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## #44079 Summary

SUMMARY REVIEW EDITING

### Submission

Authors	The Maria Meiwati Widagdo, Claudia Bella Laurentia, Bagus Anggawaisna Anggawaisna Suryadiningrat, Teguh Kristian Perdamaian	
Title	Long-Term Effects of Exercise on Balance and Fear of Falling in Elderly	
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Date submitted	April 29, 2023 - 10:56 PM	
Section	Articles	
Editor	Oktia Handayani, M.Kes	
Author comments	Dear Editor of <i>Jurnal Kesehatan Masyarakat</i> ,  We are submitting our manuscript entitled "Long-Term Effects of Exercise on Balance and Fear of Falling in Elderly" for your kind consideration of its suitability for publication as a research article paper in <i>Jurnal Kesehatan Masyarakat</i> .  Falls is the main cause of injuries in elderly. There have been studies on the positive effect of balance exercise to prevent falls and reduce fear of falling. However, the number of studies assessing the long-term effect of exercise is still limited, especially in developing countries. Beyond the researchers of the current study, this was the first study that measured the long-term (two years) effect of exercise on the balance and fear of falling of elderly study participants. This finding provides evidence for the inclusion of exercise in community-based health program for older people to improve balance, reduce fear of falling and prevent falls.  We believe that the present work would be important for the readers of <i>Jurnal Kesehatan Masyarakat</i> . Researchers and professionals working on the falls prevention and geriatric research would find this paper valuable.  I hereby certify that all of the listed authors have contributed substantially in the study; all the authors have approved	

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Dear Editor of *Jurnal Kesehatan Masyarakat*,

We are submitting our manuscript entitled "Long-Term Effects of Exercise on Balance and Fear of Falling in Elderly" for your kind consideration of its suitability for publication as a research article paper in *Jurnal Kesehatan Masyarakat*.

Falls is the main cause of injuries in elderly. There have been studies on the positive effect of balance exercise to prevent falls and reduce fear of falling. However, the number of studies assessing the long-term effect of exercise is still limited, especially in developing countries. Beyond the researchers of the current study, this was the first study that measured the long-term (two years) effect of exercise on the balance and fear of falling of elderly study participants. This finding provides evidence for the inclusion of exercise in community-based health program for older people to improve balance, reduce fear of falling and prevent falls.

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I hereby certify that all of the listed authors have contributed substantially in the study; all the authors have approved the submitted manuscript. The study complies with current ethical considerations. This manuscript has not been published in any journal nor is it under consideration for publication elsewhere.

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

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**Abstract.** Falls is the main cause of injuries in elderly. Studies on the long-term effects of balance training are still limited. This study aimed to assess the long-term impact of a physical exercise on the balance and fear of falling in community dwelling elderly. This was a quasi-experimental study with pre-post design. The participants were older people  $\geq 60$  years with balance problems. They received a one-month physical exercise. The instruments included Functional Reach Test (FRT) to assess balance and Falls Efficacy Scale-International (FES-I) to assess fear for falling. Assessment was conducted at pre- and post-intervention and two years later. Data were analysed using Wilcoxon Signed-Rank Test and linear mixed model regression. Data of 23 participants were analysed. 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 significant improvement in the balance and fear of falling one month and two years after the program. The balance program had long-term effect that lasted at least for two years. Inclusion of the balance program in community-based health program for elderly can improve balance and prevent falls.

Keywords: elderly, exercise, falls, fear of falling, functional reach test

## Introduction

Falls are one of leading causes of death and disability in elderly population. (WHO, 2021) Falls are the leading cause of fatal and nonfatal injuries among elderly. The age-adjusted mortality rate of falls in the elderly in the US is 64:100,000, which increased about 30% in 18 years.<sup>2</sup> Older age, women, previous history of falling, and multimorbidity have higher risk of falls. (Kim, Choi and Xiong, 2020) (Pirrie *et al.*, 2020) Other important risk factors are sensory impairment, cognitive decline, certain medication, and environmental hazards. (Saftari and Kwon, 2018) (Wang, Liu and Zhao, 2022) (Montero-odasso and 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 overtime, through muscle atrophy caused by lack of activity. (Jeon, Gu and Yim, 2017) (Park *et al.*, 2014) (Merchant *et al.*, 2020)

Falls are preventable. Health promotion and prevention activities, such as screening of falls 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 the healthcare professionals to prioritise the falls 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, Kakara and Henry, 2020) (Matla *et al.*, 2021) (Whipple, Hamel and Talley, 2019)

There have been studies reporting the effectiveness of physical exercise for fall prevention in elderly. However, most of the studies were conducted over a short period of time. (Matla *et al.*, 2021) (Chen *et al.*, 2019) (Im, Bang and Seo, 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 adopt to community settings in Indonesia. However, until now, there is no study in Indonesia that discusses 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.

## Methods

### Study Design

This was a quasi-experimental study with 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.

### *Population and eligibility criteria*

Elderly, above 60 years of age, with moderate and severe risk of falling were included in this study, regardless of the presence of chronic diseases or multimorbidity. The risk of falling was assessed by balance with Functional Reach Test (FRT), where FRT scores more than 25 is considered to have 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, Folstein and McHugh, 1975) (Hogervorst *et al.*, 2011) Elderly with MMSE scores lower than 23 were excluded from this study. All participants were purposively recruited from 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.

### Intervention

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 side leg, walking sideways, raising heels, stepping up a step, sitting to standing. The exercises were designed to challenge the participants' balance and coordination. Intervention was carried out within a week, then intervention for three weeks and finally post intervention at the end of November 2017.

### *Outcome measurement and follow-up*

Outcome on balance were collected with Functional Reach Test (FRT) and the perceived fear of falling were assessed by Falls Efficacy Scale-International (FES-I) to assess the fear of falling. 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 was considered to have low risk of falls. (Thomas, 2020) The FRT has been widely used in many studies on elderly. (Bohannon, Wolfson and White, 2017) (Balasubramanian, Boyette and Wludyka, 2015) (Fujimoto *et al.*, 2015) People with a functional reach of  $\geq 10''/25$  cm was considered to have 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-questionnaire. (Tinetti, Richman and Powell, 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 elderly 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. 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 simple question of whether they performed the exercise at least once a week in the past 2 years after the exercise program completed.

## Data analysis

Data of the baseline characteristics were presented descriptively. Univariate analyses were performed with non-parametric analysis (Wilcoxon signed rank test), with 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.

## Ethics Approval and Consent to Participate

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

Initially there were 24 elderly who participated in the study, but one of them passed away within the study period, so there were data of 23 participants analysed. They aged between 61-80 years old, with a mean±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. More than a half of 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. Baseline characteristics of community-dwelling elderly participating from Wirobrajan sub-district, Yogyakarta in 2017 (n=23)

Description	N	Percentage
<b>Age</b>		
60-74 years	18	78.3 %
75-89 years	5	21.7 %
<b>Sex</b>		
Female	20	87 %
Male	3	13 %
<b>Education</b>		
Did not complete Elementary School	17	74 %
Elementary School	3	13 %
Junior High School	2	9 %
Senior High School	1	4 %
<b>Current occupation</b>		
Tradesperson	5	21 %
Pensioner	1	4 %
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%

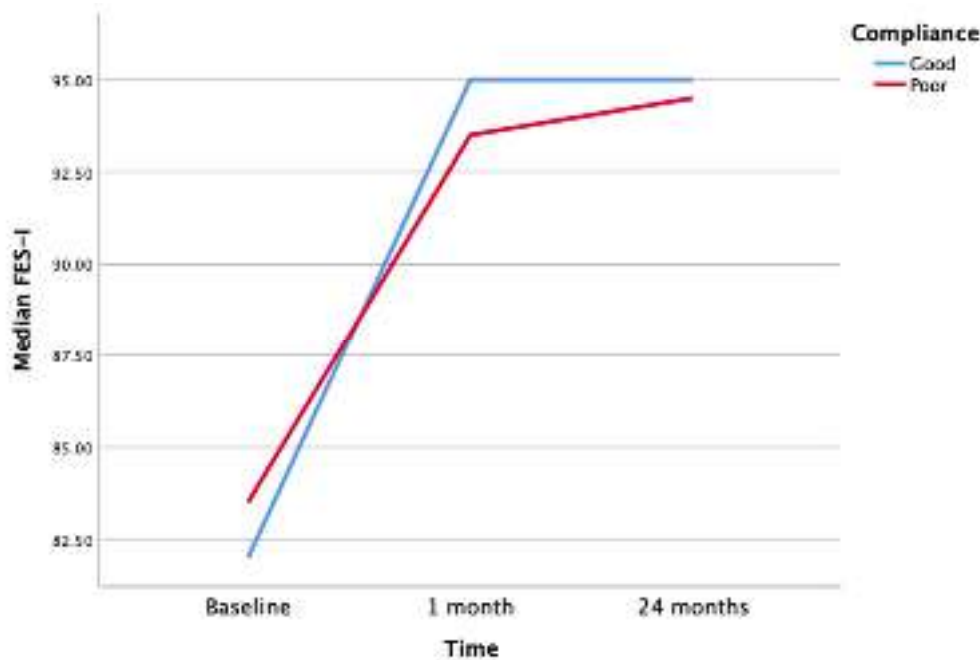
Table 2 shows the changes in outcome measurement before and after intervention, and 2 years after intervention. There was a significant improvement of fall risk (according to FRT) from 17.04 cm to 21.87 cm, which slightly decreased to 20.65 over 2 years. There was a significant difference of FRT after 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 is not statistically significant. Figure 1 highlights the different progression between patients with good and poor compliance overtime, where the FRT return to the baseline condition in participants with poor compliance.

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)

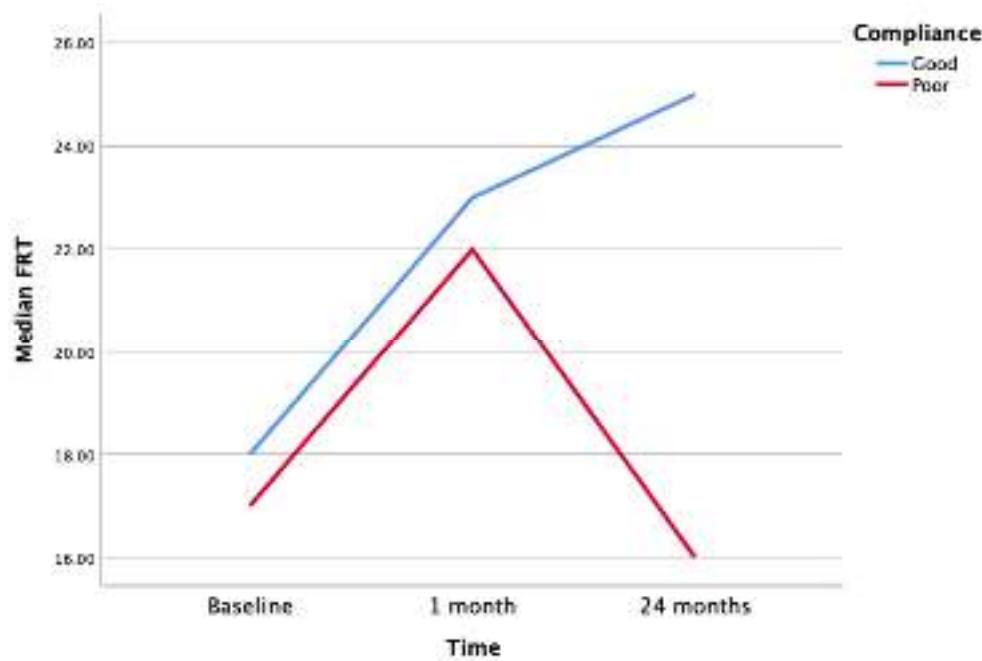
Variable	Baseline	Post-intervention (1 month)	Long-term (2 years)		
			All (n=23)	Good compliance (n=15)	Poor compliance (n=8)
<b>FRT</b>					
mean (SD), cm	17.04 (2.65)	21.87 (3.39)*	20.65 (4.79)*	23.00 (3.61) †	16.25 (3.49)
median (IQR), cm	18 (1)	22 (3)	21 (9)	25 (5)	16 (2.5)
<b>FES-I</b>					
mean (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 ( $p < 0.05$ )



(a)



(b)

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 exercise program.

Further details of the changes of FRT and FES-I between pre, post intervention, and 2 years follow up is shown in table 3. Generally, the table shows that the exercise program significantly improved the balance and perceived fear of falling, where good compliance can maintain the improvement overtime.

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
<b>FRT</b>		
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
<b>FES-I</b>		
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

## Discussion

This study followed 23 study participants aged 60 years and over. Most of them were females, which was consistent with a study that reported falls occurred more commonly in women.(Gale, Cooper and Sayer, 2016) They were given a balance exercise program for one month.

