Balance Exercise Improves Muscle Strength And Body Stability In Frail Older People

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Abstract

Background: Many elderly people in Indonesia experience falling every year and the half had fallen more than once. This falls due to loss of bone and muscle mass which results in poor of balance. This study aimed to show whether balance excercise could improve muscle strength and balance on elderly people with risk of falling. Methods: This was a quasi-experimental design with two-group pretest-posttest control group. The sample was taken by purposive sampling and the total of 27 elderly people was selected into 2 groups: intervention (n = 14) and control (n = 13). The intervention group received the balance exercise regularly 3 times a week for 3 weeks. The balance exercise consists of plantar flexion, knee flexion, hip flexion, hip extention, and single leg side. Results: As an independent t test showed a significant difference in the balance and muscle strength between the intervention and the control group. Paired t-test on balance values obtained (p = 0.003) and the muscular strength (p = 0.000) which means that there was effect of balance exercise on muscle strength and balance in elderly with risk of falling. Conclusions: Balance exercise for 3 weeks regularly could improve balance score and muscle strength on the older people. Therefore, elderly people escpecially who are at risk of falling better to do balance exercise as their routine and getting support for doing this from family and health workers.

Keywords: balance exercise, muscle strength, older people.

Introduction

The growth of elderly population in the world is increasing, a survey by the United Nations (UN) estimates the number of elderly in the world can reach 1 billion people within the next 10 years. Most injury or falls in elderly people occurred in the midrange of group age and approximately 196 per 1000 persons elderly population aged 65 years and over have experienced falls (Department of Commerce, cited in Eliopoulos, 2014). Eliopoulos (2014) also mentioned that women have more experienced of falls as their getting older compare to men. Probosuseno (cited in Yuda, Utoyo, and Ernawati, 2019) stated that approximately 30% of elderly people in Indonesia at home and experienced a fall each year. Head trauma and fractures are the most common consequences of falls (Stephen, cited in Shubert, 2011). These leads to increase the number of admission in the emergency department and need a lot of costs. Considering high incidence and seriously negative impacts of fall among older people, the concern of associated factors should be given to prevent fall.

Falls that occur in the elderly is caused by several factors. According to Sari, Rahayu, & Fauziah (2021), the risk factors of falls are previous history of falls, hypertension, joint pain, vertigo, drugs use, cognitive impairments, mild dependence on daily activities, and balance disorders. Potter, Perry, Stockert & Hall (2017) describes that total mass of progressive bone loss occurs in elderly persons as a result of physical activity, hormonal changes, and the actual bone resorption causes weaker bones. Additionally the spine is softer and depressed, and long bone is less resistant to slouching. Elderly had changed of the secondary functional status due to changes in the status of mobilization. Elderly walks slower, shorter, tighter, and seemed less coordinated. So that the balance of the body is unstable and they are very risky of falling and injury (Potter, Perry, Stockert, & Hall, 2017). In the process of aging the percentage of muscle mass was decreased, resulting in decreased muscle strength by 30-40%. Muscle strength in the elderly is also associated with problems of balance so that the elderly at risk to fall over (Pizzigali, et al. 2011). Although falls are associated with many factors, imbalances are the main factors (Cangussu et al, 2012). As Gschwind et al. (2013) confirm that weak muscles, balance deficits and gait instabilities are three common causes of falls.Therefore, we should correct imbalance among older people in order to prevent falls.

Impaired postural balance often occurs in the elderly people. There are several things that can cause postural balance disorder, including the effects of aging, accident, or because of illness. But of these three things, the aging factor is the main factor causing postural balance disorders in the elderly people (Avers, 2007). Age, gender, and work are the elderly characteristic can affect the balance. 90% of the those aged over 65 years experience imbalance (Patt, 1998 & Rees, etal.,1999, in Mauk, 2010). Balance problems often occur in elderly women due to hormonal changes, lifestyle, muscle mass, resting metabolic, body fat and psychological (Mauk, 2010).

