemian indoor pool. In the first session, the researcher provided a 45-minute training, in which the subjects were taught how to walk inside the pool, hold the body straight, and keep the sacrum perpendicular to the pool floor. Aquatic exercises were performed in three 1-hour sessions per week for six weeks and under the supervision of a rehabilitation medicine specialist. The aquatic exercise program was designed based on the subjects' condition, according to the suggestions of reliable resources (27), and with the approval of the rehabilitation medicine specialist. Each aquatic exercise session consisted of three stages: (i) warming up by slow walking (200 m) in water for 15 minutes, (ii) stretching of all joints, and (iii) walking forward, backward, and sideways on heels and on toes at 10, 15, and 25 meter distances, each exercise was repeated twice with moderate intensity (for 5 minutes; Table 1). This exercise was performed as a group activity so that it would be of the same intensity for all the subjects. It was decided that subjects who expressed inability to perform the exercise or showed excessively high heart rate (according to age) or excessively low blood pressure should be stopped and removed from the sample, but no such event occurred during the study.

The land-based exercise sessions were also held in Kazemian sports hall. The land-based exercise program was designed based on the subjects' condition and the recommendations of reliable sources (24) and under the supervision of the rehabilitation medicine specialist. This program consisted of four stages: (i) warming up, (ii) muscle-resistance exercises, (iii) balance exercises, and (iv) rest. The first stage, warming up, involved 10 minutes of walking, which was followed by 10 minutes of muscle resistance exercise (e.g., flexion and extension of the limbs, moving the limbs towards and away from the trunk, turning the neck and waist, and flexion and extension of the neck and waist). The third stage involved 10 minutes of balance exercise (e.g., walking forward and backward with balance, transferring weight from one foot to the other, walking on toes and heels, and standing on one foot), and the last stage of the cycle was resting (Table 2). For this group, the exercise program was implemented for six weeks, three sessions a week, each session lasting one

Table 1. Aquatic exercise program

	First session	Second session	Third session
First week	Transferring weight: 10 sets in 4 directions and with 1 minute of rest between sets Standing on one foot for 20 seconds: 10 sets for each leg and 1 minute of rest between sets	Transferring weight: 10 sets in 4 directions and with 1 minute of rest between sets	Walking slowly: in 4 directions in two 2-minute sets and with 2 minutes of rest between sets Standing on one foot for 20 seconds: 10 sets for each foot and with 1 minute of rest between sets
Second week	Walking around a square: five 30-second sets in each direction and 2 minutes of rest between sets	Balance exercise: 30 seconds for each foot, 5 sets for each foot and with 3 minutes of rest between sets	Transferring weight from one foot to the other: 30 seconds for every foot, 5 sets with 2 minutes of rest between sets
Third week	Slow sideways walking with 10-second stops, 10 sets for each side, then 1 minute of rest	Treading water with one foot: 20 times for each foot, and then 5 minutes of rest	Transferring weight from front to back: 10 sets in 4 directions and with 30 seconds of rest between sets Treading water with one foot: 20 times for each foot, and then 5 minutes of rest
Fourth week	Squatting in water up to 60°: 20 times for each leg, and then 5 minutes of rest	Stretching the hamstring: 20 times for each leg, and then 5 minutes of rest	Stretching the legs: 20 times for each leg and then 5 minutes of rest Stretching the hamstring: 20 times for each leg, and then 5 minutes of rest
Fifth week	Swinging hands and legs: 20 times for each hand and leg, and then 5 minutes of rest	Combo hand and leg exercises while walking	Transferring weight from front to back: 10 sets in four directions and with 30 seconds of rest between sets
Sixth week	Running forward and back at different speeds	Running sideways at different speeds and performing passive stretching exercises	Stretching exercises with 20-second contraction for large muscles

