



Original Article

The Effect of Lower Limb Resistance Exercise with Elastic Band on Balance, Walking Speed, and Muscle Strength in Elderly Women

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ABSTRACT

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Introduction: The aim of this study was to investigate the effect of an 8-week resistance exercise program on balance, walking speed, and muscle strength in elderly women.

Methods: This randomized controlled trial was performed on 50 elderly women aged 60-66 years who were assigned to two groups of experimental and control. The Time Up and Go test, was used to measure dynamic balance, Romberg's test was used to measure static balance, and the 10 Meter Walk Test was used to measure walking speed, and the 30 Second Chair Stand test was used to measure muscle strength. Paired t-test and independent t-test was used for comparing balance time before and after the exercise program.

Results: The mean duration of static balance increased in the experimental group from 21.64 ± 10.98 before exercise to 28.20 ± 13.47 after exercise ($p < 0.001$). The mean duration of Up and Go Time decreased from 12.88 ± 1.45 seconds before exercise to 10.80 ± 1.80 seconds after exercise ($p < 0.001$). Ten-meter walking time in the experimental group decreased from 1.15 ± 0.1 seconds before exercise to 1.00 ± 0.11 seconds after exercise ($p < 0.001$) and muscle strength in the experimental group increased from 7.8 ± 1 before exercise to 9.56 ± 1.71 after exercise ($p < 0.001$).

Conclusion: Lower limb resistance exercises with elastic band improve static and dynamic balance and also walking speed, which possibly improve muscle strength. It is recommended that these exercises be considered in developing the elderly women's health care programs due to their accessibility, affordability, and reliability.

Keywords: Aged, Resistance, Exercises, Balance.

Introduction

Physical activity and exercise are among the methods used to prevent, delay, and treat the problems due to ageing (1). As age increases, height fluctuations increase, which is more evident in women (2). Despite the benefits of physical activity in the elderly in the United States, 85% of elderly women and 70% of elderly men do not participate in regular physical

activity (3). Studies in Iran have also shown that over 80% of the elderly are physically inactive; and 30% of the participants do not have a specific exercise program and also do not want to participate in the exercise program (4).

Benefits of resistance training include increased bone and muscle mass, muscle strength, flexibility, and

dynamic balance (5). Balance is one of the basic needs for everyday activities that play an important role in static and dynamic activities (6). In the elderly, age-related changes affect their balance. These changes also affect the sensory and motor systems responsible for maintaining balance (7). Researchers have identified, among other reasons, the weakness of the lower limb muscles and, consequently, the reduction of balance as the main causes of falls among older adults (8, 9). Reduced muscle strength and balance of the elderly leads to a decrease in walking ability, which leads to falls (10). In Iran, 12% of every 8,000 traumatized people admitted to hospitals are elderly people aged 60 or older, and 70% suffer from fall injuries (11). Physical activity aimed at increasing balance improves balance, walking, and muscle strength and, in some cases, decreases the incidence of falls (12).

Muscle strength is one of the effective factors in maintaining balance. Its level in the curve is horizontal up to 50 years of age and then declines, so that in the mid-60s, muscle strength decreases dramatically (13). As age increases, due to inactivity and obesity, muscle volume may be reduced due to the reduction of proteins and muscle tears, so the balance is directly affected by muscle strength (14). Research findings have shown that with decreasing muscle mass, an age-related decrease in skeletal muscle strength is observed (15). Sensory receptors in the leg muscles provide a lot of sensory data for body stability, which is likely to be the main components of balance (16).

Another aspect of walking that can be affected by age is the walking speed, so that after seven decades of life, walking speeds drop by about 12% - 16% per every decade (17). On the other hand, there is an association between muscle weakness of ankle and falls risk during walking and movement (18). Performing age-appropriate physical activity for 20 minutes per session, three times a week, improves muscle strength and functional strength (3).

Exercise interventions such as elastic band strength exercises are reported to improve the strength and ability to maintain a balanced lower limb, and can reduce excessive load on the inner side of knee and reduce the risk of progression of structural damage in the elderly. Therefore, exercise is useful for this age group (19). Weight training or the use of resistance devices in sports facilities and in older people, the use of lighter weights and elastic bands are examples of resistance exercises (20). According to Sidaway and Trzaska, the methods used by specialist people to improve muscle strength include weight resistance exercises, elastic bands and isotonic devices (21). Elastic band exercises have been reported to be risk-free tools for improving musculoskeletal system, improving muscle strength, and enhancing ability to perform functional tasks in the elderly (22). Almost all exercises that are performed with elastic band can be done at different places while walking, traveling, and everywhere else and there is no need for tools and equipment (23). Nowadays, resistance exercises using elastic band is widely used for the rehabilitation of disorders and sports injuries because of their low cost and simplicity (24). These bands are usually made of plastic material in sheets and their