The effects of the program were measured using FRT to assess balance and FES-I to assess fear of falling before and after the interventio and two years later. The results of the statistical analysis of functional reach test showed that there were significant improvement between pre-intervention and post-intervention, and between pre-intervention and two years after. There was no significant difference between functional reach test post-intervention and two years later. This study found both short- and long-term benefits of physical exercise on the balance of elderly. A study participated by community-dwelling elderly reported that a one-month exercise increased the muscle strength and joint flexibility, which improved balance.(Suzuki *et al.*, 2019)

This study also showed that exercise had long-term positive impact on the elderlies' balance. Patil et al (2015) conducted a 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) 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-month, 12-month and 18-month. The physical functioning at 24-month decreased compared to that at 18-month, 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 the 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, Basha and Jungade, 2020)

The statistical analysis of the fear of falling found significant reduced fear of falling between pre- and post-intervention, and between pre-intervention and two years later. There was no significant difference between 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)

This study observed that compliance to exercise was an important factor that affected the long-term positive impact of exercise on the balance of elderly. This was consistent with the finding or a study that reported compliant older people had 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 elderly.

### **Conclusion and Recommendations**

Preventing falls in elderly needs to consider complex nature of its risk factors. This study showed that simple exercise program in community is feasible to improve the physical and psychological risk of falls in elderly both in 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 elderly with long term impact. A balance exercise program can be included in the Indonesian community-based program, Posyandu Lansia (program integrated service post for older people) to improve balance and prevent falls.

Future trial with randomisation, control group, and larger population is needed to design a program that suitable in Indonesian setting, especially in community setting. Regarding the compliance of participants, further studies needed to explore the motivation and other characteristics that might influence it.

### **Acknowledgment**

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### **References**

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Long-Term Effects [of Exercise on Balance and Fear of Falling in Elderly](#) The Maria Meiwati Widagdo<sup>1,a</sup>), Claudia Laurentia Bella<sup>2</sup>, Bagus Anggawaisna Suryadiningrat<sup>2</sup>, Teguh Kristian Perdamaian<sup>1</sup> | <sup>1</sup>Department of Public Health, Faculty of Medicine, Duta Wacana Christian University <sup>2</sup>Faculty of Medicine, Duta Wacana Christian University, Yogyakarta 55224 a) [Corresponding author: The Maria Meiwati Widagdo, Department of Public Health, Faculty of Medicine, Duta Wacana Christian University, Email: \[maria\\\_widagdo@staff.ukdw.ac.id\]\(mailto:maria\_widagdo@staff.ukdw.ac.id\)](#) Abstract. Falls is the main cause of injuries in elderly. Studies on the long-term effects of balance training [are still](#) limited. [This study aimed](#) to assess [the](#) long-term impact [of](#) a physical [exercise on the](#) balance and fear [of](#) falling in community dwelling elderly. This was a quasi-experimental study with pre-post design. The participants were older people  $\geq 60$  years with balance problems. They received a one-month physical exercise. The instruments included [Functional Reach Test \(FRT\) to assess balance and Falls Efficacy Scale-International \(FES-I\) to assess fear for falling](#). Assessment was conducted at pre- and post- intervention and two years later. Data were analysed using Wilcoxon Signed-Rank Test and linear mixed model regression. Data of 23 participants were analysed. 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 significant improvement in the balance and fear of falling one month and two years after the program. The balance program had long-term effect that lasted at least for two years. Inclusion of the balance program in community-based health program for elderly can improve balance and prevent falls. Keywords: elderly, exercise, falls, fear of falling, functional reach test Introduction Falls are one of leading causes of death and disability in elderly population.(WHO, 2021) [Falls are the leading cause of fatal and nonfatal injuries among](#) elderly. The age-adjusted mortality rate of falls in the elderly in the US is 64:100,000, which increased about 30% in 18 years..<sup>2</sup> Older age, women, previous history of falling, and multimorbidity have higher risk of falls..(Kim, Choi and Xiong, 2020),(Pirrie et al., 2020)

Other important risk factors are sensory impairment, cognitive decline, certain medication, and environmental hazards. (Saftari and Kwon, 2018), (Wang, Liu and Zhao, 2022), (Monterodasso and 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 overtime, through muscle atrophy caused by lack of activity. (Jeon, Gu and Yim, 2017) (Park et al., 2014) (Merchant et al., 2020) Falls are preventable. Health promotion and prevention activities, such as screening of falls 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 the healthcare professionals to prioritise the falls 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, Kakara and Henry, 2020) (Matla et al., 2021) (Whipple, Hamel and Talley, 2019) There have been studies reporting the effectiveness of physical exercise for fall prevention in elderly. However, most of the studies were conducted over a short period of time. (Matla et al., 2021) (Chen et al., 2019) (Jin, Heng and Seo, 2019) A few studies have been conducted in community settings in Indonesia, but there is no long-term evaluation yet. (Freiberger et al., 2012) (Hass 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 adopt in community settings in Indonesia. However, until now, there is no study in Indonesia that discusses 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.

**Methods Study Design** This was a quasi-experimental study with 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. Population and eligibility criteria Elderly, above 60 years of age, with moderate and severe risk of falling were included in this study, regardless of the presence of chronic diseases or multimorbidity. The risk of falling was assessed by balance with Functional Reach Test (FRT), where FRT scores more than 25 is considered to have 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, Folstein and McHugh, 1975) (Hogervorst et al., 2011) Elderly with MMSE scores lower than 23 were excluded from this study. All participants were purposively recruited from 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.

**Intervention** 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 side leg, walking sideways, raising heels, stepping up a step, sitting to standing. The exercises were designed to challenge the participants' balance and coordination. Intervention was carried out within a week, then intervention for three week and finally post intervention at the end of November 2017.

**Outcome measurement and follow-up** Outcome on balance were collected with Functional

Reach Test (FRT) and the perceived fear of falling we assessed by Falls Efficacy Scale-International (FES-I) to assess the fear of falling. 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  $\geq 107/25$  cm was considered to have low risk of falls. (Thomas, 2020) The FRT has been widely used in many studies on elderly. (Bohannon, Weisman and White, 2017), (Balasubramanian, Boyatta and Wludyka, 2015), (Fujimoto et al., 2015) People with a functional reach of  $\geq 107/25$  cm was considered to have low risk of falls. (Thomas, 2020) The subjects of this study were elderly with functional reach  $< 107/25$  cm. The FES-I is a questionnaire containing ten activity-questionnaire. (Tinetti, Richman and Powell, 1990) The scoring was modified to 0-10 (0=not 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 elderly as research participants, and proven valid in several languages. (Meimawati et al., 2021), (Canevar et al., 2022), (Toranzo-Herrillo et al., 2018) The measurements were taken before and after the intervention. 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 simple question of whether they performed the exercise at least once a week in the past 2 years after the exercise program completed. Data analysis Data of the baseline characteristics were presented descriptively. Univariate analyses were performed with non-parametric analysis (Wilcoxon signed rank test), with 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. Ethics Approval and Consent to Participate Ethical clearance for this study was obtained from the Ethical Committee for Health Research, Faculty of Medicine, Duta Wacana Christian University (No.: 47/EC.16/FHS/2017) and all study participants gave written informed consent. Results Initially there were 24 elderly who participated in the study, but one of them passed away within the study period, so there were data of 23 participants analysed. They aged between 61-80 years old, with a mean  $\pm$  SD of  $69.96 \pm 6.138$  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  $28.69 \pm 1.55$ . Table 1 shows the baseline characteristics of participants. More than a half of 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. Baseline characteristics of community-dwelling elderly participating from Wirobrajan sub-district, Yogyakarta in 2017 (n=23)

Description	N	Percentage
Age		
60-74 years	18	78.3 %
75-89 years	5	21.7 %
Sex		
Female	12	52.2 %
Male	11	47.8 %
Education		
Did not complete Elementary School	3	13 %
Elementary School	17	74 %
Junior High School	3	13 %
Senior High School	2	9 %
Current occupation		
Tradesperson	1	4 %
Pensioner	5	21 %
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	12	52.2 %
Follow-up compliance: not good	11	47.8 %

Table 2 shows the changes in outcome measurement before and after intervention, and 2 years after intervention. There was a significant improvement of 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 of 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 is not statistically significant. Figure 1 highlights the different progression between patients with good and poor compliance overtime, where the FRT return to the baseline condition in participants with poor compliance. 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 Long-term (2 years) (1 month) All (n=23) Good compliance Poor compliance (n=15) (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), 18 (1) 22 (3) 21 (9) 25 (5) 16 (2.5) cm 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 \(p < 0.05\)](#) (a) (b) 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 exercise program. Further details of the changes of FRT and FES-I between pre, post intervention, and 2 years follow up is shown in table 3. Generally, the table shows that the exercise program significantly improved the balance and perceived fear of falling, where good compliance can maintain the improvement overtime. 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 Discussion This study followed 23 study participants aged 60 years and over. Most of them were females, which was consistent with a study that reported falls occurred more commonly in women.(Gale, Cooper and Sayer, 2016) They were given a balance exercise program for one month. 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. The results of the statistical analysis of functional reach test showed that there were significant improvement between pre-intervention and post-intervention, and between pre- intervention and two years after. There was no significant difference between functional reach test post- intervention and two years later. This study found both short- and long-term benefits of physical exercise on the balance of elderly. A study participated by community-dwelling elderly reported that a one-month exercise increased the muscle strength and joint flexibility, which improved balance.(Suzuki et al., 2019) This study also showed that exercise had long-term positive impact on the elderly's balance. Patil et al (2015) conducted a 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) 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-month, 12-month and 18-month. The physical functioning at 24- month decreased compared to that at 18-month, 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 the 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, Basha and Jungade, 2020) The statistical analysis of the fear of falling found significant reduced fear of falling between pre- and post-intervention, and between pre-intervention and two years later. There was no significant difference between 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) This study observed that compliance to exercise was an important factor that affected the long-term positive impact of exercise on the balance of elderly. This was consistent with the finding of a study that reported compliant older people had 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 elderly.

**Conclusion and Recommendations** Preventing falls in elderly needs to consider complex nature of its risk factors. This study showed that simple exercise program in community is feasible to improve the physical and psychological risk of falls in elderly both in 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 elderly with long term impact. A balance exercise program can be included in the Indonesian community-based program, Posyandu Lansia (program integrated service post for older people) to improve balance and prevent falls. Future trial with randomisation, control group, and larger population is needed to design a program that suitable in Indonesian setting, especially in community setting. Regarding the compliance of participants, further studies needed to explore the motivation and other characteristics that might influence it.

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**KOMISI ETIK PENELITIAN KESEHATAN  
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**KETERANGAN KELAIKAN ETIK**

*(Ethical Clearance)*

Nomor : 474/C.16/FK/2017

Komisi Etik Penelitian Kedokteran Fakultas Kedokteran Universitas Kristen Duta Wacana, setelah mempelajari dengan seksama rancangan penelitian yang diusulkan, dengan ini menyatakan bahwa penelitian dengan:

Judul : EFEKTIVITAS EDUKASI DAN LATIHAN KESEIMBANGAN TERHADAP PENCEGAHAN JATUH PADA LANSIA DI KAMPUNG GAMPINGAN KELURAHAN PAKUNCEN KECAMATAN WIROBRAJAN YOGYAKARTA

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Dinyatakan memenuhi persyaratan etik untuk dilaksanakan, dengan catatan sewaktu-waktu komisi dapat melakukan pemantauan. Kelaikan etik ini berlaku 1 (satu) tahun sejak tanggal di tetapkan.

Yogyakarta, 26 Oktober 2017

  
Dr. dr. Rizaldy Taslim Pinzon, Sp.S., M.Kes.

(Ketua)



  
dr. Arum Krismi, M.Sc, Sp.KK

(Sekretaris)

# Falls prevention in Elderly

*by* The Maria Meiwati Widagdo

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

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**Abstract.** Falls is the main cause of injuries in elderly. Studies on the long-term effects of balance training are still limited. This study aimed to assess the long-term impact of a physical exercise on the balance and fear of falling in community dwelling elderly. This was a quasi-experimental study with pre-post design. The participants were older people  $\geq 60$  years with balance problems. They received a one-month physical exercise. The instruments included Functional Reach Test (FRT) to assess balance and Falls Efficacy Scale-International (FES-I) to assess fear for falling. Assessment was conducted at pre- and post-intervention and two years later. Data were analysed using Wilcoxon Signed-Rank Test and linear mixed model regression. Data of 23 participants were analysed. 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 significant improvement in the balance and fear of falling one month and two years after the program. The balance program had long-term effect that lasted at least for two years. Inclusion of the balance program in community-based health program for elderly can improve balance and prevent falls.

