Effect of 8 Weeks Balance Training in Aquatic and Land Environment on Fall Risk in Middle-aged Women

Zahra Arabnarni, Ahmad Ebrahimi Atri, Ali Akbar Hashemi Javaheri and Mohammad Mosaferi Ziaaldini

Physical Education and Sport Sciences Faculty, Ferdowsi University of Mashhad, Mashhad, Iran

Abstract: Ability to balance largely reduced with age. Exercises are important in preventing of reduced physical activity and complications of falls and improve the ability to balance; water as a supportive and low risk environment can reduce the fear of falling and injury during exercise. The objective of this study was to compare the effects of a balance protocol exercise on the land and Aquatic environment on the stability index and fall risk in elderly women. 20 voluntary subjects who participated in the study randomly were divided in one of the whether aquatic training (n = 10) or land training (n =10) groups. Exercises protocol was similar in both groups. Exercise training period was 8 weeks, two sessions per week (16 sessions) and each exercise session consisted of three stages warm up, exercises and cool down. Fall risk score was obtained before and after the training period by Biodex Stability System. In order to determine any difference within and between groups, paired and independent sample t-test was down respectively. Results showed that: The results showed, the difference between balance scores before and after the training period, both groups was significant (p<0/05), but There is no significant difference between the two groups (p>0/05). This study showed that exercise in both water and land environment can improve balance in and reduce risk of falling in older women.

Key words: Aquatic training • Land training • Balance • Risk of fall • Elderly

INTRODUCTION

Loss of muscle strength and functional ability seemed to begin in the fourth decade of life [1]. Falling is one of the major health concern among elderly and causes several problems such as physical, social, psychological, economical. It has been reported that 33% of people over 65 years who live in the community fall yearly and among of them, 50% will have falls more than one per year [2-4]. It has been estimated that annual incidence rates of injurious fall events and related hip fractures is 30.4 per 100,000 person-years in Iranian female population. These figures is 93.6 per 100,000 person-years for people over the age of 50 years [5]. It has been reported the direct and indirect costs of falls among American people aged 60 years and over was $23.3 billion in 2008 and is projected to increase up to $54.9 billion by 2020 [6-8]. In addition to the economic costs, falls negatively impact an individual’s health, behavior and quality of life by increasing a fear of falling. The fear of falling may trigger a restriction in activity, decreased mobility, increased social isolation and a loss of independence [7]. Decreased in maintaining balance is a strong indicator of falls with aging [9, 10]. Aging may affect central nervous system (i.e., changes in brain volume) and neuromuscular system properties (i.e., loss of sensory and motor neurons) leading to deficits in balance and gait performance [11]. It is well known that exercise training can prevent falls in older people [12-14]. In the recent years, aquatic training has been considered as a strategy against fall risk and health promoter in aged people [15-22]. The benefits of aquatic training arise from the special properties of water which are included buoyancy, hydrostatic pressure and viscosity [23]. Therefore the purpose of this study was investigation of 8 weeks of a balance training protocol in water and land environments on balance and fall risk among middle aged women.

Corresponding Author: Mohammad Mosaferi Ziaaldini, Physical Education and Sport Sciences Faculty, Ferdowsi University of Mashhad, Mashhad, Iran. Tel: +36702782889, E-mail: m.mosaferi@hotmail.com.
MATERIALS AND METHODS

Subject: This was a quasi-experimental pre/post study without a control group. Twenty inactive elder women voluntarily participated in this research and were randomized into two groups, aquatic training (AT) and land training (LT). General Characteristics of subjects including age, height, mass and body max index (BMI) is given in Table 1. The University institutional review board approved this study. All participants signed an informed consent document approved by the Institution human subjects review board. The subjects fully reported any record of joint dislocation and possible falling in a specific form. Subjects who had experienced falling over the past 12 months or had any joint dislocation, chronic arthritis, or dizziness were excluded from further study. All subjects in each group were instructed about the exercise program.

Exercise Protocol: Exercises were comparable for both land and water and were administered 2 times per week for 8 weeks. Subjects exercised to their tolerance and were allowed rest periods as needed. Subjects were instructed to report any discomfort immediately. Land exercises were conducted indoors in an assisted living recreation area.

Aquatic exercises were performed in an indoor pool with a temperature that was 33° Celsius (92° F). The program was included warm-up 10 minutes, exercise 30 minutes and cool-down 10 minutes. The program training for each season is presented in Table 2.

Fall Risk Test Protocol: In order to assess the balance function, the falls risk test protocol of Balance System SD® was used and the "Stability index" was calculated. Briefly, subjects got on a round 55 cm diameter platform connected to a desktop and monitor with eye opened. For the safety of subjects, they are allowed to hold a handle. Each session lasted of 20 seconds, completed a total of 3 times trial and platform was designed to be flexible without fixed state to induce the change of center of gravity therefore we could evaluate the subjects' dynamic balance function and expressed it as balance measure (Fig. 1, A). The "Stability index" was calculated by a formula described below (Fig. 1, B) and higher score means poorer balance function.