coloring shows their strength levels. The force generated by the elastic band is directly proportional to its length. By changing the thickness and length of these bands, their resistance levels can be increased or decreased (25). Generally, elastic band strength exercise improves balance, walking ability, flexibility (26), strength, mobility, and performance and also relieves joint pain (27). Chen et al. have suggested that elastic bands are a cheap alternative to weight machines, because their use has a significant effect, when compared to other resistance exercises, with respect to adjustment, body composition, or improvement of balance, pain, and muscle strength and, unlike traditional elastic devices, allows easy exercise in both the upper and lower extremities, at any location, and provides a greater range of movements in the muscles, with both concentric and eccentric contractions (28).

Despite the potential benefits of resistance exercises for rehabilitation, few studies have been conducted on the effect of resistance training with elastic band in maintaining the balance and strength of the elderly's muscles, especially in women. Since female elderly are more likely to suffer from osteoporosis and loss of balance, to fall and consequently experience the fracture of the lower extremities and spinal cord, the purpose of this study was to investigate the effect of lower limb resistance exercise with elastic band on balance, walking speed, and muscle strength in elderly women.

Methods

Study procedure

This randomized controlled trial study was conducted on 60 healthy elderly women aged 60 - 66 (mean age: 63.22 ± 1.88) years old at Center of the Cultural Community, Meybod district, Yazd province, Iran. After completing the consent form, the elderly women who were eligible to enter the study, were assigned to two groups: intervention (n : 30) and control (n : 30). Randomization was done by convenience method using a lottery. Before the beginning of the study, all inclusion and exclusion criteria were confirmed by a physician, and the control group was asked to continue their daily activities.

The inclusion criteria were: attaining a score of at least 25 on The Mini-Mental State Examination, being female and aged at least 60 years, being able to walk alone, and not suffering from any central nervous system disorders, visual impairment, and acute hearing loss so that the women could perform exercises, not taking any drugs influencing balance. Exclusion criteria included withdrawing from participation in exercise program, lack of attending more than two exercise sessions, lack of general physical health, suffering from vision and hearing impairments, musculoskeletal and neurological disorders, and acute and disabling diseases so that the women could not perform exercises and follow exercise instructions, confirmed by a physician.

In the present study, before the beginning of the training, we set one week to identify and determine the ability of individuals, and the intensity and number of repetitions under the supervision of a physician. After selecting participants and training exercises to them, one

individual, as an observer, monitored the performance of exercises for 8 weeks (three times a week). The exercise protocol consisted of 10 minutes of warm-up (including aerobic and walking exercises), elastic band strength exercise protocol (30 minutes), and cool-down (5 minutes) so that an exercise session lasted about 45-50 minutes.

Resistance exercises included 6 movements of the muscle group: Extending thighs (abductors), closing thighs, opening thighs (extensors), bending thighs (flexors), bending ankle (dorsal flexion), ankle opening (plantar flexion) by using highly elastic band (orange color) (29), exercises were performed circularly with a 2 min rest after each cycle. Cool-down included static stretching (Table 1). Finally 50 people (25 in each group) completed the study protocol. At completion and after a 24-session period (lasting 8 weeks), the measurements was performed as post-test.

Table 1. Elastic Band Lower Resistance Exercise Protocols

| Week | Warm-up | Main activity Sets/repetitions | Cool down |
|-----------------|------------|-----------------------------------|--------------|
| First week | 10 minutes | 2/10 | 5minutes |
| Second week | 10 minutes | 2/12 | 5 minutes |
| Third week | 10 minutes | 2/15 | 5 minutes |
| Fourth week | 10 minutes | 3/10 | 5 minutes |
| Fifth week | 10 minutes | 3/12 | 5 minutes |
| Sixth week | 10 minutes | 3/15 | 5 minutes |
| Seventh week | 10 minutes | 3/20 | 5 minutes |
| Eighth Week | 10 minutes | 3/25 | 5 minutes |

Measurements

The Sharpened Romberg's test with eyes open was used to measure static balance and Timed Up and Go test, was used to measure dynamic balance. The 10 Meter Walk Test was used to measure walking speed, and the 30 second Chair Stand test was used to measure muscle strength. The measuring procedure was as follow.