Keywords: elderly, exercise, falls, fear of falling, functional reach test

## Introduction

Falls are one of leading causes of death and disability in elderly population (WHO, 2021). Falls are the leading cause of fatal and nonfatal injuries among elderly. The age-adjusted mortality rate of falls in the elderly in the US is 64:100,000, which increased about 30% in 18 years.<sup>2</sup> Older age, women, previous history of falling, and multimorbidity have higher risk of falls. (Kim, Choi and Xiong, 2020) (Pirie *et al.*, 2020) Other important risk factors are sensory impairment, cognitive decline, certain medication, and environmental hazards. (Saftari and Kwon, 2018) (Wang, Liu and Zhao, 2022) (Montero-odasso and 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 overtime, through muscle atrophy caused by lack of activity. (Jeon, Gu and Yim, 2017) (Park *et al.*, 2014) (Merchant *et al.*, 2020)

Falls are preventable. Health promotion and prevention activities, such as screening of falls 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 the healthcare professionals to prioritise the falls 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, Kakara and Henry, 2020) (Matla *et al.*, 2021) (Whipple, Hamel and Talley, 2019)

There have been studies reporting the effectiveness of physical exercise for fall prevention in elderly. However, most of the studies were conducted over a short period of time. (Matla *et al.*, 2021) (Chen *et al.*, 2019) (Im, Bang and Seo, 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 adopt to community settings in Indonesia. However, until now, there is no study in Indonesia that discusses 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.

## Methods

### Study Design

This was a quasi-experimental study with 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.

### Population and eligibility criteria

Elderly, above 60 years of age, with moderate and severe risk of falling were included in this study, regardless of the presence of chronic diseases or multimorbidity. The risk of falling was assessed by balance with Functional Reach Test (FRT), where FRT scores more than 25 is considered to have 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, Folstein and McHugh, 1975) (Hogervorst *et al.*, 2011) Elderly with MMSE scores lower than 23 were excluded from this study. All participants were purposively recruited from 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.

### Intervention

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 side leg, walking sideways, raising heels, stepping up a step, sitting to standing. The exercises were designed to challenge the participants' balance and coordination. Intervention was carried out within a week, then intervention for three week and finally post intervention at the end of November 2017.

### Outcome measurement and follow-up

Outcome on balance were collected with Functional Reach Test (FRT) and the perceived fear of falling we assessed by Falls Efficacy Scale-International (FES-I) to assess the fear of falling. 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 was considered to have low risk of falls. (Thomas, 2020) The FRT has been widely used in many studies on elderly. (Bohannon, Wolfson and White, 2017) (Balasubramanian, Boyette and Wludyka, 2015) (Fujimoto *et al.*, 2015) People with a functional reach of  $\geq 10''/25$  cm was considered to have 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-questionnaire. (Tinetti, Richman and Powell, 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 elderly 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. 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 simple question of whether they performed the exercise at least once a week in the past 2 years after the exercise program completed.

## Data analysis

Data of the baseline characteristics were presented descriptively. Univariate analyses were performed with non-parametric analysis (Wilcoxon signed rank test), with 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.

## Ethics Approval and Consent to Participate

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

Initially there were 24 elderly who participated in the study, but one of them passed away within the study period, so there were data of 23 participants analysed. They aged between 61-80 years old, with a mean $\pm$ SD of 69.96 $\pm$ 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  $\pm$  1.55. Table 1 shows the baseline characteristics of participants. More than a half of 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. Baseline characteristics of community-dwelling elderly participating from Wirobrajan sub-district, Yogyakarta in 2017 (n=23)

Description	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 %
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%

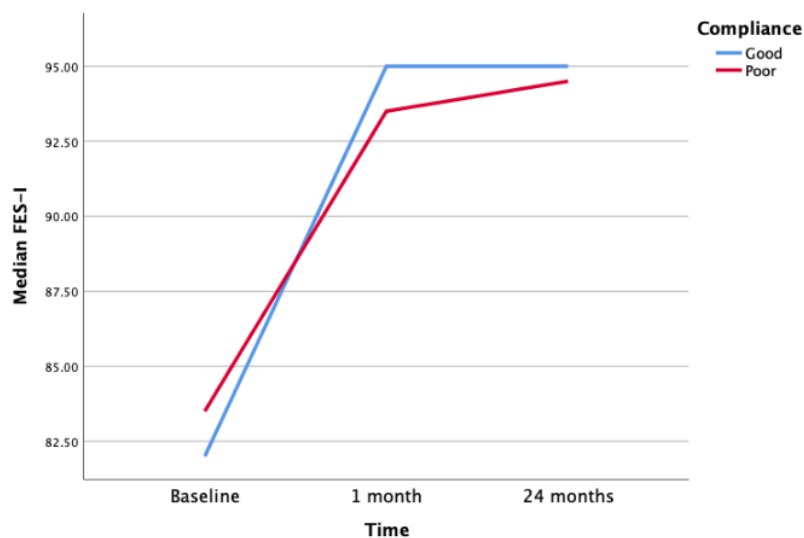
Table 2 shows the changes in outcome measurement before and after intervention, and 2 years after intervention. There was a significant improvement of fall risk (according to FRT) from 17.04 cm to 21.87 cm, which slightly decreased to 20.65 over 2 years. There was a significant difference of FRT after 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 is not statistically significant. Figure 1 highlights the different progression between patients with good and poor compliance overtime, where the FRT return to the baseline condition in participants with poor compliance.

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)

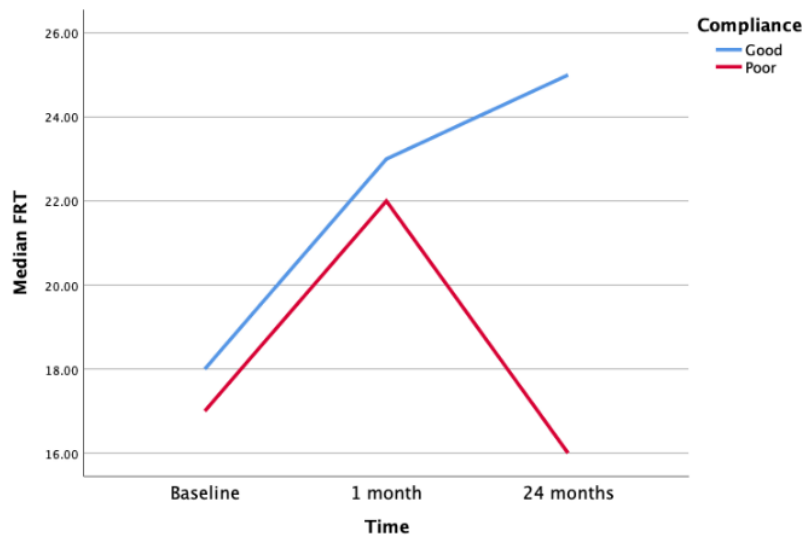
Variable	Baseline	Post-intervention (1 month)	Long-term (2 years)		
			All (n=23)	Good compliance (n=15)	Poor compliance (n=8)
<b>FRT</b>					
mean (SD), cm	17.04 (2.65)	21.87 (3.39)*	20.65 (4.79)*	23.00 (3.61) †	16.25 (3.49)
median (IQR), cm	18 (1)	22 (3)	21 (9)	25 (5)	16 (2.5)
<b>FES-I</b>					
mean (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 ( $p < 0.05$ )



(a)



(b)

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 exercise program.

Further details of the changes of FRT and FES-I between pre, post intervention, and 2 years follow up is shown in table 3. Generally, the table shows that the exercise program significantly improved the balance and perceived fear of falling, where good compliance can maintain the improvement overtime.

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
<b>FRT</b>		
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
<b>FES-I</b>		
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

## Discussion

This study followed 23 study participants aged 60 years and over. Most of them were females, which was consistent with a study that reported falls occurred more commonly in women.(Gale, Cooper and Sayer, 2016) They were given a balance exercise program for one month.

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. The results of the statistical analysis of functional reach test showed that there were significant improvement between pre-intervention and post-intervention, and between pre-intervention and two years after. There was no significant difference between functional reach test post-intervention and two years later. This study found both short- and long-term benefits of physical exercise on the balance of elderly. A study participated by community-dwelling elderly reported that a one-month exercise increased the muscle strength and joint flexibility, which improved balance.(Suzuki *et al.*, 2019)

This study also showed that exercise had long-term positive impact on the elderlies' balance. Patil *et al* (2015) conducted a 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) 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-month, 12-month and 18-month. The physical functioning at 24-month decreased compared to that at 18-month, 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 the 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, Basha and Jungade, 2020)

The statistical analysis of the fear of falling found significant reduced fear of falling between pre- and post-intervention, and between pre-intervention and two years later. There was no significant difference between 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)

This study observed that compliance to exercise was an important factor that affected the long-term positive impact of exercise on the balance of elderly. This was consistent with the finding or a study that reported compliant older people had 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 elderly.

#### **Conclusion and Recommendations**

Preventing falls in elderly needs to consider complex nature of its risk factors. This study showed that simple exercise program in community is feasible to improve the physical and psychological risk of falls in elderly both in 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 elderly with long term impact. A balance exercise program can be included in the Indonesian community-based program, Posyandu Lansia (program integrated service post for older people) to improve balance and prevent falls.

Future trial with randomisation, control group, and larger population is needed to design a program that suitable in Indonesian setting, especially in community setting. Regarding the compliance of participants, further studies needed to explore the motivation and other characteristics that might influence it.

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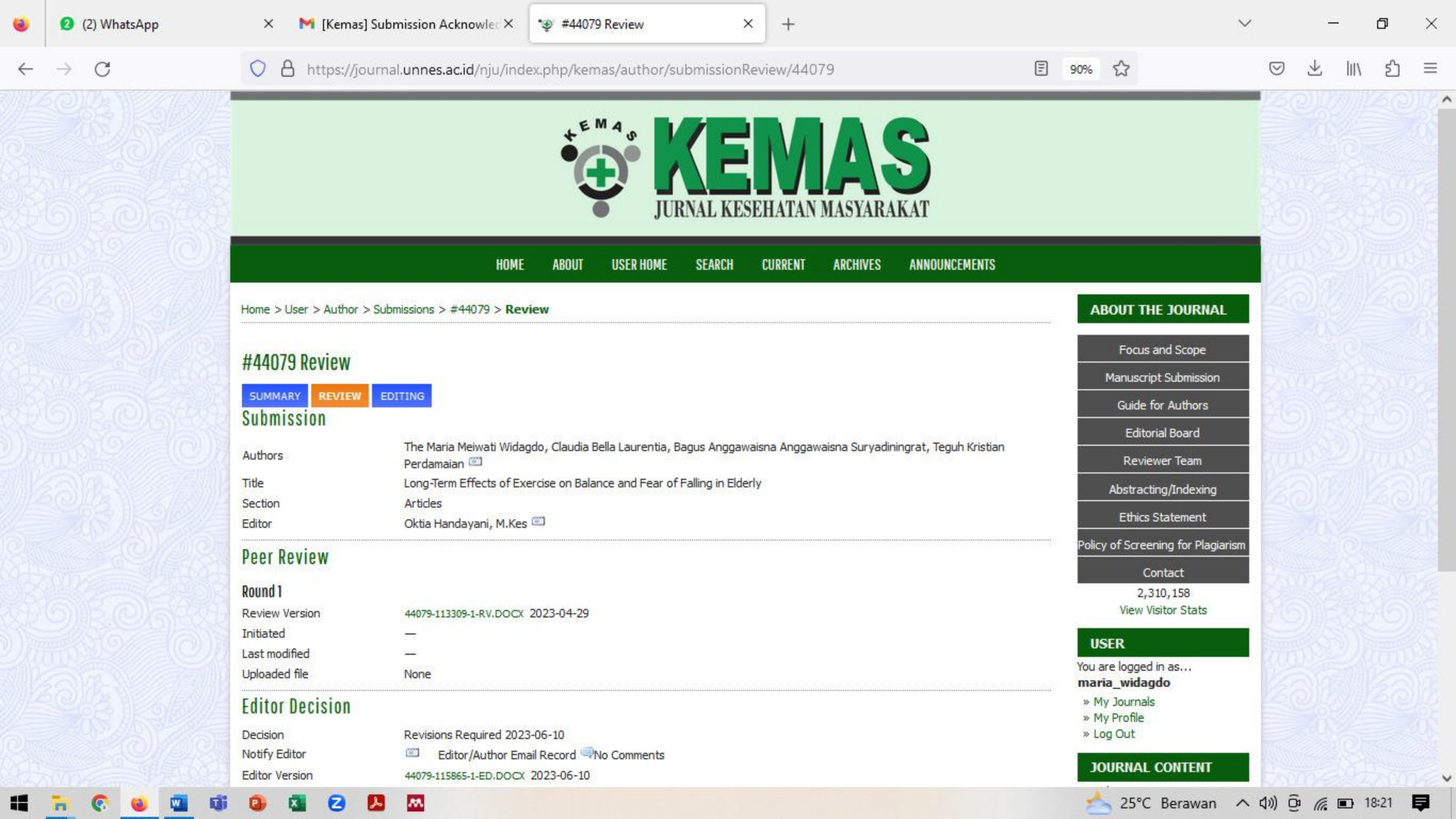
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### JOURNAL CONTENT

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

The Maria Meiwati Widagdo<sup>1,a)</sup>, Claudia Bella Laurentia<sup>2</sup>, Bagus Anggawaisna Suryadiningrat<sup>2</sup>, Teguh Kristian Perdamaian<sup>1</sup>

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**Abstract.** Falls is the main cause of injuries in elderly. Studies on the long-term effects of balance training are still limited. This study aimed to assess the long-term impact of a physical exercise on the balance and fear of falling in community dwelling elderly. This was a quasi-experimental study with pre-post design. The participants were older people  $\geq 60$  years with balance problems. They received a one-month physical exercise. The instruments included Functional Reach Test (FRT) to assess balance and Falls Efficacy Scale-International (FES-I) to assess fear for falling. Assessment was conducted at pre- and post-intervention and two years later. Data were analysed using Wilcoxon Signed-Rank Test and linear mixed model regression. Data of 23 participants were analysed. 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 significant improvement in the balance and fear of falling one month and two years after the program. The balance program had long-term effect that lasted at least for two years. Inclusion of the balance program in community-based health program for elderly can improve balance and prevent falls.

