Original Article

Effectiveness Comparison between Foot Massage and Active Range of Motion Exercise in Reducing the Risk of Falling among Older People in Indonesia

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Abstract

Background: Older people who suffered injuries due to falls have varying severity. About 40 - 60% of falls results in significant lacerations, fractures, brain injuries, and even death.
Objective: This study aimed to compare the effectiveness of foot massage (FM) and active range of motion exercise in lower extremities (Lower ROM) in reducing the risk of falling among older people.
Methodology: This study was a quasi-experimental study with a time-series design. At the same time, the two groups were assigned to two groups with different treatment arms; the first group was assigned to specific FM intervention, and the second group was assigned to Lower ROM exercises. Both groups were given intervention every three days for 12 days.
Results: Significant results were found in both groups in reducing the risk of falling and improving muscle strength ($p<0.05$). However, there were no different effects of both groups in reducing the risk of falling and improving muscle strength ($p>0.05$).
Conclusion: Both FM and Lower Rom are similarly effective in reducing the risk of falling and improving muscle strength among older people.

Keywords: foot massage; lower ROM; risk of falling; muscle strength; older people

Introduction

A fall is an event where someone accidentally sits on the ground or in a lower place (Vieira, Palmer and Chaves, 2016). According to the World Health Organization (WHO), every year, 28-35% of older people (aged; ≥65 years) experience falling globally, and the number increases with age. Falling is a significant cause of injury, disability, and death (Tareef, 2011). Older people who suffer from injuries due to falls have varying severity, and 40-60% falls, resulting in significant lacerations, fractures, or brain injuries (Alekna *et al.*, 2015). The cause of falls in older people is multifactorial. Older people are experiencing decreased body function and being aggravated by the course of the disease that can reduce the balance, muscle strength, and the ability to walk (Dewanti, 2017). As the impact of these changes,

activities in older people will be reduced and lead to inactivity, short step, decreased rhythm, reduced feet tread, and tended not to be able to maintain their balance (Lee and Song, 2018). Besides, lack of exercise could worsen the condition, and it is found out that one-fifth of Indonesian older people never perform exercise activities (Irwan *et al.*, 2016). Fall prevention is one of the essential things in older people who have a risk of falling (Holt, Haavik and Elley, 2012). Prevention can be conducted by targeting modified fall risk factors, for example, balance and gait, and environmental factors (Lee and Song, 2018).

One of the factors that can be modified is problems in the lower extremity. Foot Massage (FM) is one of the nursing interventions that can improve local blood circulation and stimulate the somatosensory system, including several receptors (Tutun et al., 2017, Potter & Perry, 2011). Direct pressure techniques in FM can increase the ability of non-contractile tissues, such as capsule and ligament, to extend and stimulate mechanical receptors that can improve the neuromuscular function, maintain joint stability and increase flexibility and postural control (Vaillant et al., 2009). To determine the adequacy of postural control, measurement of the risk of falling and strength of lower extremity muscles is necessary. The standard for falling risk measurement is to use the Time-Up and Go (TUG) test and a handheld dynamometer to measure muscle strength (Herman, Giladi and Hausdorff, 2011).

A previous study by Chatchwan shows that FM could reduce the risk of falling by using the TUG score as an outcome. There was a significantly increased TUG score for the FM group when compared to the control group (Chatchawan, 2015). Besides, a study conducted by Hin & Ung shows that FM can increase muscle strength (Hin and Ung, 2015). Another benefit of FM is that it is one of the non-pharmacological therapies that are easy to do, economical, and can be applied in health services or hospitals. However, until now, FM is still a controversial topic in terms of its effectiveness (Zainuddin, et all., 2005).

On the other hand, which is Lower ROM is a group of movements performed on the lower extremities aimed at increasing flexibility and muscle strength that can improve postural control (Widyawati, Irawaty, & Sabri, 2010, Potter & Perry, 2011). Lower ROM can be safely applied as a therapy in various conditions and has a positive impact both physically and psychologically (Tseng, et al., 2007). Both FM and Lower ROM have been proven effective in preventing the risk of falling due to decreased postural control in older people. However, so far, no research has been conducted to compare the effectiveness of the two interventions. Knowing the effectiveness of a particular intervention can help nurses in providing appropriate nursing care for older people who are at risk of falling. This study aims to compare the efficacy of FM and Lower ROM in reducing the risk of falling among older people.