Sharpened Romberg's Test: In a closed and quiet room, the person standing puts the heel of one (dominant) foot in front of the other hand's thumb with hands placed in a split over the chest. The length of time that a person could maintain the condition was determined by a chronometer three times consecutively and is considered to indicate static balance (30).

The Timed Up and Go Test: In a closed and quiet room, the person is seated on a chair and asked to rise from the chair, walk three meters, turn around, walk back to the chair, and sit down on the chair to the maximum speed that he/she can go (without running) three times consecutively. The mean duration of the three runs is considered to indicate dynamic balance duration (31).

The 10 Meter Walk Test: In this test, the individual walks without assistance for 10 meters two times to the maximum speed that he/she can go, and his/her better record is calculated. By dividing this number by the distance of interest, the walking speed of the individual in m/s is obtained (32).

The 30 Second Chair Stand Test: The individual is seated on the chair with his/her back flat, legs as far apart

as the width of the shoulders, and hands ringed at the front of the chest; on go the person rises to a full standing position and then sits back down again. The individual constantly sits on and then rises from the chair within 30 seconds as much as he/she can. The total number of correct standing positions in 30 seconds indicates the test score. Jones et al. has argued that this test as a valid and reliable tool for measuring the lower limb strength in the elderly in the community. The purpose of sitting on and rising from a chair is to measure the strength of the lower extremity without the use of large and expensive equipment. This test has a good correlation with the ability to climb stairs, walking speed, and falls risk (33).

The 30 Second Chair Stand test has been shown to provide a reliable and valid indicator of the strength of the lower extremity and is a reliable and sensitive method for determining age-related power loss and the effects of physical activity in the elderly (34).

Ethical Considerations

The participants were assured that their personal and health information would be kept confidential, and were allowed to withdraw the study whenever they wished. During the study, the researcher and a physical education expert participated in exercise activities. Written consent form was obtained from all participants. The study protocol was approved by the Ethics Committee in School of Public Health, Shahid Sadoughi University of Medical sciences, (IR.SSU.SPH.REC.1395.160).

Data analysis

Data were analyzed by SPSS software. Independent samples t-test was used for comparing the balance scores between the intervention and control groups and paired samples t-test was used for comparing the balance scores before and after intervention. Significance level was considered as $p < 0.05$

Results

The participants in the two groups were completely matched with respect to skeletal disease, neurological disease, chronic disease, history of surgery and taking medication ($p > 0.05$).

The results of balance tests before the exercise were examined in the two groups. The two groups were similar with respect to these tests. (Table 2)

Table 2. Comparison of balance tests' scores in the two groups before intervention

| Tests | Intervention | Control | p-value |
|-----------------|---------------|--------------|---------|
| Romberg's test | 21.64 ± 10.98 | 24.64 ± 9.66 | 0.31 |
| Timed up and go | 12.88 ± 1.45 | 13.40 ± 1.25 | 0.18 |
| 10 Meters walk | 1.15 ± 10 | 1.23 ± 11 | 0.1 |
| Muscle strength | 7.28 ± 1.45 | 7.84 ± 1.40 | 0.17 |

Table 3. Comparison of balance tests' scores before and after exercise in the intervention and control groups

| | Intervention | | p-value | Control | | p-value |
|------------------------|---------------|---------------|---------|--------------|--------------|---------|
| | before | after | | before | after | |
| Romberg's test | 21.64 ± 10.98 | 28.20 ± 13.47 | < 0.001 | 24.64 ± 9/66 | 25.8 ± 10.16 | 0.41 |
| Timed up and go | 12.88 ± 1.45 | 10.80 ± 1.80 | < 0.001 | 13.40 ± 1.25 | 13.44 ± 1.52 | 0.84 |
| 10 Meters Walk | 1.15 ± 0.1 | 1 ± 0.11 | < 0.001 | 11.23 ± 0.11 | 1.23 ± 0.17 | 0.83 |
| Muscle strength | 7.28 ± 1.45/1 | 9.56 ± 1.71 | < 0.001 | 7.84 ± 1.40 | 8.08 ± 1.82 | 0.28 |

Table 4. The mean of changes in balance tests' scores in pre and post intervention in two groups

| | Control | Intervention | p-value |
|----------------------------|---------------------------|---------------------------|---------|
| | Mean ± standard deviation | Mean ± standard deviation | |
| Romberg's test | 0.44 ± 2.64 | 6.56 ± 3.83 | < 0.001 |
| Timed get up and go | 0.40 ± 0/97 | 2.08 ± 0.90 | < 0.001 |
| 10 Meters Walk | 0.00 ± 0.93 | 0.15 ± 0.08 | < 0.001 |
| Muscle strength | 0.24 ± 1.09 | 2.28 ± 1.02 | < 0.001 |