One of the solutions to overcome and prevent the disruption of balance are efforts to provide training, such as balance exercise. Nyman (2007), states that the balance exercise is a physical activity that is done to improve the stability of the body by increasing the lower limb muscle strength. In his another study, Nyman (2013) also revealed that the balance exercises like Taichi is very effective for improving the functional and static balance and mobility of the elderly through the usage of footwork pattern, increase reaction to movement and good flow of energy. Exercise is very important balance in the elderly because these exercises are very helpful in order to maintain a stable body so as to prevent falls that often occurs in the elderly. This balancing exercise is also very useful for the elderly's independence in order to optimize its ability to avoid the effects due to inability (Jowir, 2009). Several studies has been done to determine the effectiveness of balance exercise on muscle strength and balance. However, similar studies from Indonesia has less reported. Based of the previous activity report from Gerontological Nursing Practice at Hasanuddin University in 2012 discovered that the 76 out of 748 older adults in Sub-district of Tallo have a history

of falling. Then, a research was needed to investigate whether the balance exercise could improve the elderly's muscle strength and body stabilty to avoid falls in the elderly in this studied area.

Research Methods

This study used quasi-experimental design with the design of the two-group pretest-posttest control group design. In this study, experimental treatments were conducted by providing the balance exercises to prevent the risk of falls in the elderly. This research was conducted from 3rd-21st December 2013 in Rappokalling subdistrict, located in the center of Makassar city, a metropolitan city in the eastern area of Indonesia. In 2014, 240 older people lived in Rappokalling. Participants were selected using the following inclusion criteria: (i) age 60 years old and above which is based on the criteria of elderly people in Indonesia by Ministry of Health of Republic of Indonesia (ii), the elderly people who are at risk of falling by the screening results of Falls Risk of Older People in Community (FROP-Com), (iii) the elderly in the good mental condition confirmed by Geriatric Depression Scale measurements, and (iv) the elderly who live with their families. Older people with hearing difficulties, sight problems, and other chronic conditions, which prevented them from participating in this study, were excluded. Absence during exercise was considered dropout criterion. Based on the inclusion and exclusion criteria, 31 eligible participants were identified. We purposively assigned participants into 2 groups: 16 people for the treatment group and 15 people for control group.
This study is approved by the Government of Makassar City: Nation Unity and Community Protection Office and Health Department of Makassar. The study also is conducted according to the National Committee of Health Research Ethics of Indonesia.

Intervention

Balance exercise given to the treatment group involves legs muscles to strengthen basic body allignment in order to increase postural balance. Balance exercise which is conducted in this study consists of plantar flexion, knee flexion, hip flexion, hip extention, and single leg side. This exercise was arranged and seen from a guideline "Exercise : a guide from the National Institute on Aging". The exercise was conducted for ten minutes (one session) and three times a week in three weeks. So, in total, there were nine sessions of exercise for each of respondents.

Data collection

The study also performed measurements of balance in the elderly using a measuring instrument Berg Balance Scale. Berg Balance Scale (BBS) is a scale for measuring static and dynamic of the balance objectively, which consists of 14 items duty equilibrium (balance task) are common in everyday life. In addition, researchers also performed measurements using muscle strength leg dynamometer . Leg dynamometer is a tool to measure the strength of the leg muscles. The measurement step are standing upright, then the knee flexed up to an angle of 1200 and then pull the handle that is on the dynamometer while standing. Score leg muscle strength will appear on the monitor screen.

Results

Participants included in this study was selected based on criteria that are participants must be 60 years of age and above, they are willing to be participated in the whole study, they have risk of falls assessed with FROM-Com screening, they are mentally heath and living with their families. The numbers of respondents were 31 but the full valid data was only taken from 27 respodents due to 4 respodents were drop out. These respondents were fully participated until the end and some data were missing. Thus, the data from 27 (67.7%) participants were then analyzed.