**Commented [A1]:** Informasikan data masalah yang ada di lapangan. Sebutkan teknik penentuan sampelnya dan tahun penelitiannya

Keywords: elderly, exercise, falls, fear of falling, functional reach test

## Introduction

Falls are one of leading causes of death and disability in elderly population.(WHO, 2021) Falls are the leading cause of fatal and nonfatal injuries among elderly. The age-adjusted mortality rate of falls in the elderly in the US is 64:100,000, which increased about 30% in 18 years.<sup>2</sup> Older age, women, previous history of falling, and multimorbidity have higher risk of falls..(Kim, Choi and Xiong, 2020)(Pirrie *et al.*, 2020) Other important risk factors are sensory impairment, cognitive decline, certain medication, and environmental hazards.(Saftari and Kwon, 2018)(Wang, Liu and Zhao, 2022)(Montero-odasso and Speechley, 2018)(Gadella *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 overtime, through muscle atrophy caused by lack of activity.(Jeon, Gu and Yim, 2017)(Park *et al.*, 2014)(Merchant *et al.*, 2020)

Falls are preventable. Health promotion and prevention activities, such as screening of falls 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 the healthcare professionals to prioritise the falls 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, Kakara and Henry, 2020)(Matla *et al.*, 2021)(Whipple, Hamel and Talley, 2019)

There have been studies reporting the effectiveness of physical exercise for fall prevention in elderly. However, most of the studies were conducted over a short period of time.(Matla *et al.*, 2021)(Chen *et al.*, 2019)(Im, Bang and Seo, 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 adopt to community settings in Indonesia. However, until now, there is no study in Indonesia that discusses 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.

## Methods

### Study Design

This was a quasi-experimental study with 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.

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### Population and eligibility criteria

Elderly, above 60 years of age, with moderate and severe risk of falling were included in this study, regardless of the presence of chronic diseases or multimorbidity. The risk of falling was assessed by balance with Functional Reach Test (FRT), where FRT scores more than 25 is considered to have 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, Folstein and McHugh, 1975) (Hogervorst *et al.*, 2011) Elderly with MMSE scores lower than 23 were excluded from this study. All participants were purposively recruited from 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.

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### Intervention

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 side leg, walking sideways, raising heels, stepping up a step, sitting to standing. The exercises were designed to challenge the participants' balance and coordination. Intervention was carried out within a week, then intervention for three week and finally post intervention at the end of November 2017.

### Outcome measurement and follow-up

Outcome on balance were collected with Functional Reach Test (FRT) and the perceived fear of falling we assessed by Falls Efficacy Scale-International (FES-I) to assess the fear of falling. 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 was considered to have low risk of falls (Thomas, 2020) The FRT has been widely used in many studies on elderly (Bohannon, Wolfson and White, 2017) (Balasubramanian, Boyette and Wludyka, 2015) (Fujimoto *et al.*, 2015) People with a functional reach of  $\geq 10''/25$  cm was considered to have 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-questionnaire (Tinetti, Richman and Powell, 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 elderly 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. 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 simple question of whether they performed the exercise at least once a week in the past 2 years after the exercise program completed.

### Data analysis

Data of the baseline characteristics were presented descriptively. Univariate analyses were performed with non-parametric analysis (Wilcoxon signed rank test), with 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.

### Ethics Approval and Consent to Participate

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

Initially there were 24 elderly who participated in the study, but one of them passed away within the study period, so there were data of 23 participants analysed. They aged between 61-80 years old, with a mean±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. More than a half of 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. Baseline characteristics of community-dwelling elderly participating from Wirobrajan sub-district, Yogyakarta in 2017 (n=23)

Description	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 %
Laborer	1	4 %
Masseur	1	4 %
Unemployed	15	65 %

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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%

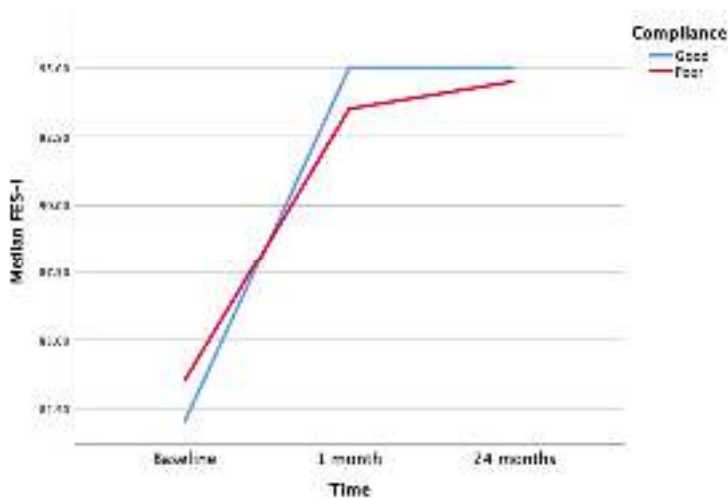
Table 2 shows the changes in outcome measurement before and after intervention, and 2 years after intervention. There was a significant improvement of fall risk (according to FRT) from 17.04 cm to 21.87 cm, which slightly decreased to 20.65 over 2 years. There was a significant difference of FRT after 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 is not statistically significant. Figure 1 highlights the different progression between patients with good and poor compliance overtime, where the FRT return to the baseline condition in participants with poor compliance.

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)

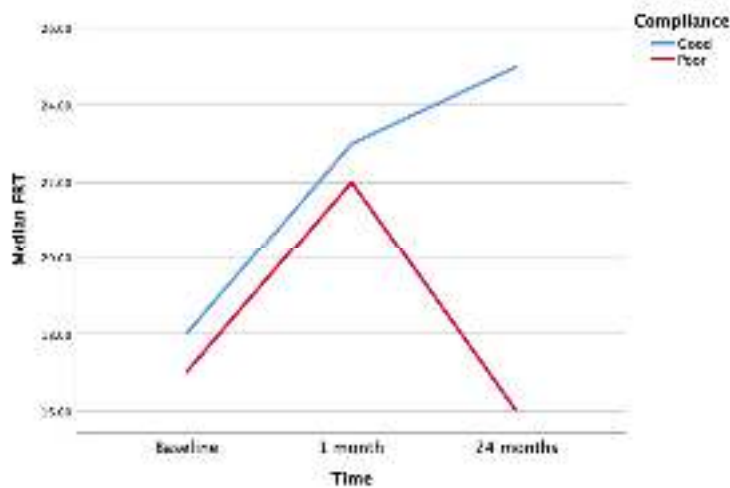
\* significant difference compared to baseline (p < 0.05)

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



(a)





(b)

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 exercise program.

Further details of the changes of FRT and FES-I between pre, post intervention, and 2 years follow up is shown in table 3. Generally, the table shows that the exercise program significantly improved the balance and perceived fear of falling, where good compliance can maintain the improvement overtime.

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
<b>FRT</b>		
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
<b>FES-I</b>		
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

## Discussion

This study followed 23 study participants aged 60 years and over. Most of them were females, which was consistent with a study that reported falls occurred more commonly in women.(Gale, Cooper and Sayer, 2016) They were given a balance exercise program for one month.

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. The results of the statistical analysis of functional reach test showed that there were significant improvement between pre-intervention and post-intervention, and between pre-intervention and two years later. There was no significant difference between functional reach test post-intervention and two years later. This study found both short- and long-term benefits of physical exercise on the balance of elderly. A study participated by community-dwelling elderly reported that a one-month exercise increased the muscle strength and joint flexibility, which improved balance.(Suzuki *et al.*, 2019)

This study also showed that exercise had long-term positive impact on the elderly's balance. Patil et al (2015) conducted a 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) 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-month, 12-month and 18-month. The physical functioning at 24-month decreased compared to that at 18-month, 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 the 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, Basha and Jungade, 2020)

The statistical analysis of the fear of falling found significant reduced fear of falling between pre- and post-intervention, and between pre-intervention and two years later. There was no significant difference between 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)

This study observed that compliance to exercise was an important factor that affected the long-term positive impact of exercise on the balance of elderly. This was consistent with the finding or a study that reported compliant older people had 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 elderly.

#### Conclusion and Recommendations

Preventing falls in elderly needs to consider complex nature of its risk factors. This study showed that simple exercise program in community is feasible to improve the physical and psychological risk of falls in elderly both in 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 elderly with long term impact. A balance exercise program can be included in the Indonesian community-based program, Posyandu Lansia (program integrated service post for older people) to improve balance and prevent falls.

Future trial with randomisation, control group, and larger population is needed to design a program that suitable in Indonesian setting, especially in community setting. Regarding the compliance of participants, further studies needed to explore the motivation and other characteristics that might influence it.

#### Acknowledgment

This research supported by Duta Wacana Christian University, Yogyakarta Indonesia

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

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**Abstract.** Falls is the main cause of injuries in elderly. Studies on the long-term effects of balance training are still limited. This study aimed to assess the long-term impact of a physical exercise on the balance and fear of falling in community dwelling elderly. This was a quasi-experimental study with pre-post design. The participants were recruited using purposive sampling. The inclusion criteria were older people  $\geq 60$  years with balance problems. They received a one-month physical exercise. The instruments included Functional Reach Test (FRT) to assess balance and Falls Efficacy Scale-International (FES-I) to assess fear for falling. Assessment was conducted at pre- and post-intervention and two years later. Data of 23 participants were collected in 2017 and 2019. Data were analysed using 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 significant improvement in the balance and fear of falling one month and two years after the program. The balance program had long-term effect that lasted at least for two years. Inclusion of the balance program in community-based health program for elderly can improve balance and prevent falls.

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Keywords: elderly, exercise, falls, fear of falling, functional reach test

## Introduction

Falls are one of leading causes of death and disability in elderly population.(WHO, 2021) Falls are the leading cause of fatal and nonfatal injuries among elderly. The age-adjusted mortality rate of falls in the elderly in the US is 64:100,000, which increased about 30% in 18 years..<sup>2</sup> Older age, women, previous history of falling, and multimorbidity have higher risk of falls..(Kim, Choi and Xiong, 2020)(Pirrie *et al.*, 2020) Other important risk factors are sensory impairment, cognitive decline, certain medication, and environmental hazards.(Saftari and Kwon, 2018)(Wang, Liu and Zhao, 2022)(Montero-odasso and 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 overtime, through muscle atrophy caused by lack of activity.(Jeon, Gu and Yim, 2017)(Park *et al.*, 2014)(Merchant *et al.*, 2020)

Falls are preventable. Health promotion and prevention activities, such as screening of falls 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 the healthcare professionals to prioritise the falls 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, Kakara and Henry, 2020)(Matla *et al.*, 2021)(Whipple, Hamel and Talley, 2019)

There have been studies reporting the effectiveness of physical exercise for fall prevention in elderly. However, most of the studies were conducted over a short period of time.(Matla *et al.*, 2021)(Chen *et al.*, 2019)(Im, Bang and Seo, 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 adopt to community settings in Indonesia. However, until now, there is no study in Indonesia that discusses 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.

## Methods

This was a quasi-experimental study with 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 Functional Reach Test (FRT), where FRT scores more than 25 is considered to have 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, Folstein and McHugh, 1975) (Hogervorst *et al.*, 2011) Elderly with MMSE scores lower than 23 were excluded from this study. All participants were purposively recruited from 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 side leg, walking sideways, raising heels, stepping up a step, sitting to standing. The exercises were designed to challenge the participants' balance and coordination. Intervention was carried out within a week, then intervention for three weeks and finally post intervention at the end of November 2017.

Outcome on balance was collected with Functional Reach Test (FRT) and the perceived fear of falling was assessed by Falls Efficacy Scale-International (FES-I) to assess the fear of falling. 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 was considered to have low risk of falls. (Thomas, 2020) The FRT has been widely used in many studies on elderly. (Bohannon, Wolfson and White, 2017) (Balasubramanian, Boyette and Wludyka, 2015) (Fujimoto *et al.*, 2015) People with a functional reach of  $\geq 10''/25$  cm was considered to have 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-questionnaire. (Tinetti, Richman and Powell, 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 elderly 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. 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 simple question of whether they performed the exercise at least once a week in the past 2 years after the exercise program completed.