Materials and Methods

Participants: The recruitment of subjects used purposive sampling with predetermined inclusion and exclusion criteria. The inclusion criteria of this study were older people with risk of falling; determined by TUG score was ≥ 12 seconds; age> 60 years; no hearing or speech impairment; and willing to participate in this study. The exclusion criteria were subjects who suffer from joint abnormalities, post-traumatic injuries (musculoskeletal injury), and diabetic injuries, and non-cooperative. In addition to the inclusion and exclusion criteria, the researchers set drop-out criteria in this study. Older people with declining health/hospital admission, older people who move out of town, and the older people who refused to continue the intervention were drop out. As many as 131 older people were screened based on the inclusion and exclusion criteria of this study. The screening resulted in 34 older people met the requirements and recruited to participate in this study. The sample size calculation that we used in this study was a minimum sample of 16 respondents for each group (Dahlaan, 2016). This study was a quasi-experimental study with a time-series design. At the same time, the two groups were assigned to two groups with different treatment arms; the first group was assigned to specific FM intervention, and the second group was assigned to Lower ROM exercises. During the study process, some subjects were dropped out due to health declining and move out of town. This study was conducted at Minasaupa Public Health Center Makassar, a metropolitan and the capital city of South Sulawesi, Indonesia.

Procedures: This study is a quasi-experiment with time-series design. The intervention was provided by one of the researchers who had been previously attended the FM training organized by the national education ministry's course and training institute. FM and Lower ROM interventions were carried out every three days for twelve days, ten minutes for each leg. The FM interventions were given in the first twelve days of the study, and the Lower ROM intervention was given in the second twelve days. Both interventions were carried out in the morning when the body was relaxed and suitable for activities (Sherwood, 2014). Measurements of TUG and muscle strength were conducted after the intervention.

Ethical Considerations: The protocol of this study was approved by the Health Research Ethics Commission of the Faculty of Medicine, Hasanuddin University, with the recommendation of ethical approval No. 445 / UN4.6.4.5.31 / PP36 / 201. Before participating in this study, all participants were explained about the research objectives, intervention procedures, possible risks, and benefits obtained, and the researcher explained the confidentiality of the data of participants. Each subject has the same right to refuse to participate or refuse to continue the intervention at any time during the study. Upon agreeing to participate, every participant signed informed consent.

Measurement of risk of falling and muscle strength: TUG is an instrument that has a high degree of accuracy to detect falls. The components observed during the procedure are body balance, leg strength, and body shake (Chan, et al., 2017). TUG measurement involves three joints: ankle, hip, and trunk. The activation of the ankle plantar flexor, hip flexor, and abductor, and trunk muscles were aimed for stepping to move the center of body mass promptly. Previous studies have used TUG as one of the inclusion criteria in determining the eligibility of study participants (Tutun Yumin et al., (2017), Indarwati et al., (2010), Vaillant et al., (2009). It has been widely used both in adolescents, adults, and older people (Vaillant et al., (2009), Chatchawan, (2015), Tutun Yumin et al., (2017). Timed-up and Go test is conducted by calculating a person's time to stand up from a standard chair, walk 3 meters, turn around, walk back to the chair, and sit again. Muscle strength was measured using a Handheld Dynamometer (HHD; μTAS MT-1 or μTAS F-1; Anima Inc., Tokyo, Japan). It is conducted by instructing subjects to sit on a chair and flexing the legs and measuring the strength of the muscles.

Foot Massage Interventions: FM is an intervention on both legs where both recipient's legs are held in various positions, gently and rhythmically rubbed to get a relaxation response (Vaillant et al., (2009), Puthusseril, (2006). FM, as the nursing intervention, was adopted from Joachim's research that had been developed by Puthusseril (Joachim, 1983, Puthusseril, 2006). Previous studies have found that FM has been shown to improve balance and reduce the risk of falling (Chatchawan, 2015, Vaillant et al., 2009).