Table 1. Frequency Distribution of Respondents Characteristics Based on the intervention group and control group in Rappokalling Village Tallo Sub-Distrct Makassar, (n = 27)

Variable	Intervention Group		Control Group	
	F	%	f	%
Age				
60-75 years	**13**	**100**	**9**	**69.2**
76-95 years	**0**	**0**	**4**	**30.8**
Gender				
Male	**1**	**7.1**	**1**	**7.7**
Female	**13**	**92.9**	**12**	**92.3**

Table 1 shows all respondents in the intervention group aged 60-75 years (100%)while in the contro group was 69,2 %. In the control group there were also 30.8% in the group aged 76-95 years old. Nearly all respondents were female (92.9%) and only one man in each intervention group or the control group (each group 7.7%).

Table 2. Frequency Distribution of balance based on the characteristics of respondents in the intervention and control group in Rappokalling Village Tallo SubDistrct Makassar (n = 27)

Variable	Risk of falling based on balance scale											
	Intervension Group						Control Group					
	High risk		Medium risk		Low risk		High risk		Medium risk		Low risk	
	f	%	f	%	f	%	f	%	f	%	f	%
Age												
60-75 years	**2**	**14.3**	**10**	**71.4**	**2**	**14.3**	**0**	**0**	**1**	**7.7**	**8**	**61.5**
76-95 years	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**7.7**	**3**	**23.1**
Gender												
Male	**2**	**14.3**	**10**	**71.4**	**1**	**7.1**	**0**	**0**	**2**	**15.4**	**10**	**76.9**
Female	**0**	**0**	**0**	**0**	**1**	**7.1**	**0**	**0**	**0**	**0**	**1**	**7.7**

Table 2 shows that in general all the elderly aged over 60 years the risk of falling. In the intervention group, more than half of respondents are at risk of falling intermediate (71.4%), and some even have a high risk of falling while in the control group, more than half the risk of falling is low (76.9%).

Table 3. Frequency Distribution Based on Scale balance before and after the balance exercise in the intervention and control group in Sub Rappokalling District of Tallo City Malassar,(n = 27)

	Scale Balance	Intervention Group		Control Group	
		f	%	f	%
Pre	**High Risk Of Falling**	**2**	**14.3**	**1**	**7.7**
	Medium Risk Of Falling	**10**	**71.4**	**5**	**38.5**
	Low Risk of falling	**2**	**14.3**	**7**	**53.8**
Post	**High Risk Of Falling**	**0**	**0**	**1**	**7.7**
	Medium Risk Of Falling	**2**	**14.3**	**8**	**61.5**
	Low Risk of falling	**12**	**85.7**	**4**	**30.8**

Table 3 shows the prior to the balance exercise, more than half of respondents (71.4%), are at medium risk of falling. This is in contrast to the control group that most respondents are at low risk of falling (53.8%). After the exercise, the number of respondents in the medium risk of falling is decreased (14.3%) and there is no longer a high risk of falling respondents in the intervention group. In the control group, the risk of falling increases with the increasing number of respondents indicated in the medium risk of falling (65%).

Table 4. Frequency Distribution Based on Muscle strength Pre and Post the Balance Exercise in Intervension Group and control Group in Rappokalling Village Sub-district of Tallo Makassar (n = 27)

	Muscle strength is less (< 65 kg)	Intervension Group		Muscle strength is less (<65 kg)	Control Group	
		f	%		f	%
Pre	>38 kg	0	0	>38 kg	1	7.7
	22-38 kg	11	78.6	22-38kg	12	92.3
	<22 kg	3	21.4	<22 kg	0	0
Post	>38 kg	5	35.7	>38 kg	1	7.7
	22-32 kg	12	64.3	22-38 kg	12	92.3
	<32 kg	0	0	<22 kg	0	0

Table 4 shows that prior to the balance exercise, all respondents indicated that less muscle strength but the score is different, where the intervention group more than half of respondents (78.6%) were on the score of 22-38 kg, but the group controls almost all respondents (92.3%) are in that category. After the balance exercise showed that all the respondents continued to show strength less muscle but the score is different, where the intervention group increased the score by (35.7%) are in the category of > 38 kg.