The static (Romberg's) and dynamic (Timed Up and Go) balance tests were performed on the two groups after 8 weeks. In both groups, the results of these tests before and after the exercise were compared using the paired t-test. The duration of the Timed Up and Go test (dynamic balance) and 10-Meters Walk Test in the experimental group decreased ($p < 0.001$). In contrast, the static balance and muscle strength increased in the experimental group ($p < 0.001$), but did not change in the control group. (Table3)

Comparison of mean changes in balance tests' scores before and after 8 weeks of resistance exercise in both groups showed a significant difference between the experimental and control groups. (Table 4)

Discussion

The aim of this study was to investigate the effect of 8 weeks of elastic band resistance exercise on balance, walking speed, and muscle resistance of elderly women. In this study, the results of the static balance test after the elastic band exercise showed a significant increase, which is consistent with the study of Wonjong et al. in which elastic band resistance exercise was observed to be effective in improving the static and dynamic balance of the elderly (35). On the other hand, the study of Erfanian et al. showed that elastic band resistance exercise did not have a significant effect on the static balance of the participants, but had a significant effect on the intensity of the pain showed after 8 weeks of training (29). The inconsistency in the research findings can be attributed to the difference in the number and health status of the participants of the two studies. In the study of Erfanian et al. (29) 24 women with arthritis and knee varus participated, but our participants were 50 healthy elderly women. Chen et al. examined the impact of an elastic band exercise on elderly people in Taiwan. That study showed that elastic band resistance training was effective in improving functional ability, increased flexibility and mobility of joints and muscles, and increased walking speed and balance in the elderly

(36). Aemi et al. reviewed the research findings on the effect of elastic band exercises in elderly women, and concluded that elastic band exercises had a significant effect on muscle improvement and led to an increase in strength and resistance (37). The study of Kwak et al. showed that 8 weeks of elastic band resistance exercise significantly increased balance, walking ability, and flexibility in the intervention group (26). Lee et al. also demonstrated the effect of elastic band exercise on women's walking and muscle strength in South Korea. Their results showed that the balance, measured by the standing on one leg, significantly improved in the intervention group when compared to the control group (38).

Ahn et al. examined the effect of elastic band resistance exercise on lower limb muscle strength and walking ability in patients with Alzheimer's disease, and observed that the static balance in the intervention group significantly increased (39). Holviala et al. (40), Ahn et al. (39), Buchner et al.(41), Judge et al. (42), have observed resistance training is not effective on muscle strength, walking speed, and dynamic balance in the elderly, which is not in agreement with our findings. In our study, the results of 30-second chair stand test showed a significant progress in the strength of lower extremity in the experimental group when compared with the control which is consistent with the Idland et al(43), Webber et al (44), Rosendahl et al (45), Lord et al (46), Lopopolo et al (47). Results of studies by Mollabashi showed that balance exercises could improve muscle strength and balance (48). According to Hwang et al. ample evidence shows that elastic band exercise improves dynamic balance, skill, muscle strength, and muscular endurance (49). Weiss et al. demonstrated that progressive resistance exercise leads to improved quality of walking and balance by increasing muscle strength (50). The results of that study are consistent with the present study, suggesting the effect of resistance exercise on balance. The inconsistency in the results of our study and other studies regarding resistance exercise, can be attributed

to the lack of agreement on a specific interval exercise protocol and number of the exercise sessions, and how long and to what extent they have the greatest impact on dynamic balance, as well as gender and age effect, and the initial level of balance scores of the participants.

Conclusion

Elastomeric resistance exercise programs will increase the balance of aesthetics and result in increased walking speed and improved muscle strength. Therefore, elderly sports coaches are recommended to take advantage of the elasticity of the strength training and to take into account the special needs of the elderly and the likelihood of injury in designing training programs to improve the dynamic and static balance of this age group.

Study limitations

The study was conducted on female members of a Center of the Cultural Community in Meybod district in Yazd. That should be addressed in using the results. Moreover, longitudinal additional studies are recommended to examine the effects of these exercises in the long term on individuals who are not healthy and well-educated.

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Conflict of interest

The authors of this article declare no conflict of interest.

Authors' contributions

All authors contributed to the design and implementation of the study, analysis and interpretation of data, and to draft or modify the article. Data collection was carried out by Najme Kuchakinejad Meybodi. All authors have read and approved the final version of the article.

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