



Long-Term Effects of Exercise on Balance and Fear of Falling in Community-Dwelling Elderly

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Abstract

Falls are the main cause of injuries in the elderly, with an estimated 684,000 fatal falls each year, 60% of which occur in Southeast Asia and the Western Pacific. Studies on the long-term effects of balance training are still limited. This study aimed to assess the long-term impact of physical exercise on the balance and fear of falling in community-dwelling elderly. This was a quasi-experimental study with a pre-post design. The participants were recruited using purposive sampling. The inclusion criteria were older people ≥ 60 years old with balance problems. They received a one-month physical exercise. The instruments included the Functional Reach Test (FRT) to assess balance and the Falls Efficacy Scale-International (FES-I) to assess fear of falling. The assessment was conducted pre- and post-intervention and two years later. Data from 23 participants were collected in 2017 and 2019. Data were analyzed using the Wilcoxon Signed-Rank Test and linear mixed model regression. There were significant differences in FRT and FES-I between pre- and post-intervention, pre-intervention, and two years later. There was no significant difference in FRT and FES-I between post-intervention and two years after. There was a significant improvement in the balance and fear of falling one month and two years after the program. The balance program had a long-term effect that lasted at least two years. The inclusion of the balance program in community-based health programs for the elderly can improve balance and prevent falls.

Introduction

Falls are one of the leading causes of death and disability in the elderly population (WHO, 2021). Falls are the leading cause of fatal and nonfatal injuries among the elderly. The age-adjusted mortality rate of falls in the elderly in the US is 64:100,000, which increased by around 30% in 18 years.² Older age, women, previous history of falling, and multimorbidity have a higher risk of falls (Kim *et al.*, 2020; Pirrie *et al.*, 2020). Other important risk factors are sensory impairment, cognitive decline, certain medications, and environmental hazards (Saftari & Kwon, 2018; Wang *et al.*, 2022; Montero-odasso & Speechley, 2018; Gadelha *et al.*, 2018). These risk factors might cause falls through psychological and physiological pathways.

One of the psychological pathways is increased perceived fear of falling, and the physiological pathway can be represented by balance. Fear of falling itself might affect the physiological pathway over time, through muscle atrophy caused by lack of activity (Jeon *et al.*, 2017; Park *et al.*, 2014; physical performance, and physical characteristics in an elderly population. Design: This study is a cross-sectional study with 883 community dwellers 60 yrs or older from a rural area. They completed surveys and evaluations including demographics, the Korean version of the Falls Efficacy Scale-International, the Short Physical Performance Battery, the timed up and go (TUGMerchant *et al.*, 2020) sarcopenia, gait speed and grip strength, cognitive impairment, depression, social isolation, self-perceived

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health, and vision. DESIGN: Observational cross-sectional study. SETTING: Community. PARTICIPANTS: A total of 493 community-dwelling older adults, 60 years and older. MEASURES: FOF and FAR were assessed using validated single closed-ended questions. Questionnaire was administered to evaluate frailty (FRAIL scale - Fatigue, Resistance, Aerobic, Illness, and Loss of Weight).

Falls are preventable. Health promotion and prevention activities, such as screening of fall risk, medication overview, environmental modification, education, and various exercise programs are proven effective in preventing future falls. Fall risk screening and medication overview would help healthcare professionals prioritize fall prevention on higher risk elderly. Exercise programs usually target muscle strength to improve gait and balance, while indirectly improving the perceived fear of falling (Moreland *et al.*, 2020; Matla *et al.*, 2021; Whipple *et al.*, 2019).

There have been studies reporting the effectiveness of physical exercise for fall prevention in the elderly. However, most of the studies were conducted over a short time (Matla *et al.*, 2021; Chen *et al.*, 2019; Im, *et al.*, 2019). A few studies have been conducted in community settings in Indonesia, but there is no long-term evaluation yet (Freiberger *et al.*, 2012; Hars *et al.*, 2014). In some studies with positive long-term outcomes, the exercise programs were more complex and took longer to complete, which might be a challenge to adapt to community settings in Indonesia. However, until now, no study in Indonesia has discussed the long-term outcomes of exercise programs for the elderly, hence this study is still relevant. In addition, for feasibility purposes, simpler programs may be needed to make these exercise programs more accessible to the community. Therefore, there is a need to conduct a community trial to implement a simple exercise program and assess its long-term outcomes. This study aimed to assess the long-term effectiveness of a simple exercise program in improving balance and perceived fear of falling in community-dwelling elderly in Yogyakarta, Indonesia. To further inform the implementation aspects of the program, we also assessed the outcome according to the participants' compliance.