Table 5. Overview The difference in the results of the independent t-test changes in muscle strength in Group Intervention and Control Group in Rappokalling Village Sub-district of Tallo Makasssar (n = 27)

Observation	Group	n	Mean (SD)	p
Pre	Intervention	14	26.643 (5:44)	0.369
	Control	13	29 308 (9339)	
Post	Intervention	14	32,179 (8,898)	0.336
	Control	13	28,462(10.759)	

Table 5 Statistical test research results obtained independent sample t test showed that the mean balance before the intervention in the intervention group was lower than the control group (26.643 <29.308). But in the post mean balance in the intervention group increased to 32.179, while the control group decreased to 28.462. There is no significant difference in muscle strength score between the intervention group and the control group.

Table 6. Overview the difference in the results of the independent t-test, analysis of mean test Paired Samples Test Results of Balance and Changes in Muscles Strength in Group Intervention and Control Group in Village of Rappokalling District of Tallo City Makasssar (n = 27)

		Intervension group	p	Eta Square	Control group	p
		Mean (SD)			Mean (SD)	
Observation BBS	Pre	36.29 (7.363)	0.003	0.51	40.23(8.983)	0.705
	Post	45.71(11.303)			39.85(9.547)	
	N	14			13	

Observation of muscle strength	**Pre**	**26.643(5.440)**			**29.31(9.326)**	
	Post	**32.179 (8.898)**	**0.000**	**0.63**	**28.54(10.738)**	**0.467**
	N	**14**			**13**	

Table 6 Statistical test results obtained independent sample t test showed that the mean balance before the intervention in the intervention group was lower than the control group (36.29 <40.23). But in the post mean balance in the intervention group increased to 45.71. The table also shows that after intervention obtained significant results where p = 0.003 <0.05 and the results of eta square obtained 0.51 (strong effect) so this means balance is getting better after exercise. This table also shows that after balance exercise, the muscle strength was increased and significantly affect with the value of p = 0.000.

Discussion

The results showed that prior to balance exercise, more than half of the respondents either the control group or the intervention had a risk of falling. It is clear that most of the elderlym is experiencing the aging process that leads to change of gait. Hadhisuyatmana, Anita and Goddes (2012) who studied to describe the prediction of falls in elderly using the Dynamic Gait Index stated that the incidence of falls are intimately associated with the aging process in which the incidence of falls occur about 25% of elderly aged 65 years and increased to 35% of the elderly aged over 75 years.

The results showed that all respondents are in the category of less muscle strength in both of intervention and control group(100%). It is clear that morphological change in the muscles cause functional changes, which has been decreasing strength, elasticity and flexibility, as well as decreased the speed of reaction time and relaxation, and decreased muscle functional performance. Decreased in function and muscle strength will result a decrease in the ability to maintain body balance, posture changes, and an increased risk of falling (Utomo, 2010).

Balance exercise was provided nine times over three weeks regularly to the respondents with risk of falling. The results showed that after providing balance exercise, the muscle strength score was significantly increased, although still in the category less muscle strength. In accordance with the theory put forward by Nyman (2017) that the balance exercise in elderly person, could improve the balance of the body via speed reaction to correct body posture during movement or muscle contraction.

The results of this research was supported by the theory of Hall & Guyton (2014) who explains when the muscle is being contracted, the contractile muscle protein synthesis takes place much faster than the devastation speed, resulting filaments actin and myosin that growing progressively in the myofibrils. Then myofibril itself will break down in each muscle fiber to form the new myofibrils. Increasing the number of additional myofibrils causes muscle fibers become hypertrophic. In muscle fiber hypertrophy is experiencing an increase in fosfagen metabolism system components, including ATP and phosphocreatine. This resulted an increase in the ability of aerobic and anaerobic metabolic system that can boost energy and muscle strength. Increased muscle strength is what makes the elderly more vigorous in supporting the body and movement. Theory of Sherwood (2015) stated that during low to moderate exercise, muscle cells were able to form enough ATP through oxidative phosphorylation to balance the energy needs in moderate level of contractile device for a long time period.