Lower ROM Interventions: Lower ROM is ROM exercises involving the lower extremity movements such as flexion, extension, abduction, adduction, internal and external rotation, circumduction, dorsiflexion, plantarflexion, inversion and eversion (Timby, (2009), Perry, A.G. & Potter, 2008). Lower ROM is one of the nursing interventions contained in nursing intervention classification (NIC), which was adopted from the fundamental nursing skills and concepts and clinical nursing skill books (Timby, (2009), Perry, A.G. & Potter, 2008).. Lower ROM has been shown to improve muscle balance and strength (El-kader, 2018, Cho, Ko, & Lee, 2012, Widyawati et al., 2010).

Statistical analysis: In this study, the data entry and tabulation processes were first carried out, and then the variables were analyzed using descriptive statistics and hypothesis testing. As the data was not normally distributed on both measurements in both groups, the nonparametric tests were used; the Friedman test and the Wilcoxon Post Hoc test. As for the comparison of variables between the FM group and the Lower ROM group using the repeated ANOVA test. $P \leq 0.05$ is the threshold of significance or degree of freedom (df) with 95% as the Confidence Interval (CI).

Results

Data from 29 (85.3%) participants were analyzed. The participants' demographic characteristics are summarized in Table 1. There were no significant differences in participant characteristics, except for gender.

Table 2 shows the differences in the mean (standard deviation) in the two groups. The difference test between the two groups showed no difference with a value of p> 0.05. There was an increase in muscle from pre H1 until day 12.

Table 3 shows that both groups are equally effective in reducing the risk of falling and increasing muscle strength (p-value <0.05).

Table 1 Frequency distribution based on respondent demographic data

Characteristics	FM	Lower ROM	Total (n=29)	*p-value*
	n (%)	n (%)	n(%)	
Gender				
Man	0 (0%)	3 (21.4%)	3 (10.3%)	0.000 [a] *
Women	15 (100%)	11 (78.6%)	26 (89.7%)	
Age				
Means (SD)	66.53 (5.84)	72.85 (6.09)	66.53 (5.84)	0.829 [b]
Level of education				
Low	2 (13.3%)	4 (28.6%)	6 (20.7%)	0.543 [b]
Intermediate	8 (53.3%)	9 (64.3%)	17 (58.6%)	
High	5 (33.3%)	1 (7.1%)	6 (20.7%)	
Employment history:				
Work	5 (33.3%)	4 (28,.6%)	9 (31.0%)	0.596 [b]
Does not work	10 (66.7%)	10 (71.4)	20 (69.0)	
Body Mass Index (BMI)				
Under weight	0 (0%)	1 (3.4%)	1 (3.4%)	0.283 [b]
Normal	11 (37.9%)	11 (37.9%)	22 (75.9%)	
Overweight	4 (13.8%)	2 (6.9%)	6 (20.7%)	
Fall Frequency				
Never	5 (17.2%)	5 (17.2%)	10 (34.5%)	0.621 [b]
Once	4 (13.8%)	4 (13.8%)	8 (27.6%)	
Twice	4 (13.8%)	4 (13.8%)	8 (27.6%)	
≥ third times	2 (6.9%)	1 (3.4%)	3 (10.3%)	

SD (Standard Deviation). [a] Test of Homogeneity of Variances. [b] Homogeneity descriptive expos

Table 2 Differences in the mean (Standard Deviation) between the Foot Massage group and the Lower ROM group