Method

This was a quasi-experimental study with a pre-post design. and without control groups. We conducted follow-up outcome measurement 2 years after the exercise program, without any intervention during that time. Study participants were recruited using purposive sampling. The inclusion criteria were elderly, above 60 years of age, with moderate and severe risk of falling, regardless of the presence of chronic diseases or multimorbidity. The risk of falling was assessed by balance with the Functional Reach Test (FRT), where an FRT score of more than 25 is considered to have a low risk of falls. The cognitive function of the elderly was clarified using the Mini Mental-State Examination (MMSE) with a score of >23 (Folstein *et al.*, 1975; Hogervorst *et al.*, 2011). Elderly with MMSE scores lower than 23 were excluded from this study. All participants were purposively recruited from the Wirobrajan subdistrict, Yogyakarta City, Indonesia. The baseline characteristics were measured by questionnaires, which are age, sex, education level, current occupation, medication history, and history of falling.

A balance exercise program based on Sherrington's recommendation to include support base reduction was conducted weekly for 60 minutes each (Sherrington *et al.*, 2011). The exercises included: standing heel to toe, raising knees, walking heel to toe with the toes of the back foot touching the heel of the front foot, raising the side leg, walking sideways, raising heels, stepping up a step, sitting to standing. The exercises were designed to challenge the participants' balance and coordination. The intervention was carried out within a week, then intervention for three weeks, and finally post-intervention at the end of November 2017.

Outcomes on balance were collected with the Functional Reach Test (FRT) and the perceived fear of falling was assessed by the Falls Efficacy Scale-International (FES-I). The Functional Reach Test (FRT) is a simple and reliable clinical measure of balance. It was developed by Duncan *et al.* (1990) and has been tested for validity and reliability (Duncan *et al.*, 1990). The FRT measures the distance that a person can reach forward while standing still with their feet shoulder-width apart. The test is performed with a measuring tape attached to a

wall at shoulder height. The person stands facing the wall with their back straight and their feet shoulder-width apart. The person then reaches forward as far as they can without taking a step. The distance that the person reaches is measured from the tip of their finger to the measuring tape. A lower FRT score indicates a greater risk of falls. People with a functional reach of $\geq 10''/25$ cm were considered to have a low risk of falls (Thomas, 2020). The FRT has been widely used in many studies on elderlies (Bohannon *et al.*, 2017; Balasubramanian *et al.*, 2015; Fujimoto *et al.*, 2015) there are few reports on physical cognitive ability. Objective: To examine the relationship of the results of motor function tests that include physical cognitive ability on the ability to predict falls and to determine which test is the most appropriate. Methods: We studied 174 community-dwelling elderly adults (mean age 75.7 ± 5.7 , 41 males and 133 females. People with a functional reach of $\geq 10''/25$ cm were considered to have a low risk of falls (Thomas, 2020). The subjects of this study were elderly with functional reach $< 10''/25$ cm.

The FES-I is a questionnaire containing ten activity questionnaires (Tinetti *et al.*, 1990). The scoring was modified to 0-10 (0=non confident, 5=fairly confident, and 10=completely confident), thus the score ranged from 0-100. The higher the score, the higher the confidence of the respondent. FES-I has been widely used in studies with elderlies as research participants, and proven valid in several languages (Meimandi *et al.*, 2021; Canever *et al.*, 2022; Toronjo-Hornillo *et al.*, 2018). The measurements were taken before and after the intervention. The intervention was carried out in October-November 2017. Another assessment was conducted in August – September 2019. Additionally, the study participants were asked about their compliance in the follow-up measurement, with a simple question of whether they performed the exercise at least once a week in the past 2 years after the exercise program was completed.

Data of the baseline characteristics were presented descriptively. Univariate analyses were performed with non-parametric analysis (Wilcoxon signed rank test), with a significant value (p) below 0.05. Further age and sex adjustment of outcome measurement were

done with linear mixed model regression. We also performed subset analyses according to the compliance of each participant. Ethical clearance for this study was obtained from the Ethical Committee for Health Research, Faculty of Medicine, Duta Wacana Christian University (No.: 474/C.16/FK/2017) and all study participants gave written informed consent.