Statistical Analysis: Descriptive statistics (±SEM) and frequencies were determined for appropriate general characteristics. Comparisons of means for equivalence at

Fig 1: Fall risk test protocol of Balance System SD® (Biodex, New York, USA). (A) Report of fall risk test protocol. (B) Formula to calculate "Stability index". YRS: Years.
Table 1: General Characteristics of subjects

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Aquatic group (N=10) Mean±SD</th>
<th>Land group (N=10) Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>57.5±2.90</td>
<td>61±3.71</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>156.5±3.74</td>
<td>153.5±4.55</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>64±8.75</td>
<td>68.5±10.55</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>26.1±3.4</td>
<td>29±5.1</td>
</tr>
</tbody>
</table>

Table 2: Program training for each season

<table>
<thead>
<tr>
<th>Stage</th>
<th>Exercise</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm-up</td>
<td>Stretching of hamstring, adductor and calf muscles and slow walk.</td>
<td>10 minutes</td>
</tr>
<tr>
<td>Exercise</td>
<td>double-leg squat, double-leg calf raise, stand stretch and bend knee,</td>
<td>30 minutes</td>
</tr>
<tr>
<td></td>
<td>standing kick leg-to-side, standing kick leg-to-front, sitting stretch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>knee, sit spin bike, fast walking forward and backward</td>
<td></td>
</tr>
<tr>
<td>Cool-down</td>
<td>slow walking</td>
<td>10 minutes</td>
</tr>
</tbody>
</table>

Baseline between and within the AT and LT groups were performed using independent and Paired-Sample t tests respectively. The data have been shown as mean differences and standard deviations of the difference. Statistical significance was set at the (p<0.05) level of probability. All analyses were conducted using the Statistical Package for Social Sciences (ver.17).

RESULT

There was a significant main of time, which demonstrated there were significant differences in balance scores between pre and post-test scores for the both aquatic and land groups (t = 4/96, P=0/001 and t = 4/22, P = 0/002 respectively). The main effect of group (difference in balance scores between groups) was not significant (t = 1/35, P = 0/19). Table 3 displays the means and (±) SD Result of within and between T-Test water and land exercise groups. Fig 2 illustrates balance score of pre and posttest in aquatic and land exercise groups.

DISCUSSION

This study was designed to compare the effectiveness of similar balance training interventions performed in a land versus aquatic environment. According to the results, both type of aquatic and land exercise significantly increased balance and decrease fall risk in healthy older subjects. Similar findings have been reported in previous studies [24-26]. Effectiveness of both type of exercises despite the differences between the exercise protocols and balance and risk of fall tests which carried out in this studies (functional reach, timed “up & go,” step test right and left leg and 6-min walk [24], Functional Reach, FR [25], Berg Balance Scale respectively [26]), clearly confirms the positive role of physical activity specially balance exercise training on balance and stability and risk of fall in aged people [27].

Impaired strength, proprioception and balance and increased levels of pain may be the most important underlying mechanisms for both falls and disability in elderly [28]. From mechanistic point of view, fast, accurate and flexible neuromuscular activation is crucial for efficacious responses to the quickly changing dynamics involved in slips or trips. The tibialis anterior (TA) must contract as soon as possible in response to a forward slip of the advancing foot so as to pull the lagging center of mass over the stance foot. If a reversed activation happens the medial gastrocnemius will cause further backward falling of the person’s center of mass. This requires the contralateral swing leg to drop to the ground to prevent a fall. Elimination of reversed activation and faster muscle onset of the TA makes it possible to smoothly continue the gait cycle without tripping or falling backward [29].

In contrast to our result where there wasn’t a significant difference between AT and LT, some studies have reported that AT significantly was effective rather than LT [16, 30, 31]. Several factors are contributed to the effectiveness of exercise programs in aged people including, mode, intensity, duration, frequency, progression and health condition of participants [32, 33]. In fact, despite the differences between exercises protocols which have been applied in previous studies, the most important factor can be involved in an effective exercise training protocol is health condition of subjects. All investigation which has reported better effect of water exercise versus land exercise have done on unhealthy elders [28].
subject especially older people with Osteoarthritis [16, 30, 31]. The water environment may be beneficial to individuals who are frail, suffer from pain, are severely kyphotic, or have poor balance, such as the osteoporotic population. The aquatic environment is beneficial for populations with musculoskeletal problems that may represent a barrier to land-based exercise. Water-based physical activity enhances balance and coordination, while stimulating, visual, vestibular and perceptual systems. Buoyancy reduces stress on joints and muscles and enables greater range of movement via supporting the weight of the body, changing depth allows for progression of resistance and warm water increases muscle efficiency [34]. The multiplicity of symptoms such as pain, muscle weakness, balance deficits, obesity, arthritic diseases and gait balance deficits, obesity, arthritic diseases and gait disease, among others, makes it difficult for elderly people to perform exercises on the ground. The situation is different with exercises in an aquatic environment, where there is a reduction in joint overload and less risk of falls and lesions. In addition, floating allows individuals to perform exercises and movements that cannot be done on the ground [35]. In overall, it seems that the differences observed among the studies regarding the effects of exercise on water and on land are due to the differences in fitness and health levels of participants.

In conclusion, the results of current study shows balance training protocols which was implied, is appropriate in healthy older women to increasing balance and decreasing risk of fall in both aquatic and land environment. However if circumstances and facilities such as cost, availability... are suitable especially for the unhealthy aged people, exercises training in water due to its positive characteristics are recommended.

REFERENCES