Variable	Baseline			Day 3			Day 6			Day 9			Day12		
	Mean (SD)			Mean (SD)			Mean (SD)			Mean (SD)			Mean (SD)		
	FM (n=15)	Lower ROM (n=14)	*p* [a]	FM (n=15)	Lower ROM (n=14)	*p* [a]	FM (n=15)	Lower ROM (n=14)	*p* [a]	FM (n=15)	Lower ROM (n=14)	*p* [a]	FM (n=15)	Lower ROM (n=14)	*p* [a]
TUG	15.87(2.64)	14.29(0.91)	0.43	13.53(2.47)	12.71(1.27)	0.27	11.6(2.06)	11.43(1.22)	0.79	10.6(1.88)	10.5(1.22)	0.87	10.47(1.92)	9.86(1.03)	0.3
Right muscle strength	3.6 (0.67)	3.38(0.38)	0.155	5.73(1.22)	5.64(1.48)	0.87	6.04(1.19)	5.79(1.35)	0.61	6.06(1.15)	5.88(1.34)	0.7	6.59(1.09)	6.32(1.23)	0.53
Left muscle strength	3.85(1.29)	3.11(0.35)	0.051	5.29(1.25)	5.11(1.36)	0.72	5.75(1.22)	5.61(1.34)	0.84	6.25(1.09)	6.03(1.34)	0.63	5.99(1.09)	5.95(1.15)	0.92

[a] p <0.05. FM, Foot Massage. [a] differences between groups using the Mann Whitney test (abnormal data distribution). [b] use an unpaired T-test (normal data distribution). Source: primary data, 2019. TUG measurements performed Day 1, day 3, curry 6, day 9, and day 12. Measurement of muscle strength was done on Pre, Day 3, day 6, day 9, day 12

Table 3 Differences between the FM group and the lower ROM group for TUG score, right and left leg muscle strengths.

Variable	Baseline	Day 3	Day 6	Day 9	Day 12	*p* [a]
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Foot Massage (n=15)						
TUG Score	15.87(2.64)	13.53(2.47)	11.6(2.06)	10.6(1.88)	10.47(1.92)	0.000
Right Leg Strength	3.6(0.67)	5.73(1.22)	6.04(1.19)	6.06(1.15)	6.59(1.09)	0.000
Left Leg Strength	3.85(1.29)	5.29(1.25)	5.75 (1.22)	6.25 (1.09)	5.99 (1.09)	0.000
Lower ROM (n=16)						
TUG Score	14.29 (0.91)	12.71(1.27)	11.43 (1.22)	10.50 (1.22)	9.86 (1.03	0.000
Right Leg Strength	3.38 (0.38)	5.64 (1.48)	5.79 (1.35)	5.88 (1.34)	6.32 (1.23)	0.000
Left Leg Strength	3.11 (0.35)	5.11 (1.36)	5.61 (1.34)	6.03 (1.34)	5.95 (1.15)	0.000

[a] p <0.05. FM, Foot Massage. Lower ROM. [a] differences between groups using the Friedman test, Post Hoc Wilcoxon analysis (abnormal data distribution). [b] use an unpaired T-test (normal data distribution). Timed Up and Go test was carried out on Pre, Day 3, Day 6, Day 9, and Day 1