Results and Discussion

Initially, there were 24 elderly who participated in the study, but one of them passed away within the study period, so there were data from 23 participants analyzed. They aged between 61-80 years old, with a mean \pm SD of 69.96 ± 6.138 years at the start of the study in 2017. The MMSE score at the beginning of the study ranged between 24-30 with a mean and standard deviation of 28.69 ± 1.55 . Table 1 shows the baseline characteristics of participants. Most of the study participants were females, which was consistent with a study that reported falls occurred more commonly in women (Gale *et al.*, 2016). They were given a balance exercise program for one month. More than half of the participants (52.2%) consumed antihypertensive medications that might affect the balance, and a few of them have had a history of falling previously (17.4%).

Table 1. Characteristics of Study Participants from Wirobrajan Sub-District, Yogyakarta in 2017 (n=23).

	Total (n)	Percentage (%)
Age		
60-74 years	18	78.3 %
75-89 years	5	21.7 %
Sex		
Female	20	87 %
Male	3	13 %
Education		
Did not complete Elementary School	17	74 %
Elementary School	3	13 %
Junior High School	2	9 %
Senior High School	1	4 %
Current occupation		
Tradesperson	5	21 %
Pensioner	1	4 %

	Total (n)	Percentage (%)
Laborer	1	4 %
Masseur	1	4 %
Unemployed	15	65 %
Medication history		
Antihypertensive	12	52.2%
Antidiabetic	5	21.7%
Hyperuricemia medication	6	26.1%
Other cardiovascular medication	5	21.7%
History of falling: yes	4	17.4%
Follow-up compliance: good	15	65.2%

Source: Primary Data, 2017

The effects of the program were measured using FRT to assess balance and FES-I to assess fear of falling before and after the intervention and two years later, as shown in Table 2. There was a significant improvement in fall risk (according to FRT) from 17.04 cm to 21.87 cm, which slightly decreased to 20.65 over 2 years. There was a significant difference in FRT after 2 years between participants with good and poor compliance. The perceived fear of falling (FES-I) was also increasing by around 10 points after intervention, and slightly increased over 2 years by 1 point, although it was not statistically significant. Figure 1 highlights the different progression between patients with good and poor compliance over time, where the FRT returns to the baseline condition in participants with poor compliance. A study conducted by community-dwelling elderly reported that a one-month exercise increased muscle strength and joint flexibility, which improved balance (Suzuki *et al.*, 2019).

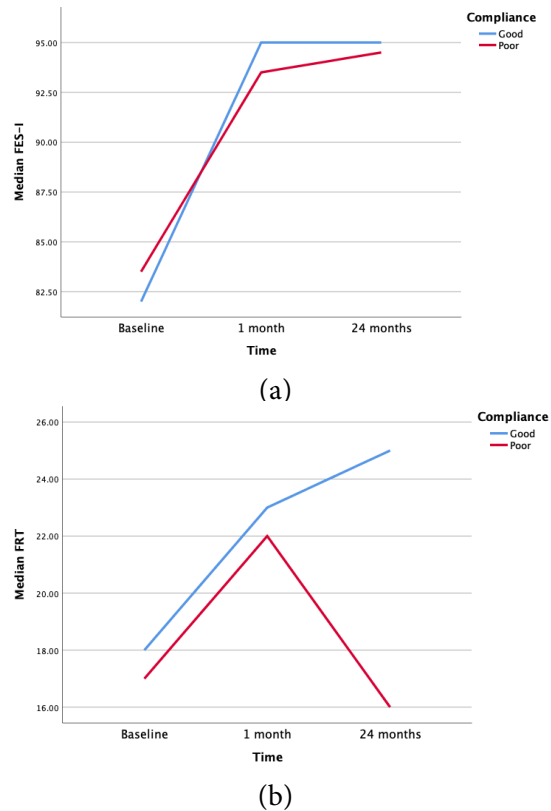


Figure 1. The changes in (a) FES and (b) FRT in three periods of time between participants with good compliance compared to poor compliance after completion of the exercise program.

This study showed that exercise had a long-term positive impact on the elderly's balance. Patil *et al* (2015) conducted case-control intervention research on women aged 70 to 80 years with a history of fall(s) in the previous year and followed them for two years (Patil *et al.*, 2015) falls, and related injuries in older women. Design Two-year randomized controlled trial. Setting Tampere, Finland.

Table 2. Changes in Balance (FRT) and Perceived Fear of Falling (FES-I) from Baseline in 2017 to Post-Intervention and Long-Term in 2019 (n=23).

