

## **Effects of Physical Exercise on Lower Body Strength, Balance and Reducing Risk of Falls of Older People**

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*Type: Research Article (Received: 25.01.2019 – Corrected: ---- – Accepted: 24.09.2019)*

### **Abstract**

The main aim of this study was to investigate the effects of physical exercises on lower body strength, balance and reducing risk of falls of community-dwelling older people in order to suggest an effective intervention for fall prevention for this population. Participants were divided into intervention and control groups. Intervention group followed exercise program in twelve weeks whereas control group still remain daily activities and did not participate in any new exercise program. The lower body strength and balance of research groups were evaluated by Chair stand test, 8-foot up and go test, Stand on one leg with eyes open and eyes closed tests. After twelve-week intervention, participants in intervention group obtained better results in all tests calculated by t-test ( $p < .05$ ), making a significant improvement in lower body strength and balance which may reduce the risk of falls. It can be suggested that the exercise program was effective in improving lower body strength, balance and reducing risk of falls of older people.

**Keywords:** Physical exercises, Strength, Balance, Risk of falls

## Introduction

With the increase in the elderly population, the fractures associated with falls in the elderly are becoming a major social problem. Falling is the sixth leading cause of death among the elderly (Tinetti, Richman, & Powell, 1990). Musculoskeletal diseases and visual defects were common medical problems responsible for falls (Shanthi & Krishnaswamy, 2005). Falls are a dangerous matter for the elderly. However, most of them are preventable. Numerous factors, both intrinsic and extrinsic factors, can cause falls in the elderly and lead to injury. Older persons, often with multiple medical problems, move through their daily routine exposed to many environmental risk factors such as grass, curbs, steps, slippery surfaces and more. Among the intrinsic risk factors that the elderly face are changes in vision and hearing, use of medications, and a declining strength in bones and muscles. As the number of risk factors present increases, so does the risk for falls (Tinetti et al., 1994).

Falls are a major cause of dependence in older age and can result in long term disability, loss of mobility, reduced quality of life and even death (Campbell et al., 1990). Falling in older age greatly increases the risk of being admitted to a residential aged care facility (Tinetti & Williams, 1997) and falls account for approximately 18% of emergency hospital admissions by older people (Bell, Talbot-Stern, & Hennessy, 2000). Muscle mass and function are important for stability and correct balance (Kannus, Parkkari, & Niemi, 2000). Falls and injuries are among the top geriatric issues because falls are often devastating and costly (Gillespie et al., 2012) and the rate of falls and severity of the resulting complication increases with age (Rubenstein, 2006).

Purpose of this study was to investigate the effects of physical exercises on lower body strength, balance and reducing risk of falls of community-dwelling older people in order to suggest an effective intervention for fall prevention for this population.

## Materials and Methods

### Design

This is a pre and post study. Two hundred and fifty subjects were asked to take part in the first survey for the concernings of falls. Fifty one subjects were recruited to be on the intervention. Subjects were randomly divided into two groups: Intervention and Control groups. Subjects aged seventy and older. They gave their written informed consent to participation in the study after the experimental procedures had been explained.

Intervention group included 26 subjects, were conducted to practice selected exercises in three month. Control group included 25 subjects, were informed not to do any exercise program, however, still maintain daily activities as usual.

Inclusion criteria included participants age 70 and older. All subjects are able to do exercises under instructor' instruction. Subjects were excluded if they had neurological impairments, severe cardiovascular diseases, persistent joint pain, or musculoskeletal impairment; required assistance from another person or a device during ambulation, or severe vision problems.

### Intervention Protocol

Subjects in intervention group were instructed to do exercises in 12 weeks (including training at center and at home). Subjects were also instructed to do exercises two times a week at the citizen centers for the first two weeks. After that the individuals performed the exercises at home by themselves three times a week for ten weeks. All one-hour sessions consisted of 10 minutes of warm-up and stretching, 40 minutes of main exercise, and 10 minutes of cool down.

### Measurement of Lower Body Strength and Balance

Chair stand test for assessing low body strength: Participant sit in the middle of the chair with back straight, feet flat on the floor, arms crossed at the wrists and held against the chest. On the signal “go”, participant rises to a full stand and returns to fully seated position in 30 seconds as described in (Rikli & Jones, 2001).

8-foot up and go for assessing agility and balance: Participant sit in the middle of the chair with back straight, feet flat on the floor, and on the thighs. The torso slightly leaning forward. On the signal “go” the participant gets up from the chair, walks as quickly as possible around either side of the cone and sits back down in the chair. The distance is 8 feet (2.44m) as described in (Rikli & Jones, 2001).

Romeberg test for assessing static and dynamic balance includes stand on one foot with open eyes and stand on one foot with open closed, as described in (Khasnis & Gokula, 2003; Lee, 1998; Pearce & John, 2005; Rogers, 1980).

### Statistical Analysis

All analyses were conducted using SPSS version 19.0. An independent simple t-test was performed to analyze the differences between groups. Analysis of variance (ANOVA) was used to analyze the differences in test phases. A  $p < .05$  was considered to be statistical significant.

### Results

#### Characteristics of Study Samples

The intervention group has one more subject than that of control group. None of subjects dropped or resigned from this study. The average age of the two groups are equal. There are no significant differences for genders, chair stand, 8-foot up and go, stand on one leg with eyes open and stand on one leg with eyes closed between two research groups. P-value  $> .05$  proved the comparisons.