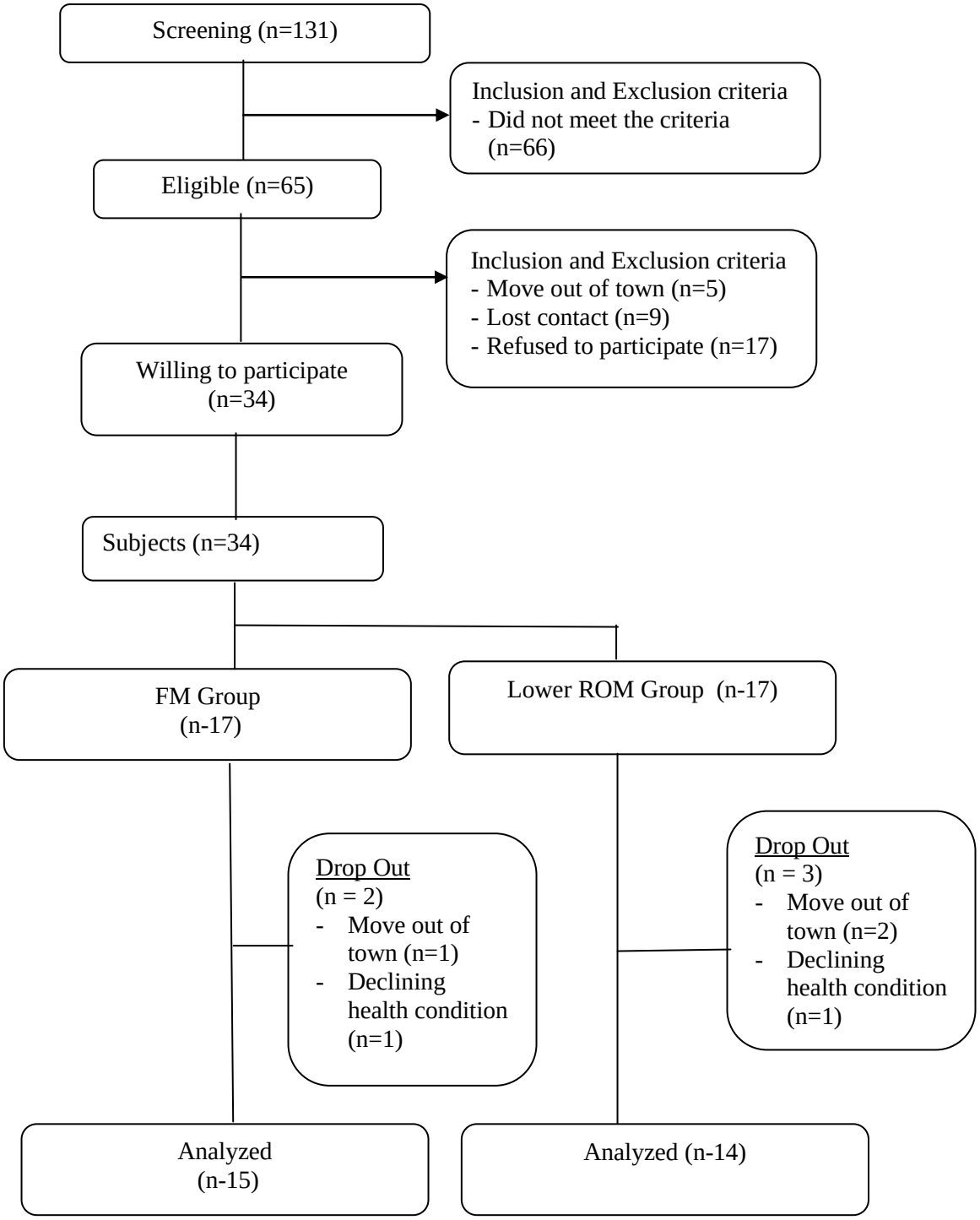

Figure 1 Flowchart of Subjects Recruitment (David Moher, 2014)

Discussion

This study aimed to compare the effectiveness of FM and Lower ROM on the risk of falling in the elderly. The results of TUG score and muscle strength in the FM group from the first day to the twelfth day of interventions showed significant changes. This result indicated that FM influences the decrease in TUG score and increased muscle strength in the FM group. This result is in line with a study by Tutun Yumin et al., who find a decrease in the TUG score after FM intervention (Tutun Yumin *et al.*, 2017). Direct pressure techniques during a massage can increase the ability of non-contractile tissues such as capsule and ligament to extend and stimulate mechanical receptors that can improve the neuromuscular function, maintain joint stability and increase flexibility to enhance postural control (Vaillant et al., 2009). Giving FM from time to time can improve muscle stiffness, smooth circulation, comfort, and the condition of the body to reduce the risk of falls in the elderly. The effects were observed in the TUG in which the risk of falling was decreasing day by day. Similarly, muscle strength had also improved daily during the intervention session. The findings are supported by previous study results that three days FM given regularly can improve local blood circulation and stimulate the somatosensory system, including several receptors, and can also cause smooth muscle contractions (Chatchawan, 2015, Potter & Perry, 2011, Sherwood, 2014). Besides, FM is also an easy and inexpensive intervention to be performed wherever needed. Thus, FM can become an alternative intervention for the elderly with the risk of falling and decreasing muscle strength.