Data of the baseline characteristics were presented descriptively. Univariate analyses were performed with non-parametric analysis (Wilcoxon signed rank test), with 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 of 23 participants analysed. They aged between 61-80 years old, with a mean±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, Cooper and Sayer, 2016) They were given a balance exercise program for one month. More than a half of 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. Baseline characteristics of community-dwelling elderly participating from Wirobrajan sub-district, Yogyakarta in 2017 (n=23)

Description	N	Percentage
<b>Age</b>		
60-74 years	18	78.3 %
75-89 years	5	21.7 %
<b>Sex</b>		
Female	20	87 %
Male	3	13 %
<b>Education</b>		
Did not complete Elementary School	17	74 %
Elementary School	3	13 %
Junior High School	2	9 %
Senior High School	1	4 %
<b>Current occupation</b>		
Tradesperson	5	21 %
Pensioner	1	4 %
Laborer	1	4 %
Masseur	1	4 %
Unemployed	15	65 %
<b>Medication history</b>		
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%

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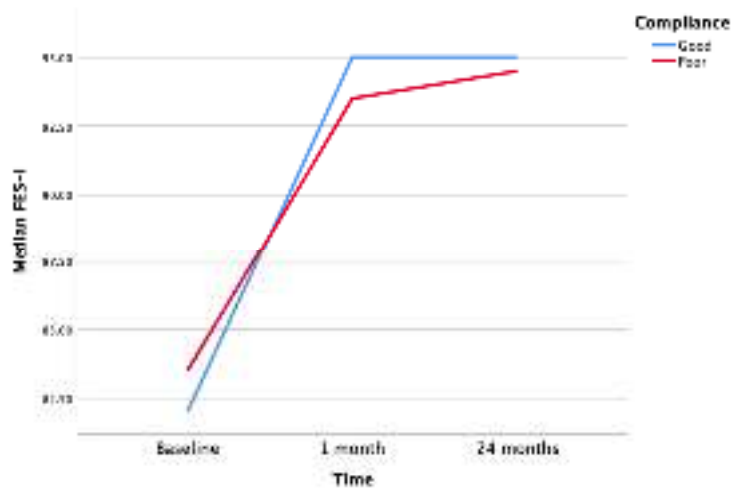
The effects of the program were measured using FRT to assess balance and FES-I to assess fear of falling before and after the intervention and two years later, as shown in Table 2. There was a significant improvement of fall risk (according to FRT) from 17.04 cm to 21.87 cm, which slightly decreased to 20.65 over 2 years. There was a significant difference of 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 overtime, where the FRT returns to the baseline condition in participants with poor compliance. A study participated by community-dwelling elderly reported that a one-month exercise increased the muscle strength and joint flexibility, which improved balance. (Suzuki *et al.*, 2019)

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)

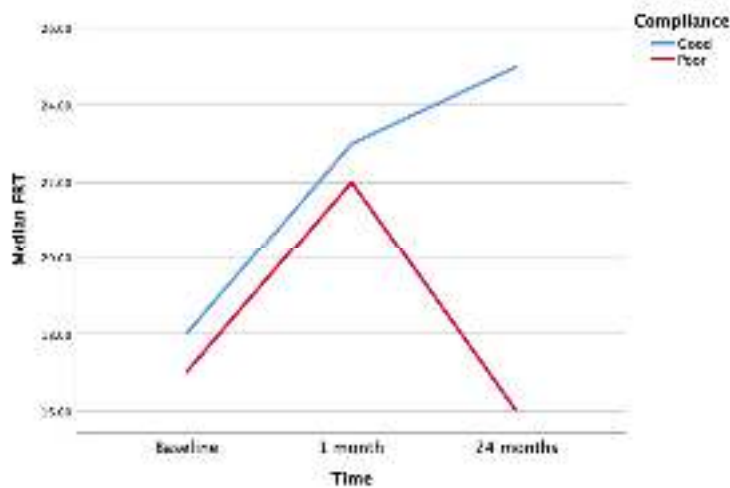
\* significant difference compared to baseline ( $p < 0.05$ )

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



(a)





(b)

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 exercise program.

This study showed that exercise had long-term positive impact on the elderly's balance. Patil et al (2015) conducted a 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) 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-month, 12-month and 18-month. The physical functioning at 24-month decreased compared to that at 18-month, 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 the 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, Basha and Jungade, 2020)

The statistical analysis of the fear of falling found significant reduced fear of falling between pre- and post-intervention, and between pre-intervention and two years later. There was no significant difference between 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)

Further details of the changes of FRT and FES-I between pre, post intervention, and 2 years follow up is shown in table 3. Generally, the table shows that the exercise program significantly improved the balance and perceived fear of falling, where good compliance can maintain the improvement overtime. This was consistent with the finding or a study that reported compliant older people had higher positive impact from exercise compared to the non-compliant subjects. (Falossi et al., 2022)

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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
<b>FRT</b>		
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
<b>FES-I</b>		

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

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 elderly.

## Conclusion

Preventing falls in elderly needs to consider complex nature of its risk factors. This study showed that simple exercise program in community is feasible to improve the physical and psychological risk of falls in elderly both in 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 elderly with long term impact. A balance exercise program can be included in the Indonesian community-based program, Posyandu Lansia (program integrated service post for older people) to improve balance and prevent falls.

Future trial with randomisation, control group, and larger population is needed to design a program that suitable in Indonesian setting, especially in community setting. Regarding the compliance of participants, further studies needed to explore the motivation and other characteristics that might influence it.

## Acknowledgment

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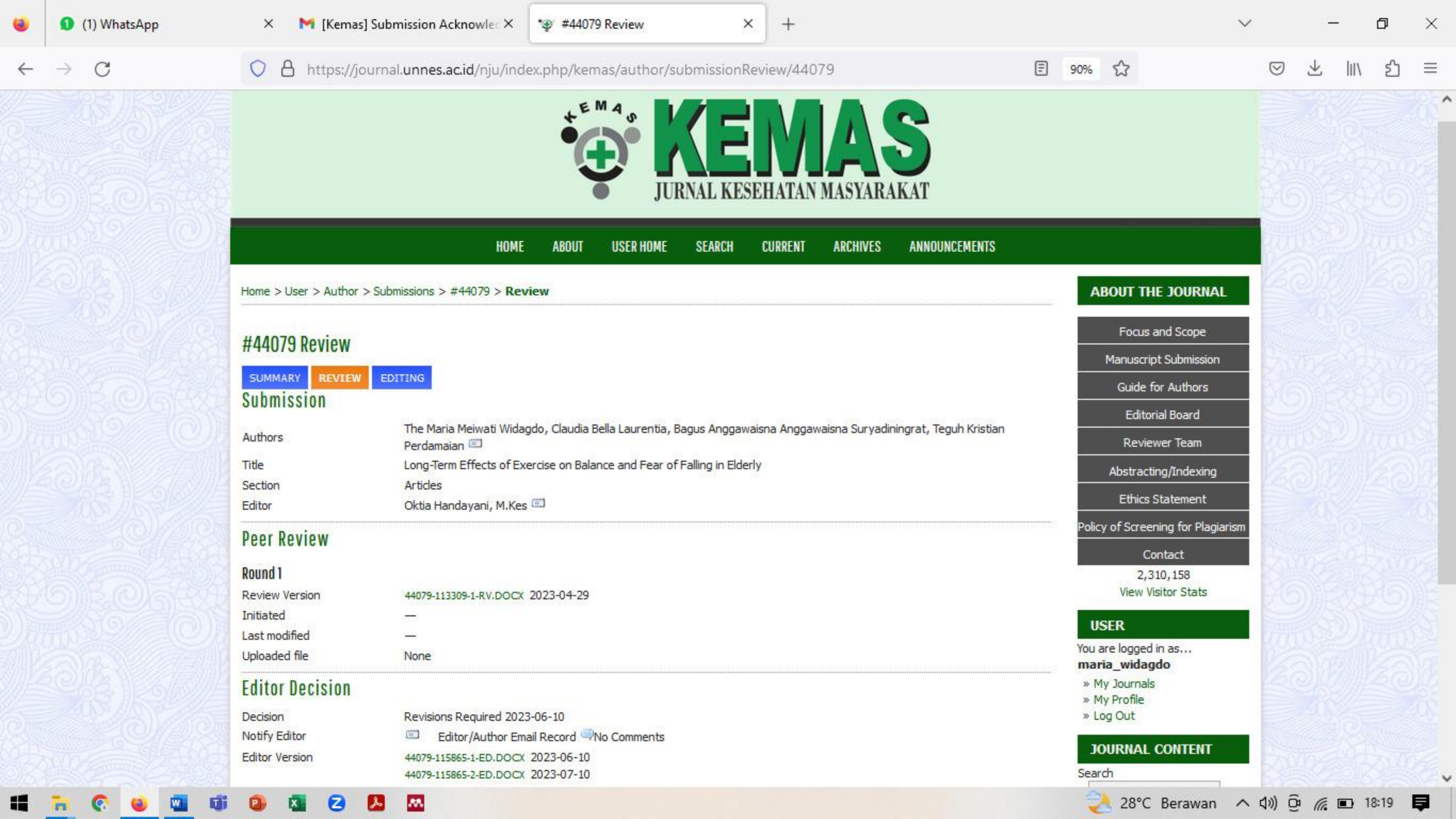
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Authors	The Maria Meiwati Widagdo, Claudia Bella Laurentia, Bagus Anggawaisna Anggawaisna Suryadiningrat, Teguh Kristian Perdanaian
Title	Long-Term Effects of Exercise on Balance and Fear of Falling in Elderly
Section	Articles
Editor	Okta Handayani, M.Kes

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

The Maria Meiwati Widagdo<sup>1,a)</sup>, Claudia Bella Laurentia<sup>2</sup>, Bagus Anggawaisna Suryadinigrat<sup>2</sup>, Teguh Kristian Perdamaian<sup>1</sup>

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**Abstract.** Falls is the main cause of injuries in elderly. Studies on the long-term effects of balance training are still limited. This study aimed to assess the long-term impact of a physical exercise on the balance and fear of falling in community dwelling elderly. This was a quasi-experimental study with pre-post design. The participants were recruited using purposive sampling. The inclusion criteria were older people  $\geq 60$  years with balance problems. They received a one-month physical exercise. The instruments included Functional Reach Test (FRT) to assess balance and Falls Efficacy Scale-International (FES-I) to assess fear for falling. Assessment was conducted at pre- and post-intervention and two years later. Data of 23 participants were collected in 2017 and 2019. Data were analysed using 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 significant improvement in the balance and fear of falling one month and two years after the program. The balance program had long-term effect that lasted at least for two years. Inclusion of the balance program in community-based health program for elderly can improve balance and prevent falls.

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Keywords: elderly, exercise, falls, fear of falling, functional reach test

## Introduction

Falls are one of leading causes of death and disability in elderly population.(WHO, 2021) Falls are the leading cause of fatal and nonfatal injuries among elderly. The age-adjusted mortality rate of falls in the elderly in the US is 64:100,000, which increased about 30% in 18 years..<sup>2</sup> Older age, women, previous history of falling, and multimorbidity have higher risk of falls..(Kim, Choi and Xiong, 2020)(Pirrie *et al.*, 2020) Other important risk factors are sensory impairment, cognitive decline, certain medication, and environmental hazards.(Saftari and Kwon, 2018)(Wang, Liu and Zhao, 2022)(Montero-odasso and Speechley, 2018)(Gadella *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 overtime, through muscle atrophy caused by lack of activity.(Jeon, Gu and Yim, 2017)(Park *et al.*, 2014)(Merchant *et al.*, 2020)

Falls are preventable. Health promotion and prevention activities, such as screening of falls 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 the healthcare professionals to prioritise the falls 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, Kakara and Henry, 2020)(Matla *et al.*, 2021)(Whipple, Hamel and Talley, 2019)

There have been studies reporting the effectiveness of physical exercise for fall prevention in elderly. However, most of the studies were conducted over a short period of time.(Matla *et al.*, 2021)(Chen *et al.*, 2019)(Im, Bang and Seo, 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 adopt to community settings in Indonesia. However, until now, there is no study in Indonesia that discusses 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.

## Methods

This was a quasi-experimental study with 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 Functional Reach Test (FRT), where FRT scores more than 25 is considered to have 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, Folstein and McHugh, 1975) (Hogervorst *et al.*, 2011) Elderly with MMSE scores lower than 23 were excluded from this study. All participants were purposively recruited from 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 side leg, walking sideways, raising heels, stepping up a step, sitting to standing. The exercises were designed to challenge the participants' balance and coordination. Intervention was carried out within a week, then intervention for three weeks and finally post intervention at the end of November 2017.