Table 2. Land-based exercise program

	First session	Second session	Third session
Walking	Forward marching: 20-25 steps	Walking in step: 20-25 steps	Forward marching: 20-25 steps Walking in step: 20-25 steps Marching in place: 20-25 steps
Muscle-resistance exercises	Flexion and extension of the limbs Moving the limbs away and toward the trunk	Moving hip away and toward the midline Slight flexion of the knee joint	Flexion and extension of the hip turning the neck and waist while performing flexion and extension
Balance exercises	Forward and backward walking with balance Skiing movement (changing the legs)	Transferring weight from one foot to the other Walking on the toes and heels	Standing on one leg Sitting and rising from a chair Rotating 360 degrees and rotating around an imaginary square
Rest	Five minutes rest between movements	Five minutes rest between movements	5 minutes rest between movements

hour. All the sessions were held under the supervision of a rehabilitation medicine specialist. This program was also implemented as a group activity so that it would be of the same intensity for all the subjects. Although it was decided that subjects who expressed inability to perform the exercise or show excessively high heart rate (according to the age) or excessively low blood pressure should be stopped and removed from the sample, none of these events occurred during the study. The researcher attended and supervised all the exercise sessions and provided guidance when necessary.

After the intervention (at the end of the third session at the 6th week), the biomotor abilities of both groups were measured again in the same manner as explained above.
This study was conducted in full compliance with the ethical requirements of clinical research, including the acquisition of permission from the Ethics Committee of the university and obtaining written informed consent from the participants. Since holding exercise sessions for the elderly, whether on land or in water, necessitates taking some precautions to prevent injury, the researcher fully supervised all the sessions and made sure of the presence of skilled lifeguards, access to first aid equipment, and controlled temperature of both the exercise hall and the pool. The collected data were analyzed in SPSS, version 16, using descriptive statistics (for data summarization), independent t-test, paired t-test, Chi-square test, and Fisher's exact test.

Results
The results of independent t-test showed no significant difference between the aquatic exercise and land-based exercise groups in the mean age of the subjects (69.9±5.1 vs. 68.0±5.0 years, P=0.15). Other demographic-medical characteristics of the subjects and the results regarding homogeneity of the two groups are presented in Table 3.

Table 3. Demographic characteristics of the elderly in the aquatic exercise and land-based exercise groups

Variable		Aquatic exercise	Land-based exercise	Test Result
Height (cm)	Mean±standard deviation	163.3±6.9	157.7±7.7	P=0.06
Weight (kg)	Mean±standard deviation	65.6±11.2	64.1±10.2	*P=0.59
Body mass index (kg/m^2)	Mean±standard deviation	24.6±3.7	25.8±3.8	*P=0.22
Level of education	Illiterate	1(3.3)	4(13.3)	**P=0.59
	Elementary school	8(26.7)	10(33.3)	
	Junior high school	6(20.0)	5(16.7)	
	Senior high school	9(30.0)	7(23.3)	
	Higher education	6(20.0)	4(13.3)	
Marital status	Married	27(90.0)	27(90.0)	**P=0.54
	Widower	3(10.0)	2(6.7)	
	Divorced	0(00.0)	1(3.3)	
Smoking	Yes	4(13.3)	0(00.0)	***P=0.05
	No	26(86.7)	30(100.0)	
History of illnesses	NA	16(53.3)	9(30.0)	**P=0.07
	Diabetes	3(10.0)	5(16.7)	
	Hypertension	3(10.0)	6(20.0)	
	Diabetes and hypertension	1(3.3)	6(20.0)	
	Heart and respiratory diseases	7(23.3)	4(13.3)	
Routine physical activity	Low	8(26.7)	8(26.7)	****P=0.61
	Medium	17(56.7)	14(46.7)	
	High	5(16.7)	8(26.7)	

*: t independent samples test
**: Exact Chi square
***: Fisher Exact
****: Chi square

At the pre-intervention stage, the aquatic exercise group had a mean score of 6.2±0.8 in motor ability, 2.1±4.0 cm in flexibility, and 602.9±103.4 in general endurance. At the same stage, the land-based exercise group had a mean score of 7.0±2.1 in motor ability, 1.2±3.4 cm in flexibility, and 547.7±142.1 in general endurance. The results of independent t-test revealed no significant difference between the two groups in terms of the mean scores of motor ability (P=0.06), flexibility (P=0.35), and general endurance (P=0.09) at the pre-intervention stage. At the post-intervention stage, however, the aquatic exercise group had significantly higher mean scores in motor ability (P=0.01) and general endurance (P=0.03) relative to the land-based exercise group. At the post-intervention stage, although the aquatic exercise group had a higher mean score of flexibility than the other group, this difference was not statistically significant (P=0.25; Table 4). There were no significant inter-group differences in