**Table 1.** Characteristics of research samples

Characteristics	Intervention Group (n = 26)	Control Group (n = 25)	P
Gender (Male/Female)	6/10	6/19	
Average age	74.76 ± 2.84	74.99 ± 2.58	>.05
Chair stand (time/30s)	16.33 ± 2.76	16.35 ± 2.59	>.05
8 foot up and go (s)	6.95 ± .84	7.12 ± .63	>.05
Stand on one leg with eyes open (s)	15.02 ± 9.30	14.02 ± 11	>.05
Stand on one leg with eyes closed (s)	4.15 ± 3.00	4.30 ± 2.00	>.05

#### Selecting exercises for improving lower body strength and balance

Exercises were taken from NIA (National Institute of Aging, 2018). Before these exercises have been applied for intervention, we interviewed experts and lectures in physical fields in order to select which exercises could be most suited for this study. In addition, participants were asked to fill the interview form for selecting which exercises they most want to do. Also, some previous findings have applied these some kinds of exercises for preventing falls (Carter, Kannus, & Khan, 2001; Clinical Excellence Commission, 2012; Land & Dinan, 2010). The results of selected exercise showed in table 2.

**Table 2.** Selected exercises for improving lower body strength and balance\*

Exercises	Area of assessment
Chair Dip	Lower - body strength
Back leg raise	Lower - body strength
Side leg raise	Lower - body strength
Knee curl	Lower - body strength
Leg strengthening	Lower - body strength
Chair stand	Lower - body strength
Step in place	Lower - body strength
Heel – to – toe walk	Agility and Balance
Balance walk	Agility and Balance
Stand on one foot with eyes open	Agility and Balance
Stand on one foot with eyes closed	Agility and Balance
Toe stand	Agility and Balance

\* Taken from National Institute of Aging

All selected exercises of assessing lower body strength, and balance are briefly described and taken from NIA (National Institute of Aging, 2018).

### Assessing the effectiveness of selected exercises for reducing the risk of fall of older people

After three months of intervention, the results of tests for lower body strength, balance are shown in table 3. These results indicated that after three months of exercises training, subjects in intervention group showed better results in lower body strength, balance than control group (between groups) and the subjects in intervention group showed significant differences within pre and post (within group). That was examined by tests: chair stand, 8-foot up go and standing on one leg with eyes open and eyes close tests with  $p < .05$ , respectively.

**Table 3.** Comparison of the results of tests between the two research groups

Test	Phases	Intervention Group (n = 26)	Control Group (n = 25)	P value
Chair-stand (time/30s)	Pre	16.33 ± 2.76	16.35 ± 2.59	>.05
	Post	19.22 ± 3.65	16.51 ± 4.02	<.05
	P	<.05	>.05	
8-foot up and go (s)	Pre	6.95 ± .84	7.12 ± .63	>.05
	Post	6.11 ± .75	7.61 ± 1.31	<.05
	P	<.05	>.05	
Standing on one leg with eyes open mean of 3 trials (s)	Pre	15.02 ± 9.30	14.02 ± 11.55	>.05
	Post	19.50 ± 10.01	14.18 ± 10.21	<.05
	P	<.05	>.05	
Standing on one leg	Pre	4.15 ± 3.00	4.30 ± 2.00	>.05

with eyes closed mean of 3 trials (s)	Post	7.94 ± 4.04	4.45 ± 2.00	<.05
	P	<.05	>.05	

### Discussion and Conclusion

In this study, the strength of lower body and balance of older people were assessed by training selected exercises. After three months of exercises training, lower body strength and balance of older people were significantly improved.

Previous findings proved that strength and lower limbs strength, and time for reaction of muscles and balance might be improved with suitable exercises (Deschenes, 2004; Keller & Engelhardt, 2014). Furthermore, previous studies have indicated that physical exercises may reduce falls for the elderly in community (Clemson et al., 2012; Gardner, Robertson, & Campbell, 2000; Hagedorn & Holm, 2010). The results of this study are concurrent with the results of several studies that improve balance for older people (Day et al., 2002), reduce falls in older people and identify the important components of effective exercise intervention strategies (Sherrington et al., 2008), reduce falls and fall risk in the community-dwelling elderly (Arnold, Sran, & Harrison, 2008), prevent injuries caused by falls (El-Khoury, Cassou, Charles, & Dargent-Molina, 2013). Study of Freiburger also suggested that a fitness program focusing on functional skills, strength, endurance and flexibility improve some aspects of physical performance and is moderately effective in reducing fall in physically active older people living in the community (Freiberger, Menz, Abu-Omar, & Rutten, 2007) and exercise is effective in lowering fall risk in older people (Gardner et al., 2000).

This result is also in accordance with the results of Cho, who conducted recreational exercises on the strength, flexibility, and balance of older-older elderly individuals (Cho, An, & Yoo, 2014) and Cho with study on exercise of dynamic stability under unstable conditions increase muscle strength and balance ability in the elderly (Cho & An, 2014), study of Hafström on exercise offer an efficient cost-effective way to improve balance control and confidence in the elderly and it is possible to enhance balance control and stability in relatively healthy community-dwelling elderly by regularly performing a few balance exercises (Hafström, Malmström, Terdèn, Fransson, & Magnusson, 2016), and a randomized control trial of Tomicki (Tomicki et al., 2016) indicated the effects of proposed exercise program in improving body balance and the performance of functional tasks, contributing to an improvement in the risk of falls.

This study revealed that regular exercises is beneficial for improving lower body strength and balance and that may help to reduce the risk of falls for community dwelling older people. The participants from intervention group had better results in chair stand test, 8-foot up and go test, standing on one leg with eyes open and eyes closed tests. However, with small sample size, it may not be represented for large population, especially, for frail elderly or people who required assistance from another person or a device during ambulation, or severe vision problems and other concernings. The subjects of intervention group were instructed to do exercise only for the first two weeks then they did at home by themselves, this made it difficult to conduct the experiment perfectly and, in somehow, reliability decreased.

### Conflict of Interest

The author has not declared any conflicts of interest.

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