Outcome on balance were collected with Functional Reach Test (FRT) and the perceived fear of falling we assessed by Falls Efficacy Scale-International (FES-I) to assess the fear of falling. 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 was considered to have low risk of falls. (Thomas, 2020) The FRT has been widely used in many studies on elderly. (Bohannon, Wolfson and White, 2017) (Balasubramanian, Boyette and Wludyka, 2015) (Fujimoto *et al.*, 2015) People with a functional reach of  $\geq 10''/25$  cm was considered to have 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-questionnaire. (Tinetti, Richman and Powell, 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 elderly 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. 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 simple question of whether they performed the exercise at least once a week in the past 2 years after the exercise program completed.

Data of the baseline characteristics were presented descriptively. Univariate analyses were performed with non-parametric analysis (Wilcoxon signed rank test), with 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 of 23 participants analysed. They aged between 61-80 years old, with a mean±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, Cooper and Sayer, 2016) They were given a balance exercise program for one month. More than a half of 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. Baseline characteristics of community-dwelling elderly participating from Wirobrajan sub-district, Yogyakarta in 2017 (n=23)

Description	N	Percentage
<b>Age</b>		
60-74 years	18	78.3 %
75-89 years	5	21.7 %
<b>Sex</b>		
Female	20	87 %
Male	3	13 %
<b>Education</b>		
Did not complete Elementary School	17	74 %
Elementary School	3	13 %
Junior High School	2	9 %
Senior High School	1	4 %
<b>Current occupation</b>		
Tradesperson	5	21 %
Pensioner	1	4 %
Laborer	1	4 %
Masseur	1	4 %
Unemployed	15	65 %
<b>Medication history</b>		
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%

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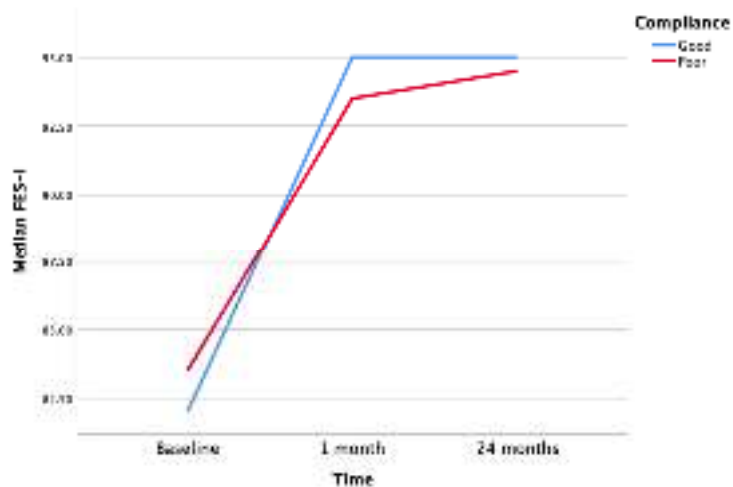
The effects of the program were measured using FRT to assess balance and FES-I to assess fear of falling before and after the intervention and two years later, as shown in Table 2. There was a significant improvement of fall risk (according to FRT) from 17.04 cm to 21.87 cm, which slightly decreased to 20.65 over 2 years. There was a significant difference of 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 overtime, where the FRT returns to the baseline condition in participants with poor compliance. A study participated by community-dwelling elderly reported that a one-month exercise increased the muscle strength and joint flexibility, which improved balance.(Suzuki *et al.*, 2019)

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)

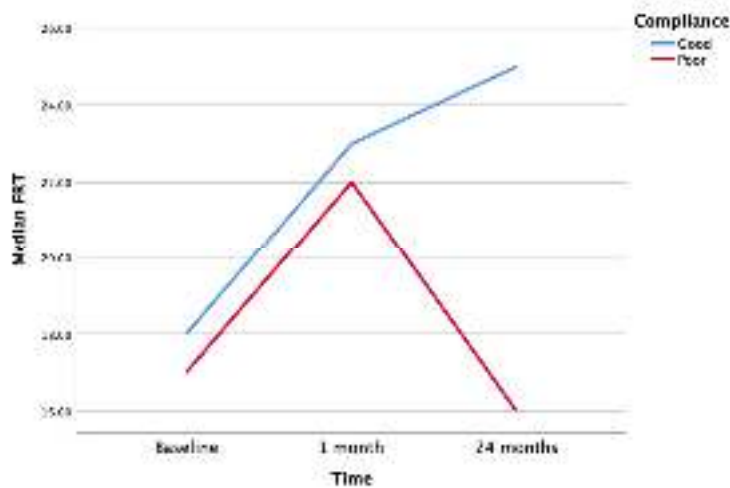
Variable	Baseline	Post-intervention (1 month)	Long-term (2 years)		
			All (n=23)	Good compliance (n=15)	Poor compliance (n=8)
FRT					
mean (SD), cm	17.04 (2.65)	21.87 (3.39)*	20.65 (4.79)*	23.00 (3.61) †	16.25 (3.49)
median (IQR), cm	18 (1)	22 (3)	21 (9)	25 (5)	16 (2.5)
FES-I					
mean (SD)	82.61 (8.61)	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 ( $p < 0.05$ )



(a)



(b)

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 exercise program.

This study showed that exercise had long-term positive impact on the elderly's balance. Patil et al (2015) conducted a 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) 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-month, 12-month and 18-month. The physical functioning at 24-month decreased compared to that at 18-month, 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 the 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, Basha and Jungade, 2020)

The statistical analysis of the fear of falling found significant reduced fear of falling between pre- and post-intervention, and between pre-intervention and two years later. There was no significant difference between 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)

Further details of the changes of FRT and FES-I between pre, post intervention, and 2 years follow up is shown in table 3. Generally, the table shows that the exercise program significantly improved the balance and perceived fear of falling, where good compliance can maintain the improvement overtime. This was consistent with the finding or a study that reported compliant older people had higher positive impact from exercise compared to the non-compliant subjects. (Falossi et al., 2022)

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
<b>FRT</b>		
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
<b>FES-I</b>		

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

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 elderly.

## Conclusion

Preventing falls in elderly needs to consider complex nature of its risk factors. This study showed that simple exercise program in community is feasible to improve the physical and psychological risk of falls in elderly both in 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 elderly with long term impact. A balance exercise program can be included in the Indonesian community-based program, Posyandu Lansia (program integrated service post for older people) to improve balance and prevent falls.

Future trial with randomisation, control group, and larger population is needed to design a program that suitable in Indonesian setting, especially in community setting. Regarding the compliance of participants, further studies needed to explore the motivation and other characteristics that might influence it.

## Acknowledgment

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

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**Abstract.** Falls is the main cause of injuries in elderly, with an estimate of 684,000 fatal falls each year, 60% of which occur in South East Asia and Western Pacific. Studies on the long-term effects of balance training are still limited. This study aimed to assess the long-term impact of a physical exercise on the balance and fear of falling in community dwelling elderly. This was a quasi-experimental study with pre-post design. The participants were recruited using purposive sampling. The inclusion criteria were older people  $\geq 60$  years with balance problems. They received a one-month physical exercise. The instruments included Functional Reach Test (FRT) to assess balance and Falls Efficacy Scale-International (FES-I) to assess fear for falling. Assessment was conducted at pre- and post-intervention and two years later. Data of 23 participants were collected in 2017 and 2019. Data were analysed using 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 significant improvement in the balance and fear of falling one month and two years after the program. The balance program had long-term effect that lasted at least for two years. Inclusion of the balance program in community-based health program for elderly can improve balance and prevent falls.

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## Introduction

Falls are one of leading causes of death and disability in elderly population. (WHO, 2021) Falls are the leading cause of fatal and nonfatal injuries among elderly. The age-adjusted mortality rate of falls in the elderly in the US is 64:100,000, which increased about 30% in 18 years.<sup>2</sup> Older age, women, previous history of falling, and multimorbidity have higher risk of falls. (Kim, Choi and Xiong, 2020) (Pirrie *et al.*, 2020) Other important risk factors are sensory impairment, cognitive decline, certain medication, and environmental hazards. (Saftari and Kwon, 2018) (Wang, Liu and Zhao, 2022) (Montero-odasso and Speechley, 2018) (Gadella *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 overtime, through muscle atrophy caused by lack of activity. (Jeon, Gu and Yim, 2017) (Park *et al.*, 2014) (Merchant *et al.*, 2020)

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There have been studies reporting the effectiveness of physical exercise for fall prevention in elderly. However, most of the studies were conducted over a short period of time. (Matla *et al.*, 2021) (Chen *et al.*, 2019) (Im, Bang and Seo, 2019) A few studies have been conducted in community settings in

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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 adopt to community settings in Indonesia. However, until now, there is no study in Indonesia that discusses 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.

## Methods

This was a quasi-experimental study with 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 Functional Reach Test (FRT), where FRT scores more than 25 is considered to have 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, Folstein and McHugh, 1975)(Hogervorst *et al.*, 2011) Elderly with MMSE scores lower than 23 were excluded from this study. All participants were purposively recruited from 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 side leg, walking sideways, raising heels, stepping up a step, sitting to standing. The exercises were designed to challenge the participants' balance and coordination. Intervention was carried out within a week, then intervention for three week and finally post intervention at the end of November 2017.

Outcome on balance were collected with Functional Reach Test (FRT) and the perceived fear of falling we assessed by Falls Efficacy Scale-International (FES-I) to assess the fear of falling. 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 was considered to have low risk of falls.(Thomas, 2020) The FRT has been widely used in many studies on elderly.(Bohannon, Wolfson and White, 2017)(Balasubramanian, Boyette and Wludyka, 2015)(Fujimoto *et al.*, 2015) People with a functional reach of  $\geq 10''/25$  cm was considered to have 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-questionnaire.(Tinetti, Richman and Powell, 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 elderly 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. 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 simple question of whether they performed the exercise at least once a week in the past 2 years after the exercise program completed.

Data of the baseline characteristics were presented descriptively. Univariate analyses were performed with non-parametric analysis (Wilcoxon signed rank test), with 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 of 23 participants analysed. They aged between 61-80 years old, with a mean±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, Cooper and Sayer, 2016) They were given a balance exercise program for one month. More than a half of 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. Baseline characteristics of community-dwelling elderly participating from Wirobrajan sub-district, Yogyakarta in 2017 (n=23)

Description	N	Percentage
<b>Age</b>		
60-74 years	18	78.3 %
75-89 years	5	21.7 %
<b>Sex</b>		
Female	20	87 %
Male	3	13 %
<b>Education</b>		
Did not complete Elementary School	17	74 %
Elementary School	3	13 %
Junior High School	2	9 %
Senior High School	1	4 %
<b>Current occupation</b>		
Tradesperson	5	21 %
Pensioner	1	4 %
Laborer	1	4 %
Masseur	1	4 %
Unemployed	15	65 %
<b>Medication history</b>		
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%

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**Commented [FK6R5]:** Sumber dari tabel berasal dari data yang dikumpulkan dalam penelitian



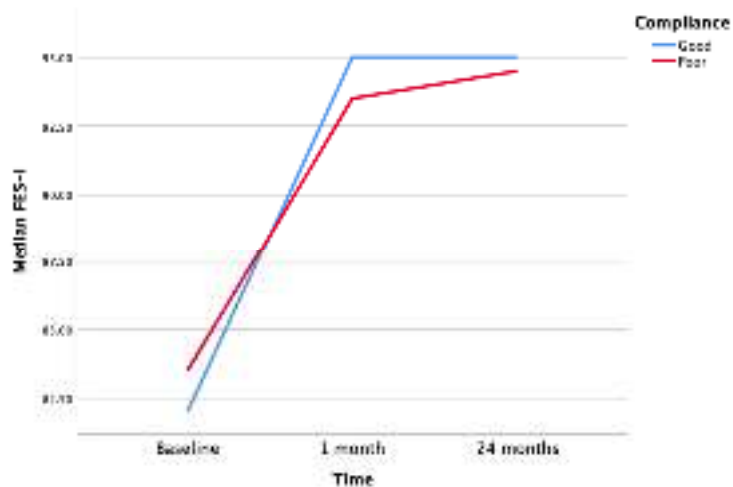
The effects of the program were measured using FRT to assess balance and FES-I to assess fear of falling before and after the intervention and two years later, as shown in Table 2. There was a significant improvement of fall risk (according to FRT) from 17.04 cm to 21.87 cm, which slightly decreased to 20.65 over 2 years. There was a significant difference of 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 overtime, where the FRT returns to the baseline condition in participants with poor compliance. A study participated by community-dwelling elderly reported that a one-month exercise increased the muscle strength and joint flexibility, which improved balance.(Suzuki *et al.*, 2019)

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)

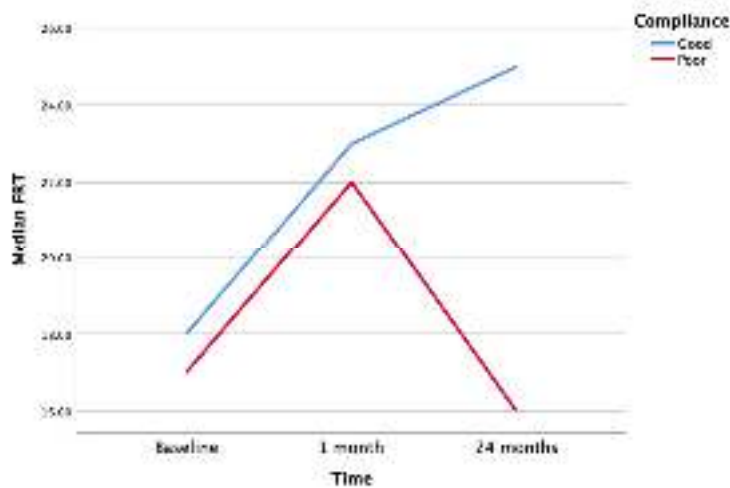
Variable	Baseline	Post-intervention (1 month)	Long-term (2 years)		
			All (n=23)	Good compliance (n=15)	Poor compliance (n=8)
FRT					
mean (SD), cm	17.04 (2.65)	21.87 (3.39)*	20.65 (4.79)*	23.00 (3.61) †	16.25 (3.49)
median (IQR), cm	18 (1)	22 (3)	21 (9)	25 (5)	16 (2.5)
FES-I					
mean (SD)	82.61 (8.61)	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 ( $p < 0.05$ )



(a)



(b)

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 exercise program.