Table 4. Mean and standard deviation of biomotor indices of the elderly in the aquatic exercise and land-based exercise groups at the pre- and post-intervention stages

Biomotor indicators		Aquatic exercise Mean±standard deviation	Land-based exercise Mean±standard deviation	Test results
Motor ability (s)	Pre-intervention	6.2±0.8	7.0±2.1	*P=0.06
	Post-intervention	5.3±1.2	6.3±1.8	*P=0.01
	Difference (pre-post)	-0.9±0.7	-0.7±0.7	*P=0.18
	Intragroup comparison	P<0.001	P<0.001	-
Flexibility (cm)	Pre-intervention	2.1±4.0	1.2±3.4	*P=0.35
	Post-intervention	3.1±3.9	2.0±3.3	*P=0.25
	Difference (pre-post)	1.0±0.9	0.8±0.8	**P=0.42
	Intragroup comparison	P<0.001	P<0.001	-
General endurance (m)	Pre-intervention	602.9±103.4	547.7±142.1	*P=0.09
	Post-intervention	645.1±105.3	569.2±147.1	*P=0.03
	Difference (pre-post)	42.2±29.9	21.4±33.9	**P<0.001
	Intragroup comparison	P<0.001	P=0.002	-

*: t independent test
**: Mann-Whitney test

terms of changes in the mean scores of motor ability (P=0.18) and flexibility (P=0.42), but such difference was significant in terms of general endurance (P=0.001). The results of t-test signified that in both groups, mean scores of motor ability, flexibility, and general endurance were significantly improved after the intervention compared to the corresponding values prior to the intervention (P<0.001).

Discussion

According to the results, the elderly who participated in the aquatic exercise program experienced higher improvements in motor ability and general endurance than those who exercised on land. However, both types of exercises boosted flexibility to the same extent.

A study by Noh et al. (2008) on the effects of aquatic and land-based exercises on balance and muscle strength of stroke survivors showed higher improvement in balance and muscle strength in the elderly who exercised in water than in those who exercised on land (23). Although the present study investigated motor ability, general endurance, and flexibility, which are different from the parameters studied by Noh et al. (2008), since muscle strength and balance are likely to be associated with motor ability, their results can be considered consistent with ours in this regard. On the contrary, Rezazadeh and Baluchi (2015) reported that aquatic and land-based exercise programs both had the same positive effects on the elderly’s static and dynamic balance and risk of falling (24). Despite the difference in the studied parameters, these results can be considered consistent with our findings regarding the effects of aquatic and land-based exercises on flexibility, but not concerning the impact of these exercises on motor ability and general endurance.

Kaneda et al. (2008) reported that aquatic and land-based exercises both improved elderlies’ balance ability (25) and both exercises had the same positive impacts on the studied indicators. In the same vein, this report is in agreement with our observation with respect to the effects of exercise on flexibility, but not regarding its effects on motor ability and general endurance. Colado et al. (2005) found no significant difference between the aquatic and land-based exercises on physiological response, heart rate, and blood lactate when both exercises continued until muscular fatigue (26). Since the aquatic and land-based exercise programs designed in the present study were not intense enough to cause muscular fatigue, the difference in physiological responses was expectable and was observed in the results.

