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THE EFFECTIVENESS OF ADDING DYNAMIC STRETCHING EXERCISES TO BALANCE STRATEGY EXERCISES IN IMPROVING BALANCE IN THE ELDERLY

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ABSTRACT

Background: *As we get older, the ability to balance the body is decreased, which will cause health problems because the risk of falling increases.* ***Aims:*** *This study aims to determine the effectiveness of adding dynamic stretching exercise to the balance strategy exercise in improving balance in the elderly.* ***Participants and Methods:*** *This study was a randomized control trial with a total number of 24 elderly as subjects who were selected based on inclusion and exclusion criteria which were then divided into 2 groups. Group 1 was given dynamic stretching exercise and balance strategy exercise, and group 2 was given balance strategy exercise only. Exercise is done 3 times a week for 6 weeks.* ***Results:*** *Data analysis using the Paired Sample T-test showed that the results of $p<0.05$ indicated that there was a significant increase in the BBS score before and after exercise. The Independent T-test on the BBS score between group 1 and group 2 after exercise showed a $p<0.05$ which indicated that there was a significant difference in the post-test BBS scores between 2 groups.* ***Conclusion:*** *The addition of dynamic stretching exercise to balance strategy exercise is more effective in improving balance in the elderly compared to balance strategy exercise only.*

INTRODUCTION

According to the Ministry of Health of the Republic of Indonesia, the elderly is individual who has reached the age of 60 years and over (Statistik, 2020). The growing of elderly population is a global phenomenon that demonstrates the success of public health programs, medical advances, and economic and social development in tackling the diseases, injuries and premature deaths that limit the human life span. There were 703 million people aged 65 years or more worldwide in 2019. The number of elderly people is projected to double to 1.5 billion in 2050 (World Health Organization, 2019)

Indonesia is in the top five countries with the largest number of elderly people. Based on data from the Ministry of Health of the Republic of Indonesia in 2020 the number of elderly people in Indonesia has reached 28.8 million or 11.34% of the total population. Based on data and information from the (Statistik, 2020), there are six provinces that have older residents including Yogyakarta, Central Java, East Java, Bali, West Sumatra and North Sulawesi. North Sulawesi is in the top four with the largest elderly population in Indonesia, which is around 11.25% (Statistik, 2020). The number of elderly people in Bali is estimated at 441 thousand people (10.5%) in 2018 (Dinas Kesehatan Provinsi Bali, 2018), in 2018 the number of elderly people reached 12,580 people (1.38%) of the population in Denpasar City (Badan Pusat Statistik Kota Denpasar, 2018). West Denpasar District has the second largest population for those aged over 50 years, which is estimated to reach 35,270 people (13.33%) in 2018 (Disdukcapil, 2018).

As they get older, physiologically the elderly will experience a decrease in function in their body's organ systems, causing the elderly to be susceptible to health problems and increasingly they will experience a decline in their ability to carry out daily activities. One of the decreased functions of the body's organ systems is decreased function of the musculoskeletal system, namely changes in muscle structure, decreased bone density, decreased muscle strength, and decreased flexibility of muscles and joints (Yuharti, 2020). A decrease in type II fast twitch muscle fibers will inhibit the ability of the muscles to create fast and strong contractions in maintaining balance. These physiological changes will result in kinematic changes from the musculoskeletal system (Putri et al., 2020).

Muscle flexibility begins to decrease by 20% – 30% in the age range of 30 – 70 years. Decreased flexibility of the lower extremity muscles which limits the range of motion of the joints of the lower extremities will reduce the ability of the elderly to maintain body (Quijoux et al., 2020). A 50% decrease in trunk extensor flexibility will cause a shift of the center of mass (COM) to the posterior heel at the age of 70 years (Putri et al., 2020). Good flexibility will help provide ease of movement and wider ROM in joints, muscle elasticity, physical activity becomes more efficient, prevents injury, improves quality of life and functional independence. Decreased flexibility can cause problems such as difficulty walking, difficulty with activities, weakness and pain. An effective balance response can

occur if there is flexibility accompanied by sufficient mechanical structure. Reduced flexibility will cause effectiveness and efficiency in maintaining balance to decrease (La Greca et al., 2022).

Balance is an important component in carrying out daily activities, from simple activities such as standing up to more complex activities such as walking while talking or when changing direction. Balance is the body's ability to maintain the center of gravity or the center of mass of the body against a supporting base. The World Health Organization (WHO) states, in the elderly the rate of falls reaches 30-50% and the percentage of repeated falls is 40%, and will increase by 20% in 2050. The increase that will occur in 2050 will occur if balance problems are not addressed (World Health Organization, 2019). Integration between the vestibular reactions, nervous and visual systems is necessary in maintaining balance to process sensory information and send appropriate motor responses continuously. Dynamic balance is needed when carrying out daily activities. Dynamic balance plays a role in controlling posture and body position so that it remains in an upright position and will create good and directed movement coordination (Kisner & Colby, 2017)

As much as 50% there is a decrease in flexibility in the trunk extensors at the age of 70 years and over which results in a shift of the center of mass (COM) to the heel. In addition, ankle flexibility at the age of 55 and over decreases by 50% in women and 35% in men (Brandão et al., 2018). If elderly were unable to overcome the problem of decreased muscle strength and muscle flexibility, then the elderly can increase the risk of falling.

Approximately 28-35% of elderly aged 65 years and over experience falls each year, and this number increases to 32-42% in elderly aged 70 years and over (World Health Organization, 2019). In Indonesia, the prevalence of injuries due to falls in people over the age of 55 reaches 49.4% and those over 65 years reaches 67.1% (Kemenkes, 2017). Estimated medical costs related to treating cases of falls in the elderly are reported to be around 50 billion dollars or the equivalent of 734 trillion rupiah in the United States (Florence et al., 2018). Based on these data, an effort is needed to deal with balance problems in the elderly, namely by providing a balance training program that is practical, easy to implement and effective for the elderly to carry out in the long term.