This study showed that exercise had long-term positive impact on the elderly's balance. Patil et al (2015) conducted a 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) 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-month, 12-month and 18-month. The physical functioning at 24-month decreased compared to that at 18-month, 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 the 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, Basha and Jungade, 2020)

The statistical analysis of the fear of falling found significant reduced fear of falling between pre- and post-intervention, and between pre-intervention and two years later. There was no significant difference between 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)

Further details of the changes of FRT and FES-I between pre, post intervention, and 2 years follow up is shown in table 3. Generally, the table shows that the exercise program significantly improved the balance and perceived fear of falling, where good compliance can maintain the improvement overtime. This was consistent with the finding or a study that reported compliant older people had higher positive impact from exercise compared to the non-compliant subjects. (Falossi et al., 2022)

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
<b>FRT</b>		
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
<b>FES-I</b>		

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

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 elderly.

## Conclusion

Preventing falls in elderly needs to consider complex nature of its risk factors. This study showed that simple exercise program in community is feasible to improve the physical and psychological risk of falls in elderly both in 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 elderly with long term impact. A balance exercise program can be included in the Indonesian community-based program, Posyandu Lansia (program integrated service post for older people) to improve balance and prevent falls.

Future trial with randomisation, control group, and larger population is needed to design a program that suitable in Indonesian setting, especially in community setting. Regarding the compliance of participants, further studies needed to explore the motivation and other characteristics that might influence it.

## Acknowledgment

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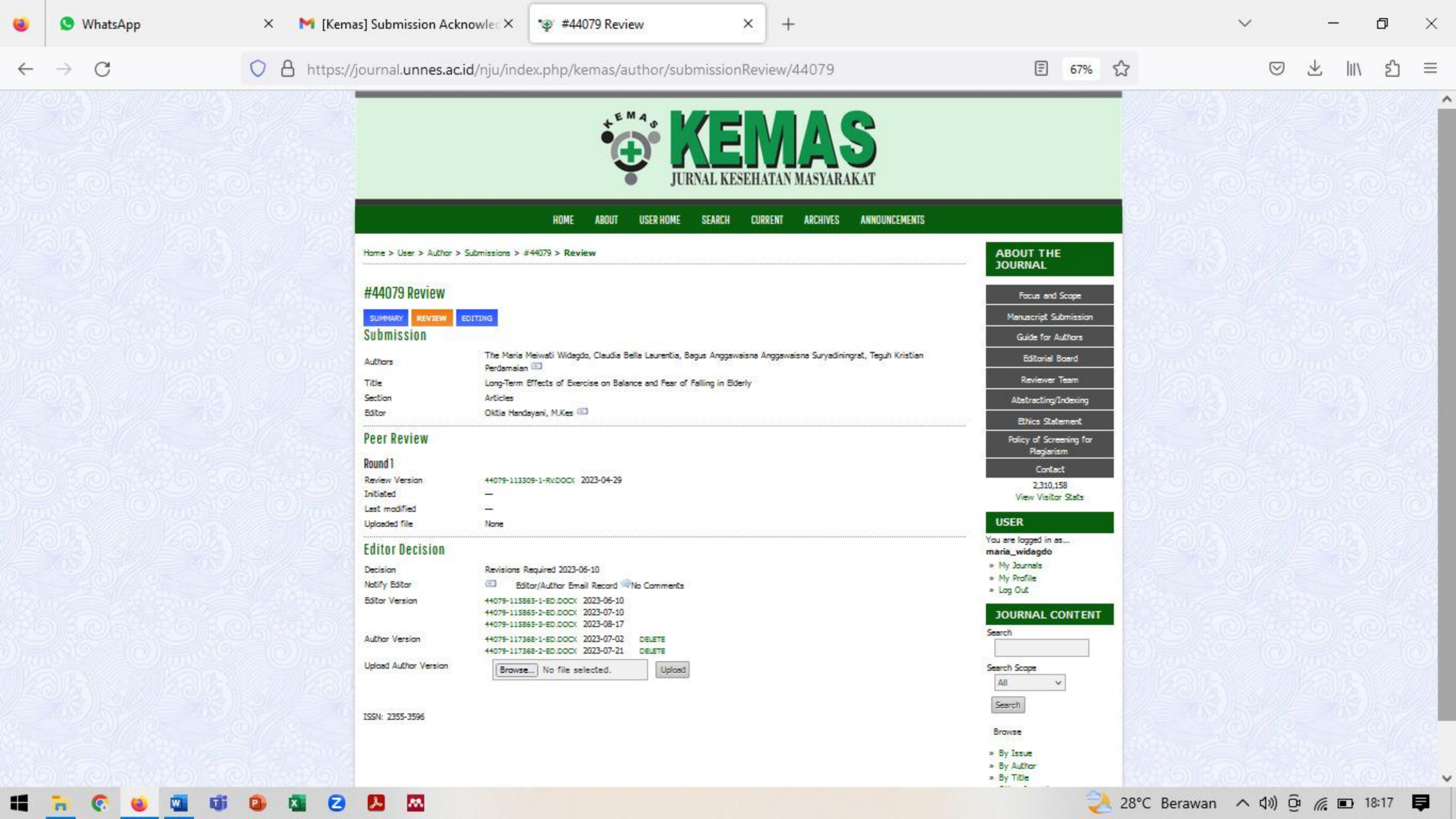
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# Long-Term Effects of Exercise on Balance and Fear of Falling in Community-Dwelling Elderly

The Maria Meiwati Widagdo<sup>1,a)</sup>, Claudia Bella Laurentia<sup>2</sup>, Bagus Anggawaisna Suryadinigrat<sup>2</sup>, Teguh Kristian Perdamaian<sup>1</sup>

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**Abstract.** Falls is the main cause of injuries in elderly, with an estimate of 684,000 fatal falls each year, 60% of which occur in South East Asia and Western Pacific. Studies on the long-term effects of balance training are still limited. This study aimed to assess the long-term impact of a physical exercise on the balance and fear of falling in community dwelling elderly. This was a quasi-experimental study with pre-post design. The participants were recruited using purposive sampling. The inclusion criteria were older people  $\geq 60$  years with balance problems. They received a one-month physical exercise. The instruments included Functional Reach Test (FRT) to assess balance and Falls Efficacy Scale-International (FES-I) to assess fear for falling. Assessment was conducted at pre- and post-intervention and two years later. Data of 23 participants were collected in 2017 and 2019. Data were analysed using 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 significant improvement in the balance and fear of falling one month and two years after the program. The balance program had long-term effect that lasted for two years. Inclusion of the balance program in community-based health program for elderly can improve balance and prevent falls.

Keywords: elderly, exercise, falls, fear of falling, functional reach test

## Introduction

Falls are one of leading causes of death and disability in elderly population. (WHO, 2021) Falls are the leading cause of fatal and nonfatal injuries among elderly. The age-adjusted mortality rate of falls in the elderly in the US is 64:100,000, which increased about 30% in 18 years.<sup>2</sup> Older age, women, previous history of falling, and multimorbidity have higher risk of falls. (Kim, Choi and Xiong, 2020) (Pirrie *et al.*, 2020) Other important risk factors are sensory impairment, cognitive decline, certain medication, and environmental hazards. (Saftari and Kwon, 2018) (Wang, Liu and Zhao, 2022) (Montero-odasso and 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 overtime, through muscle atrophy caused by lack of activity. (Jeon, Gu and Yim, 2017) (Park *et al.*, 2014) (Merchant *et al.*, 2020)

Falls are preventable. Health promotion and prevention activities, such as screening of falls 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 the healthcare professionals to prioritise the falls 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, Kakara and Henry, 2020) (Matla *et al.*, 2021) (Whipple, Hamel and Talley, 2019)

There have been studies reporting the effectiveness of physical exercise for fall prevention in elderly. However, most of the studies were conducted over a short period of time. (Matla *et al.*, 2021) (Chen *et al.*, 2019) (Im, Bang and Seo, 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 adopt to community settings in Indonesia. However, until now, there is no study in Indonesia that discusses 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.

## Methods

This was a quasi-experimental study with 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 Functional Reach Test (FRT), where FRT scores more than 25 is considered to have 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, Folstein and McHugh, 1975)(Hogervorst *et al.*, 2011) Elderly with MMSE scores lower than 23 were excluded from this study. All participants were purposively recruited from 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 side leg, walking sideways, raising heels, stepping up a step, sitting to standing. The exercises were designed to challenge the participants' balance and coordination. Intervention was carried out within a week, then intervention for three weeks and finally post intervention at the end of November 2017.

Outcome on balance were collected with Functional Reach Test (FRT) and the perceived fear of falling we assessed by Falls Efficacy Scale-International (FES-I) to assess the fear of falling. 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 was considered to have low risk of falls.(Thomas, 2020) The FRT has been widely used in many studies on elderly.(Bohannon, Wolfson and White, 2017)(Balasubramanian, Boyette and Wludyka, 2015)(Fujimoto *et al.*, 2015) People with a functional reach of  $\geq 10''/25$  cm was considered to have 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-questionnaire.(Tinetti, Richman and Powell, 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 elderly 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. 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 simple question of whether they performed the exercise at least once a week in the past 2 years after the exercise program completed.

Data of the baseline characteristics were presented descriptively. Univariate analyses were performed with non-parametric analysis (Wilcoxon signed rank test), with 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 of 23 participants analysed. They aged between 61-80 years old, with a mean±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, Cooper and Sayer, 2016) They were given a balance exercise program for one month. More than a half of 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. Baseline characteristics of community-dwelling elderly participating from Wirobrajan sub-district, Yogyakarta in 2017 (n=23)

Description	N	Percentage
<b>Age</b>		
60-74 years	18	78.3 %
75-89 years	5	21.7 %
<b>Sex</b>		
Female	20	87 %
Male	3	13 %
<b>Education</b>		
Did not complete Elementary School	17	74 %
Elementary School	3	13 %
Junior High School	2	9 %
Senior High School	1	4 %
<b>Current occupation</b>		
Tradesperson	5	21 %
Pensioner	1	4 %
Laborer	1	4 %
Masseur	1	4 %
Unemployed	15	65 %
<b>Medication history</b>		
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%

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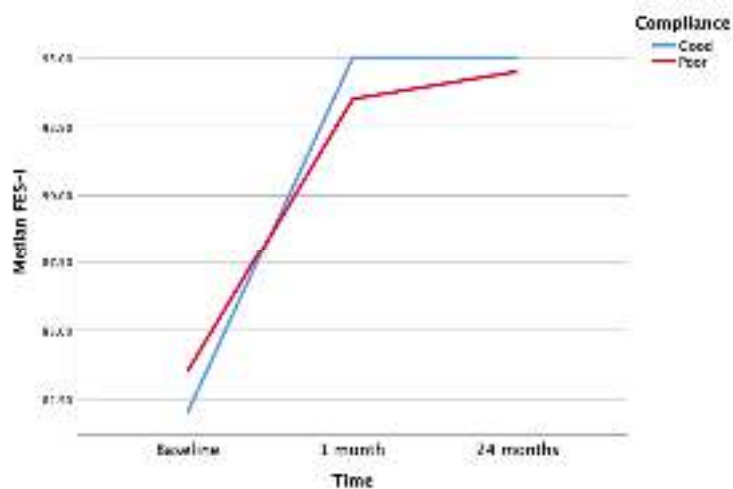
The effects of the program were measured using FRT to assess balance and FES-I to assess fear of falling before and after the intervention and two years later, as shown in Table 2. There was a significant improvement of fall risk (according to FRT) from 17.04 cm to 21.87 cm, which slightly decreased to 20.65 over 2 years. There was a significant difference of 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 overtime, where the FRT returns to the baseline condition in participants with poor compliance. A study participated by community-dwelling elderly reported that a one-month exercise increased the muscle strength and joint flexibility, which improved balance.(Suzuki *et al.*, 2019)

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)

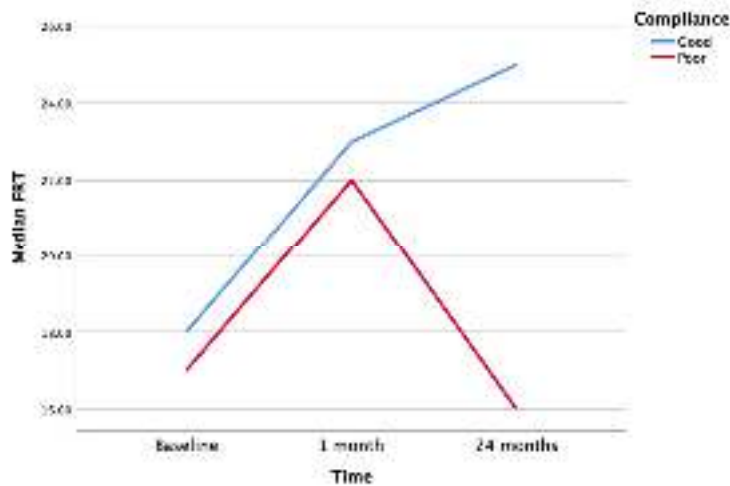
Variable	Baseline	Post-intervention (1 month)	Long-term (2 years)		
			All (n=23)	Good compliance (n=15)	Poor compliance (n=8)
<b>FRT</b>					
mean (SD), cm	17.04 (2.65)	21.87 (3.39)*	20.65 (4.79)*	23.00 (3.61) †	16.25 (3.49)
median (IQR), cm	18 (1)	22 (3)	21 (9)	25 (5)	16 (2.5)
<b>FES-I</b>					
mean (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 ( $p < 0.05$ )



(a)



(b)

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 exercise program.