There are several other studies that have examined the effect of either aquatic or land-based exercises on the same indices studied in the present work. A study carried out by Soori et al. (2015) revealed significantly higher motor ability in the elderly who participated in aquatic exercises than in those who did not (11). We also found that the elderly in the aquatic exercise group obtained higher motor skill scores at the post-intervention stage. Thus, these results can be considered in concordance. This consistency can be attributed to the similarity of the types of exercise programs and research populations. Findings of a study by Dokht Abdiyan et al. (2016), which reported significantly higher motor abilities in the aquatic exercise group than in the control group (27), were also consistent with our results. This congruence can be due to the use of aquatic exercise in both studies with the specific goal of improving the physical ability of the elderly and considering the fact that the elderly find typical exercises too difficult and unappealing and often consider them as a compulsory activity. Furthermore, because of chronic pain, fatigue, and fear of complications, the elderly are less inclined to engage in physical activities (6). Thus, diverse exercise programs, including the ones containing aquatic exercise, are likely to be more successful in attracting the elderly to physical activity.

In a study entitled as "Effect of aquatic and land-based exercise programs on the pain and motor function of weightlifters with patellofemoral pain syndrome", Babakhani et al. (2015) found no significant differences in the motor function of two groups after eight weeks of training (28). This report was not consistent with our results. This inconsistency can be due to the differences in sample sizes and research populations. In detail, Babakhani et al. (2015) studied 20 subjects (versus 60 subjects in our study); thus, the smaller sample size in that study may have affected its internal validity and results. In addition, the subjects of that study were all suffering from patellofemoral pain syndrome, and one cannot expect one type of exercise to show significant superiority over a different type in improving the symptoms of a chronic disease in only eight weeks.

Regarding flexibility, the present study found that the elderly men who exercised in water achieved a higher mean flexibility score than those who exercised on land, but this difference was not statistically significant. Flexibility is defined as a person's ability to move one or a group of joints smoothly and easily through an unrestricted range of motion (9, 10). Therefore, it cannot be improved easily and via short interventions. In this regard, a study by Lord et al. (1993) reported significantly enhanced flexibility in 70-year-old subjects after nine weeks of aquatic exercise (1 hour per week) (29). In this respect, this result was in line with our finding regarding flexibility. This consistency can be due to the advanced age of the subjects in both studies, as age has an inverse relationship with flexibility. The present study also indicated an inverse relationship between the elderly's age and their flexibility, which confirms the above argument. Therefore, the lack of significant changes in the flexibility of the subjects of this study can be related to their age (60 to 78 years).

A study by Lund et al. (2008) also showed no significant difference in the muscle strength (muscle extension and flexion) of subjects who exercised in water, those who exercised on land, and a control group (32). This result is somewhat congruent with the present findings. Possible causes of this consistency are the nature of osteoarthritis and the duration of the intervention. Osteoarthritis is a type of joint inflammation or swelling that can be caused by physical injury, gout, pseudogout, psoriasis, Charcot, and hemophilia. Osteoarthritis is especially degenerative if caused by physical injury since damage to the joint ligaments causes joint instability, which leads to concentration of pressure on one part of the joint. This condition is more common in the elderly because of decreased visual acuity, reduced balance, and muscle weakness; thus, they are likely to experience motion restriction and dryness in the joints (31), which are unlikely to be alleviated with only eight weeks of exercise in water. Note that the elderly participated in the present study were not diagnosed with disease-induced motion restriction, but perhaps the 6-week intervention was not long enough to improve the flexibility of the 70-year-old subjects. Therefore, the lack of significant difference between the flexibility of aquatic and land-based exercise groups was expected.

On the other hand, Bergamin et al. (2013) reported that elderly subjects in an aquatic exercise group had significantly higher flexibility in the upper and lower extremities than those in a land-based exercise group and a control group (32). The study of Soori et al. (2015) also showed that after six weeks of exercise in water, the flexibility of their experimental group was significantly higher than that of their control group (11). Although the interventions of these two studies were of the same length as our intervention, their results were not congruent with ours. The present study measured slightly higher flexibility in the aquatic exercise group than in the land-based exercise group. This difference that can be attributed to the effects of aquatic exercise, where the elderly have better interaction with their peers, enjoy a pleasurable environment, and have more opportunity to sympathize with one another. Thus, the aquatic exercise group showed more commitment to this exercise, and therefore, developed better muscular flexibility. The mentioned commitment may also be enhanced by improved self-confidence due to performing some exercises in the deeper section of the pool (16). Research has also shown that continued aquatic exercise will make it easier to perform (33), which may be helpful for older people with diminished physical ability. This reason could account for the insignificantly higher mean flexibility score observed in the aquatic exercise group compared to the land-based exercise group.