Variable	Baseline	Post-intervention (1 month)	Long-term (2 years)		
			All (n=23)	Good compliance (n=15)	Poor compliance (n=8)
FRT					
mean (SD), cm	17.04 (2.65)	21.87 (3.39)*	20.65 (4.79)*	23.00 (3.61) †	16.25 (3.49)
median (IQR), cm	18 (1)	22 (3)	21 (9)	25 (5)	16 (2.5)
FES-I					
mean (SD)	82.61 (8.61)	92.65 (5.43)*	93.91 (5.46)*	93.60 (6.21)	94.50 (4.00)
median (IQR)	83 (9)	94 (9)	95 (7)	95 (7)	94.5 (7.5)

* significant difference compared to baseline (p < 0.05)

† significant difference between good and poor compliance (p < 0.05)

Table 3. Multivariate Models of Change in Balance (FRT) and Perceived Fear of Falling (FES-I) from Baseline in 2017 to Post-Intervention and Long-Term in 2019 Adjusted with Compliance (n=23).

	Coefficient (95 CI%)	p-value
FRT		
Intercept	14.522 (12.806 – 16.237)	< 0.001
Time = 2 years vs pre-intervention	3.609 (1.706 – 5.512)	< 0.001
Time = 2 years vs post-intervention	4.826 (2.923 – 6.729)	< 0.001
Compliance = good vs poor	3.867 (2.235 – 5.498)	< 0.001
FES-I		
Intercept	82.134 (78.571 – 85.697)	< 0.001
Time = 2 years vs pre-intervention	11.304 (7.352 – 15.257)	< 0.001
Time = 2 years vs post-intervention	10.043 (6.091 – 13.996)	< 0.001
Compliance = good vs poor	0.728 (-2.660 – 4.116)	0.669

Participants Women aged 70 to 80 who had fallen in the previous year (n = 409). They found that the exercise group had improved physical functioning indicated by leg strength, chair rise time, backward walking time, and fast walking speed. The physical functioning improved at 6 months, 12 months, and 18 months. The physical functioning at 24 months decreased compared to that at 18 months, but still better than at the beginning of the program. Freiburger *et al.* (2012) gave strength and balance training to women aged 70 – 90 years and measured the effects on their physical performance measured by Timed Get Up and Go test, modified Romberg test, chair rise test, and walking speed. The physical performance of the research participants kept improving until 24 months later. Comparing the functional reach after the intervention and two years later, there was a tendency to decrease with age. This finding was consistent with the results of other studies that reported the effect of age on functional reach (de Waroquier-Leroy *et al.*, 2014; Mohammed *et al.*, 2020).

The statistical analysis of the fear of falling found significantly reduced fear of falling between pre- and post-intervention, and between pre-intervention and two years later. There was no significant difference between the functional reach test post-intervention and two years after. A study delivered balance training to women aged 75 to 85 years and found improved balance, physical activity level, and reduced fear of falling assessed using FES-I (El-Khoury *et al.*, 2015) two arm, parallel group, randomised controlled trial. Setting 20 study sites in 16 medium to large cities throughout

France. Participants 706 women aged 75-85, living in their own home, and with diminished balance and gait capacities, randomly allocated to the experimental intervention group (exercise programme, n=352. Further details of the changes in FRT and FES-I between pre-, post-intervention, and 2 years of follow-up are shown in Table 3. Generally, the table shows that the exercise program significantly improved the balance and perceived fear of falling, whereas good compliance can maintain the improvement over time. This was consistent with the finding of a study that reported compliant older people had a higher positive impact from exercise compared to the non-compliant subjects (Falossi *et al.*, 2022).

This research had some limitations. The number of research participants was relatively small and there was no control group. However, this is the first research in Indonesia that investigated the long-term impact of balance exercise in the elderly.

Conclusion

Preventing falls in the elderly needs to consider the complex nature of its risk factors. This study showed that a simple exercise program in the community is feasible to improve the physical and psychological risk of falls in the elderly both in the short term and long term. The findings of this study provided evidence that balance exercise could improve the balance and reduce the fear of falling in the elderly with long-term impact. A balance exercise program can be included in the Indonesian community-based program, Posyandu Lansia (integrated

service post for older people program) to improve balance and prevent falls. Future trial with randomization, control groups, and a larger population is needed to design a program that is suitable in Indonesian settings, especially in community settings. Regarding the compliance of participants, further studies are needed to explore the motivation and other characteristics that might influence it.

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