This study showed that exercise had long-term positive impact on the elderly's balance. Patil et al (2015) conducted a 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) 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-month, 12-month and 18-month. The physical functioning at 24-month decreased compared to that at 18-month, 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 the 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, Basha and Jungade, 2020)

The statistical analysis of the fear of falling found significant reduced fear of falling between pre- and post-intervention, and between pre-intervention and two years later. There was no significant difference between 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)

Further details of the changes of FRT and FES-I between pre, post intervention, and 2 years follow up is shown in table 3. Generally, the table shows that the exercise program significantly improved the balance and perceived fear of falling, where good compliance can maintain the improvement overtime. This was consistent with the finding or a study that reported compliant older people had higher positive impact from exercise compared to the non-compliant subjects. (Falossi et al., 2022)

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
<b>FRT</b>		
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
<b>FES-I</b>		

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

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 elderly.

## Conclusion

Preventing falls in elderly needs to consider complex nature of its risk factors. This study showed that simple exercise program in community is feasible to improve the physical and psychological risk of falls in elderly both in 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 elderly with long term impact. A balance exercise program can be included in the Indonesian community-based program, Posyandu Lansia (program integrated service post for older people) to improve balance and prevent falls.

Future trial with randomisation, control group, and larger population is needed to design a program that suitable in Indonesian setting, especially in community setting. Regarding the compliance of participants, further studies needed to explore the motivation and other characteristics that might influence it.

## Acknowledgment

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

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**Abstract.** Falls is the main cause of injuries in elderly, with an estimate of 684,000 fatal falls each year, 60% of which occur in South East Asia and Western Pacific. Studies on the long-term effects of balance training are still limited. This study aimed to assess the long-term impact of a physical exercise on the balance and fear of falling in community dwelling elderly. This was a quasi-experimental study with pre-post design. The participants were recruited using purposive sampling. The inclusion criteria were older people  $\geq 60$  years with balance problems. They received a one-month physical exercise. The instruments included Functional Reach Test (FRT) to assess balance and Falls Efficacy Scale-International (FES-I) to assess fear for falling. Assessment was conducted at pre- and post-intervention and two years later. Data of 23 participants were collected in 2017 and 2019. Data were analysed using 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 significant improvement in the balance and fear of falling one month and two years after the program. The balance program had long-term effect that lasted at least for two years. Inclusion of the balance program in community-based health program for elderly can improve balance and prevent falls.

Keywords: elderly, exercise, falls, fear of falling, functional reach test

## Introduction

Falls are one of leading causes of death and disability in elderly population. (WHO, 2021) Falls are the leading cause of fatal and nonfatal injuries among elderly. The age-adjusted mortality rate of falls in the elderly in the US is 64:100,000, which increased about 30% in 18 years.<sup>2</sup> Older age, women, previous history of falling, and multimorbidity have higher risk of falls. (Kim, Choi and Xiong, 2020) (Pirrie *et al.*, 2020) Other important risk factors are sensory impairment, cognitive decline, certain medication, and environmental hazards. (Saftari and Kwon, 2018) (Wang, Liu and Zhao, 2022) (Montero-odasso and Speechley, 2018) (Gadella *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 overtime, through muscle atrophy caused by lack of activity. (Jeon, Gu and Yim, 2017) (Park *et al.*, 2014) (Merchant *et al.*, 2020)

Falls are preventable. Health promotion and prevention activities, such as screening of falls 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 the healthcare professionals to prioritise the falls 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, Kakara and Henry, 2020) (Matla *et al.*, 2021) (Whipple, Hamel and Talley, 2019)

There have been studies reporting the effectiveness of physical exercise for fall prevention in elderly. However, most of the studies were conducted over a short period of time. (Matla *et al.*, 2021) (Chen *et al.*, 2019) (Im, Bang and Seo, 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 adopt to community settings in Indonesia. However, until now, there is no study in Indonesia that discusses 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.

## Methods

This was a quasi-experimental study with 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 Functional Reach Test (FRT), where FRT scores more than 25 is considered to have 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, Folstein and McHugh, 1975)(Hogervorst *et al.*, 2011) Elderly with MMSE scores lower than 23 were excluded from this study. All participants were purposively recruited from 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 side leg, walking sideways, raising heels, stepping up a step, sitting to standing. The exercises were designed to challenge the participants' balance and coordination. Intervention was carried out within a week, then intervention for three week and finally post intervention at the end of November 2017.

Outcome on balance were collected with Functional Reach Test (FRT) and the perceived fear of falling we assessed by Falls Efficacy Scale-International (FES-I) to assess the fear of falling. 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 was considered to have low risk of falls.(Thomas, 2020) The FRT has been widely used in many studies on elderly.(Bohannon, Wolfson and White, 2017)(Balasubramanian, Boyette and Wludyka, 2015)(Fujimoto *et al.*, 2015) People with a functional reach of  $\geq 10''/25$  cm was considered to have 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-questionnaire.(Tinetti, Richman and Powell, 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 elderly 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. 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 simple question of whether they performed the exercise at least once a week in the past 2 years after the exercise program completed.

Data of the baseline characteristics were presented descriptively. Univariate analyses were performed with non-parametric analysis (Wilcoxon signed rank test), with 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 of 23 participants analysed. They aged between 61-80 years old, with a mean±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, Cooper and Sayer, 2016) They were given a balance exercise program for one month. More than a half of 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 (%)
<b>Age</b>		
60-74 years	18	78.3 %
75-89 years	5	21.7 %
<b>Sex</b>		
Female	20	87 %
Male	3	13 %
<b>Education</b>		
Did not complete Elementary School	17	74 %
Elementary School	3	13 %
Junior High School	2	9 %
Senior High School	1	4 %
<b>Current occupation</b>		
Tradesperson	5	21 %
Pensioner	1	4 %
Laborer	1	4 %
Masseur	1	4 %
Unemployed	15	65 %
<b>Medication history</b>		
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

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**Commented [FK4R3]:** Sumber dari tabel berasal dari data yang dikumpulkan dalam penelitian

**Commented [FK5R3]:** Revised

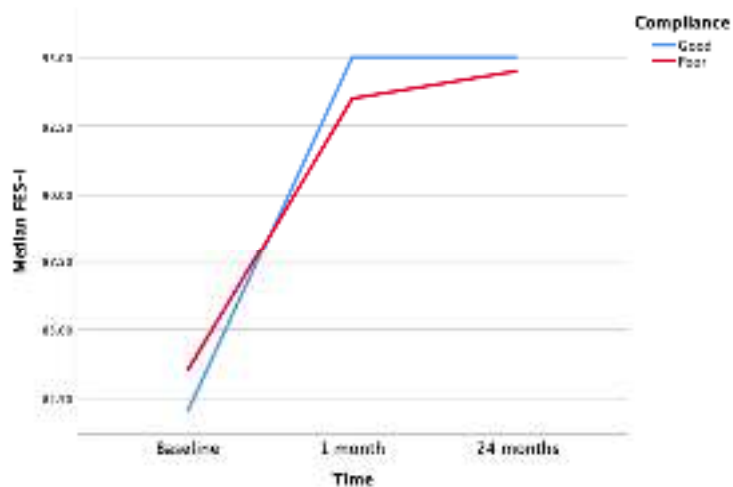
The effects of the program were measured using FRT to assess balance and FES-I to assess fear of falling before and after the intervention and two years later, as shown in Table 2. There was a significant improvement of fall risk (according to FRT) from 17.04 cm to 21.87 cm, which slightly decreased to 20.65 over 2 years. There was a significant difference of 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 overtime, where the FRT returns to the baseline condition in participants with poor compliance. A study participated by community-dwelling elderly reported that a one-month exercise increased the muscle strength and joint flexibility, which improved balance.(Suzuki *et al.*, 2019)

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)

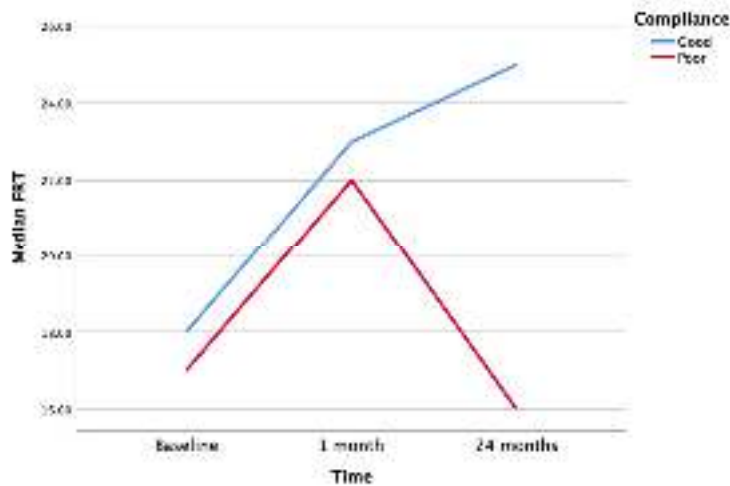
Variable	Baseline	Post-intervention (1 month)	Long-term (2 years)		
			All (n=23)	Good compliance (n=15)	Poor compliance (n=8)
FRT					
mean (SD), cm	17.04 (2.65)	21.87 (3.39)*	20.65 (4.79)*	23.00 (3.61) †	16.25 (3.49)
median (IQR), cm	18 (1)	22 (3)	21 (9)	25 (5)	16 (2.5)
FES-I					
mean (SD)	82.61 (8.61)	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 ( $p < 0.05$ )



(a)



(b)

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 exercise program.

This study showed that exercise had long-term positive impact on the elderly's balance. Patil et al (2015) conducted a 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) 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-month, 12-month and 18-month. The physical functioning at 24-month decreased compared to that at 18-month, 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 the 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, Basha and Jungade, 2020)

The statistical analysis of the fear of falling found significant reduced fear of falling between pre- and post-intervention, and between pre-intervention and two years later. There was no significant difference between 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)

Further details of the changes of FRT and FES-I between pre, post intervention, and 2 years follow up is shown in table 3. Generally, the table shows that the exercise program significantly improved the balance and perceived fear of falling, where good compliance can maintain the improvement overtime. This was consistent with the finding or a study that reported compliant older people had higher positive impact from exercise compared to the non-compliant subjects. (Falossi et al., 2022)

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
<b>FRT</b>		
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
<b>FES-I</b>		

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

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 elderly.

## Conclusion

Preventing falls in elderly needs to consider complex nature of its risk factors. This study showed that simple exercise program in community is feasible to improve the physical and psychological risk of falls in elderly both in 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 elderly with long term impact. A balance exercise program can be included in the Indonesian community-based program, Posyandu Lansia (program integrated service post for older people) to improve balance and prevent falls.

Future trial with randomisation, control group, and larger population is needed to design a program that suitable in Indonesian setting, especially in community setting. Regarding the compliance of participants, further studies needed to explore the motivation and other characteristics that might influence it.

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## #44079 Review

SUMMARY REVIEW EDITING

### Submission

**Authors** The Maria Meiwati Widagdo, Claudia Bella Laurentia, Bagus Anggawaisna Anggawaisna Suryadiningrat, Teguh Kristian Perdamaian ✉️

**Title** Long-Term Effects of Exercise on Balance and Fear of Falling in Elderly

**Section** Articles

**Editor** Oktia Handayani, M.Kes ✉️

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