Our findings presented a significant improvement in the mean flexibility score of both aquatic and land-based exercise groups, which can be attributed to the general effect of exercise on flexibility and quality of life (34). Although both exercise programs are effective in improving the flexibility of the elderly, the choice of the best method for enhancing flexibility should be made according to cost considerations and availability of the facilities required for the exercise.

Regarding general endurance, we found that the elderly who exercised in water had a higher post-intervention mean endurance score than those who exercised on land. In this respect, our results are consistent with the results of Soori et al. (2015) and Dokht Abdiyan et al. (2016), who reported that the elderly in their aquatic exercise groups had significantly higher general endurance than those in the respective control groups (11, 27). This similarity is probably due to the general effect of aquatic exercise on cardiovascular endurance, which enables the body to better deal with the stress of long physical activity. People who enjoy higher endurance have stronger heart muscles, lower heart rates, and higher cardiac contractility, and therefore, increased cardiac output (35), which translates into the higher ability of the heart to pump blood and nutrients to more active cells. This results in lower variations in blood pressure, which is a primary cause of myocardial infarction (19). These changes also lead to a general improvement in fitness and delayed fatigue (20).

The study of Katsural et al. (2010) on 65-year-old elderlies presented that eight weeks of aquatic exercise (three sessions a week, each session lasting 90 minutes) with an emphasis on walking in water could significantly promote strength, speed, balance, and motor ability (34). This result is consistent with our findings. Furthermore, physical activity in water allows for a wider range of movements without exposing the elderly to danger or injury and leads to improved motor ability and control over physical condition (27). When in water, the body experiences enhanced afferent stimulation from skin sensors. Thus, aquatic exercises can elevate the transmission of sensory messages to the corresponding section in the central nervous system. (27). This may boost general endurance by improving hemoglobin and blood volumes, and thereby, the amount of oxygen supply to the muscles (20). This improvement may also reduce blood lipid level and prevent clots and atherosclerosis, which are the most important causes of myocardial infarction, and enhance the performance of muscles in using blood oxygen following an increase in the mitochondrial enzymes within muscle cells. In prolonged physical activities, there is a higher tendency to use slow-twitch muscle fibers, and endurance performance depends on the ability of active muscle cells to consume oxygen and nutrients to generate energy (17, 18). All these changes lead to improved fitness and delayed fatigue (20).

One of the limitations of this study was the restriction of the sample to the elderly who visited the two health centers, which indicates that our results may not be generalizable to the elderly living in nursing homes, who were not included in the study due to lack of cooperation of these facilities.

Implications for Practice

Aquatic exercise was found to have a significantly greater impact on the biomotor ability of elderly men than did land-based exercise. Given the association of biomotor ability with general health, quality of life, and independence of the elderly, and therefore, with their performance in physical, psychological, social, and environmental dimensions, aquatic exercise can be used more effectively to improve the independence and quality of life of the elderly and their performance in the mentioned dimensions. The provided insight into the effects of different factors on the efficacy of aquatic and land-based exercises for the elderly may help the authorities to choose the method to be used in long-term programs to achieve satisfactory results with acceptable cost-efficiency. These exercise programs, which contribute to prevention, care, and rehabilitation, must be devised based on specific aging considerations and with the goal of improving the elderly’s motor mobility. Since economic woes currently limit the applicability of aquatic exercise programs for the Iranian elderly, further prolonged studies on the possible complications of land-based and aquatic exercises and the effects of these exercises on static and dynamic balance and quality of life are recommended.

Acknowledgments
This paper is part of a thesis submitted in partial fulfillment of the requirements for a Master's degree in Geriatric Nursing. The research plan was approved in advance by the Ethics Committee of Mashhad University of Medical Sciences with the code IR.MUMS.REC94877 and was registered in Iranian Registry of Clinical Trials with the code IRCT20767018244845N3. The authors would like to express their sincere gratitude to the Research Deputy of Mashhad University of Medical Sciences for their financial support, and to all the professors at the Faculty of Nursing and Midwifery, the staff of Imamat and Daneshamuz health centers, and the elderly who volunteered to participate in this study.