This study reinforced by Kusnanto, et al (2007) in his research that aimed to analyze the effects of balance exercises to increase postural stability in elderly concluded that the balance of exercise performed three times a week for three weeks can cause muscle contractions in the elderly which can lead to increased of muscle fiber (hypertrophy), hypertrophy of muscle fibers undergo fosfagen metabolism system components, including ATP and phosphocreatine that can improve muscle strength in the elderly. With the increased strength of these muscles, it can improve postural balance in the elderly.

In addition to improving muscle strength, the balance exercises also improve the balance evidence from the increase in the average

balance. According to Ulfiana, Dewi & Yusuf (2019), balance exercise can improve postural balance in the elderly through plantar flexion, knee flexion, hip flexion, hip extension and single leg side movements, which can stimulate the ability of the elderly to maintain postural balance. This is in accordance with the opinion stated by Kaesler et al. (2007) that the balance exercise is a series of movements designed to improve postural balance, both for the balance of static and dynamic balance. At the series of movement, there is processes in the brain, called the central compensation, the brain will attempt to adjust their signal changes as a result of a series of movements to adapt.

This study was in line with research conducted by Rahayu and Masitoh (2013) which aimed to observe the phenomenon of balance exercise providing in improving postural balance of older results showed that 5 respondents elderly women after a given balance exercise exhibit a phenomenon that its balance postural experienced an average increase in berg balance scale score as many as 32 before the intervention to 47.8 after the intervention. From research conducted by Salsabili et al. (2011) explained that training will compensates disordered balance by improving standing postural control in patients with type 2 diabetic neuropathy.

In the end of the results showed that the intervention group increased the balance and muscle strength, but in the control group showed that the group who did not follow the balance exercise has no increasing in balance and muscle strength. It means that in general the elderly who do not follow the practice have a higher risk of falling compared with them who follow exercise. The maintained balance will improve postural stability, so that the elderly doing the exercise will have more benefit than who did not (Stanley & Beare, 2007).

Additionally, Booth, Roberts & Laye (2012) states that physical activity or exercise is examined as primary prevention against balance disorders occurrence. This study are supported with research conducted by Nurhayati, Arwani, & Purnomo (2012) which aimed to analyze differences in elderly body balance based on exercise participation. They indicates that the balance of the body of the elderly have a higher score than the elderly. This study is supported by Lee (2013) who examines the effects of exercise to improve the strength of lower extremity and balance function in the elderly, found out that after training for 3 weeks, there is an increase of lower extremity' strength and the balance of elderly. Generally, it can be clearly stated that elderly people who followed the exercises could improve their body balance and muscle strength.

This is obvious that balance exercise that had been performed in this study could increase range of motion and prevent lose of muscle strength. Good range of motion and strong muscle cause elderly easy to move and keep their body balance when walking or doing activities then it could decrease risk of fall.

Conclusion

This study concluded that the balance of the elderly after exercise had been better After doing the exercise, more of elderly persons are at low risk of falling than before. This is in contrast to the elderly who do not perform the balance exercise, the scores were increased risk of falling in the elderly due to a growing number of elderly who are at medium risk of falling. Muscle strength in the older people who regularly exercise increased more than before, although still in the category of low muscle strength. This shows that the balance exercise effectively support the older people's balance and muscle strength. Therefore, it is recommended that the elderly to do balance exercise at least three times a week so that the body of the elderly is stable and not easily falling. Community health workers can also help the elderly to provide the balance exercise regularly in order to avoid the incidents of elderly falls. In addition, family could also support their elderly member in psychologically and socially by motivating, guiding and accompanying them in doing exercise.

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