The results of TUG score and muscle strength measurement in the Lower ROM group from the first day to the twelfth day of interventions also showed significant changes. This result is in line with a study conducted by Cho et al., and Widyawati et al. that shows a decrease in TUG score and an increase in muscle strength after Lower ROM (Widyawati et al., 2010, Cho et al., 2012). Lower ROM can stimulate baroreceptors and thereby activates neuromuscular and muscular chemistry (Potter & Perry, 2011) (Sherwood, 2014). Stimulation through neuromuscular will increase the stimulation of the external nerve fibers, especially the parasympathetic nerve, which stimulates the production of acetylcholine, resulting in contractions (Sherwood, 2014). Increased contraction and smooth muscle tone in the lower extremities will lead to an increase in muscle strength, which ultimately leads to increased postural control (Cho et al., 2012). Therefore, it is expected that the routine Lower ROM can reduce the risk of falls and increase muscle strength in the elderly. Besides, Lower ROM is also a lightweight sport that can be carried out independently at home, in the health service, or elsewhere. Therefore, the Lower ROM intervention can be an alternative intervention for the elderly with a risk of falling.

In this study, it was found that the TUG score and muscle strength changed daily for both groups. This result is supported by Vaillant et al. study that shows a significant increase in TUG score after 20 minutes of massage and mobilization of the ankle joint in older people, with a mean difference of about 0.7 seconds compared with the control group (Vaillant et al., 2009). Likewise, a study conducted by Cahtchawan et al. shows an increase in the TUG score after 30 minutes of FM intervention for two weeks in diabetic patients, with an average difference of about 1.13 seconds compared with the control group (Chatchawan, 2015). A study by Cho et al. also shows a significant increase in TUG score after mobilization of the ankle joint for four weeks, three times a week with 2 minutes per session, with an average change of 2.54 seconds when compared to the control group (Hin and Ung, 2015). The provision of FM is intended to stimulate plantar foot mechanoreceptors that are useful in reducing or preventing balance problems and mobility problems by increasing afferent information that is fed to the postural system (Tutun Yumin *et al.*, 2017). Thus, the effect of giving FM can help improve balance on both legs.

In the results of this study, the comparison of TUG values and muscle strength in the FM and lower ROM groups obtained no significant difference in the two groups. This finding is supported by Pertille et al., who reported an insignificant increase in TUG after three sets of 30-second ankle joint mobilization in older women (Pertille, Macedo, 2012). Besides, this was also supported by Zainuddin in his research finding that there was no significant difference in ROM values between the control group and the massage group

(Zainuddin, et al., 2005). Both FM and Lower ROM interventions have physiological effects in increasing blood circulation and relaxing leg muscle stiffness. However, as both interventions improved postural control, no intervention was better than the other in improving the risk of falling in the elderly. Besides, postural balance testing was not carried out as a whole, so that the results obtained showed that there is no difference between FM and lower ROM in improving the risk of falling in the elderly.

From the results of the study above, it was found that by regularly carrying out FM interventions, each can regularly improve the condition of the body associated with the risk of falls and muscle strength. Likewise, with Lower ROM, regular interventions can also help the elderly in reducing and preventing the risk of falls and increasing muscle strength. This research can be information in determining the provision of health interventions in the elderly.

A limitation in this study is the short duration of intervention, so it is not clear how long the duration of treatment is needed to achieve the maximum effect, and it is also not known how long this positive effect can last. Therefore, further studies are needed by adding the duration or frequency of interventions to see an increase in muscle strength and a decreased risk of falling to confirm the effects of FM and Lower ROM in the elderly with a risk of falling. Moreover, the number of participants in this study still lacked to be able to see the maximum results of the interventions. Therefore, further studies are needed by increasing the duration or frequency of interventions to see improvements of muscle strength and risk of falling, with a higher number of participants to confirm the effects of FM and Lower ROM in the elderly with a risk of falling.

This study found that there was no difference between the FM and Lower ROM in reducing the risk of falling and increasing muscle strength among older people in Indonesia. Clinically, both FM and Lower ROM interventions were effective in reducing the risk of falling and increasing muscle strength among older people.

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