Conflicts of Interest
The authors declare no conflicts of interest.

References
1. Eshaghi SR, Shahsanai A, Ardakani MM. Assessment of the physical activity of elderly population of Isfahan, Iran. J Isfahan Med Sch. 2011;29(147):1-8 (Persian).
2. Ng TP, Niti M, Chiam PC, Kua EH. Prevalence and correlates of functional disability in multiethnic elderly Singaporeans. J Am Geriatr Soc. 2006;54(1):21-9.
3. Khoga-Naamat K, Sadeghi H, Sahebozamani M. The effect of resistance and endurance training on health-related quality of life in elderlies. J Isfahan Med Sch. 2014;32(303):1623-31 (Persian).
4. Janssen I, Heymsfield SB, Ross R. Low relative skeletal muscle mass (sarcopenia) in older persons is associated with functional impairment and physical disability. J Am Geriatr Soc. 2002;50(5):889-96.
5. Tanimoto Y, Watanabe M, Sun W, Sugiura Y, Tsuda Y, Kimura M, et al. Association between sarcopenia and higher-level functional capacity in daily living in community-dwelling elderly subjects in Japan. Arch Gerontol Geriatr. 2012;55(2):e9-13.
6. Nelson M, Layne JE, Bernstein MJ, Nuernberger A, Castaneda C, Kaliton D, et al. The effects of multidimensional home-based exercise on functional performance in elderly people. J Gerontol A Biol Sci Med Sci. 2004;59(2):M154-60.
7. Morgan K, Bath PA. Customary physical activity and psychological wellbeing: a longitudinal study. Age Ageing. 1998;27(Suppl 3):35-40.
8. Khajavi DF, Jaberimoghaddam A, Kazemnazhad A. The effect of an exercise intervention on motor functions associated with falling in older men without regular physical activity. J Evid Based Care. 2013;12:49-65.
9. Haywood KL, Garratt AM, Fitzpatrick R. Quality of life in older people: a structured review of generic self-assessed health instruments. Qual Life Res. 2005;14(7):1651-68.
10. Elavsky S, McAuley E, Motl RW, Konopack JF, Marquez DX, Hu L, et al. Physical activity enhances long-term quality of life in older adults: efficacy, esteem, and affective influences. Ann Behav Med. 2005;30(2):138-45.
11. Soori R, Akbarnejad A, Naseri Mobarake E, Dokht Abdiyan R, Zeinali V. The effect of water exercises on physiological indices and bio-motor capabilities of sedentary elderly men. J Sport Biosci. 2015;7(1):57-76 (Persian).
12. Irandoust K, Taheri M. The effects of aquatic exercise on body composition and nonspecific low back pain in elderly males. J Phys Ther Sci. 2015;27(2):433-5.
13. Lim HS, Roh SY, Yoon S. An 8-week aquatic exercise program is effective at improving gait stability of the elderly. J Phys Ther Sci. 2013;25(11):1467-70.
14. Raffaelli C, Lanza M, Zanolla L, Zamparo P. Exercise intensity of head-out water-based activities (water fitness). Eur J Appl Physiol. 2010;109(5):829-38.
15. Bocalini DS, Serra AJ, Rica RL, Dos Santos L. Repercussions of training and detraining by water-based exercise on functional fitness and quality of life: a short-term follow-up in healthy older women. Clinics. 2010;65(12):1305-9.

16. Rica RL, Carneiro RM, Serra AJ, Rodriguez D, Pontes Junior FL, Francisco L, et al. Effects of water-based exercise in obese older women: impact of short-term follow-up study on anthropometric, functional fitness and quality of life parameters. Geriatr Gerontol Int. 2013;13(1):209-14.
17. Habibi Sola A, Nikpour S, Rezaei M, Haghani H. Relation between health promoting behaviors and activities of daily living and Instrumental activities of daily living among older people in Tehran. Salmand. 2008;2(5):332-5 (Persian).
18. Acree LS, Longfors J, Fjeldstad AS, Fjeldstad C, Schank B, Nickel KJ, et al. Physical activity is related to quality of life in older adults. Health Qual Life Outcomes. 2006;4(1):37.
19. Schutzer KA, Graves BS. Barriers and motivations to exercise in older adults. Prev Med. 2004;39(5):1056-61.
20. Cromwell RL, Meyers PM, Meyers PE, Newton RA. Tae Kwon Do: an effective exercise for improving balance and walking ability in older adults. J Gerontol A Biol Sci Med Sci. 2007;62(6):641-6.
21. Lin MR, Hwang HF, Wang YW, Chang SH, Wolf SL. Community-based tai chi and its effect on injurious falls, balance, gait, and fear of falling in older people. Phys Ther. 2006;86(9):1189-201.
22. Hartholt KA, van Beeck EF, Polinder S, van der Velde N, van Lieshout EM, Panneman MJ, et al. Societal consequences of falls in the older population: injuries, healthcare costs, and long-term reduced quality of life. J Trauma. 2011;71(3):748-53.
23. Noh DK, Lim JY, Shin HI, Paik NJ. The effect of aquatic therapy on postural balance and muscle strength in stroke survivors-a randomized controlled pilot trial. Clin Rehabil. 2008;22(10-11):966-76.
24. Rezazadeh N, Baluchi R. The effect of 12 weeks exercise in the water and land on the static and dynamic balance and the risk of falling the old people. Iran J Ageing. 2016;10(4):140-51 (Persian).
25. Kaneda K, Sato D, Wakabayashi H, Hanai A, Nomura T. A comparison of the effects of different water exercise programs on balance ability in elderly people. J Aging Phys Act. 2008;16(4):381-92.
26. Colado J, Tella V, Llop F. Response to resistance exercise performed in water versus on land. Rev Port Cien Desp. 2006;6(Suppl 2):361-5.
27. Dokht Abdiyan R, Naseri Mobaraki E, Bagheri G, Ahmadi A. Effect of water-based training frequency on the balance and motor function in sedentary elderly men. Iran J Ageing. 2016;11(2):330-9 (Persian).
28. Babakhani F, Roomiany S, Khamoshian K, Rezaei J. Effect of aquatic and land-based exercise programs on the pain and motor function of weight lifters with patellofemoral pain syndrome. J Kermanshah Univ Med Sci. 2015;19(4):173-80.
29. Lord S, Mitchell D, Williams P. Effect of water exercise on balance and related factors in older people. Aust J Physiother. 1993;39(3):217-22.
30. Lund H, Weile U, Christensen R, Rostock B, Downey A, Bartels EM, et al. A randomized controlled trial of aquatic and land-based exercise in patients with knee osteoarthritis. J Rehabil Med. 2008;40(2):137-44.
31. Smeltzer S, Bare BG. Textbook of medical-surgical nursing. Philadelphia: Lippincott Co; 2010.
32. Cavani V, Mier CM, Musto AA, Tummers N. Effects of a 6-week resistance-training program on functional fitness of older adults. J Aging Phys Act. 2002;10(4):443-52.
33. Ruoti R, Morris DM, Cole AJ. Aquatic rehabilitation. Philadelphia: Lippincott Williams & Wilkins; 1997.
34. Pourtaghi F, Emami Moghadam Z, Ramezani M, Behnam Vashani H, Mohajer S. Effect of resistance training using Thera-band on muscular strength and quality of life among the Elderly. Evid Based Care. 2017;7(3):7-16
35. Rimmer JH, Wang E, Smith D. Barriers associated with exercise and community access for individuals with stroke. J Rehabil Res Dev. 2008;45(2):315-22.
36. Katsura Y, Yoshikawa T, Ueda SY, Usui T, Sotobayashi D, Nakao H, et al. Effects of aquatic exercise training using water-resistance equipment in elderly. Eur J Appl Physiol. 2010;108(5):957-64.