Balance strategy exercise is a balance exercise whose movements are

simple, easy to understand and apply, useful in improving the balance ability of the elderly, safe and the movements are easy for the elderly to remember, so that it can be an effective balance exercise for the elderly to do in the long term. The form of balance strategy exercise is based on three main movement strategies, namely ankle strategy, hip strategy and stepping strategy to recover balance after getting disturbed/perturbated (Kisner & Colby, 2017).

Research that conducted by Hyun proves that ankle strategy exercise can increase limits of stability so as to increase stability of the ankle joint (Choi & An, 2015). This is supported by research from Hyoun which proves that ankle strategy exercise can increase the stability of the ankle joint in all directions of movement and plantarflexion and dorsiflexion muscle strength, so as to improve balance in the elderly (Sobhani et al., 2018).

Dynamic stretching is a type of stretching exercise that uses muscle contractions to stretch. In its implementation, dynamic stretching stretches the muscles by making rhythmic movements, slowly, smoothly, without stomping and is carried out in a controlled manner on the muscles that you want to stretch as wide as the range of motion of the joints that are trained and carried out repeatedly at a certain speed. In addition, during dynamic stretching there is no resistance in every stretching movement. Dynamic stretching is used to increase joint range of motion, activate muscles and improve muscle performance (Grieve et al., 2015).

Based on the research that conducted by Zhou et al., dynamic stretching can increase joint range of motion more effectively in hip flexion and extension compared to static stretching. This is because the rhythmic and repetitive movements and the gradual change in the angle of the range of motion of the joints during dynamic stretching contributes to an increase in the range of motion of the active joints and muscle performance (Zhou et al., 2019).

Based on the data above, a combination of stretching exercises and muscle strengthening is needed in the elderly to improve the balance of the elderly. Thus, the addition of dynamic stretching exercise to the balance strategy exercise is the right combination of exercises to increase the flexibility and muscle strength of the elderly, so as to maintain and improve the balance of the elderly.

METHODS AND MATERIALS

This research is experimental research with randomized pre and post-test group design. This research was conducted

in West Denpasar in March 2021. The target population in this study were all elderly people in Bali Province. While the affordable population in this study were all elderly aged 60-74 years in Banjar Munang Maning, West Denpasar.

Research subjects were selected through inclusion criteria: elderly aged 60-74 years, had a Berg Balance Scale (BBS) score between 21 and 40 means elderly with moderate risk of falling. The BBS score of 21 - 40 is determined on the grounds that at this score the elderly still have the ability to maintain their balance and to see an increase in balance that occurs in the elderly, and a normal BMI. Exclusion criteria: elderly with a history of neurovascular, neuromusculoskeletal, and cardiopulmonary disease, elderly having hearing loss and visual impairment through assessment, and elderly who are not willing to be research participants by filling out the informed consent.

We selected the participants following the inclusion and exclusion criteria and conducted a simple random sampling technique to select 24 participants. After getting a total of 24 subjects, then dividing the subjects into 2 groups using random allocation. At the time of the measurements, the physiotherapist who measured the balance of the participants did not know which group the participants were in (single-blind). Group 1 gets the addition of dynamic stretching exercise to the balance strategy exercise, while group 2 gets the balance strategy exercise.

The parametric statistical tests that was used in this study were the Paired Sample T-test to determine whether there was a significant difference in the Berg Balance Scale (BBS) mean pre-test score and BBS mean post-test score in each group and the Independent T-test to determine whether there was a significant difference in the BBS mean post-test score between the two groups.

Balance strategy exercise is carried out in 3 movements, namely ankle strategy exercise, hip strategy exercise and stepping strategy exercise with a total duration of about 45 minutes.

The ankle strategy exercise is carried out through 4 movements, namely: forward head movement and following by the body movements, head movement to the back and body movements accompanying the backward shift in the middle of the mass, head movements to the right side and body accompanying the sideways shift in the middle of the mass. the middle of the body mass, as well as the movement of the head to the left side and the body accompanies the sideways shift in the middle of the body mass. Each of these movements is done as much as 3 sets. Each set is repeated 10 times where 1 movement

is held for 10 seconds, then returns to its original position and rests for 5 seconds. In each set, rest for 30 seconds, as shown in the picture.

Figure 1. Angkle Strategy Exercise

The Hip Strategy Exercise is carried out through two movements, namely: hip flexion in a standing position and hip extension in a standing position. Each of these movements is done as much as 3 sets. Each set is repeated 10 times where 1 movement is held for 10 seconds, then returns to its original position and rests for 5 seconds. In each set, rest for 30 seconds, as shown in the picture.

Figure 2. Hip Strategy Exercise

Stepping strategy exercise is carried out with two gait styles, namely the normal gait and the gait with crossed legs. Stepping strategy exercise is carried out for 3 minutes in each gait with rest as needed, as shown in the figure.

Figure 3. Stepping Strategy

Dynamic stretching exercise is performed on the ankle and hip, where 2 movements are performed on the ankle, namely dorsi-flexion and plantarflexion of the ankle, while on the hip, 3 stretching movements are performed, namely stretching on the hip extensor and hamstring, and stretching on the hip flexor.

Dynamic stretching exercises are carried out in 5 sets of each movement and region, wherein 1 set consists of 20 repetitions and is interspersed with 10 seconds of rest in each set. The following details the implementation of dynamic stretching exercise.

Dynamic stretching dorsiflexor and ankle plantarflexor. The elderly in a supine sleeping position then perform stretching movements by contracting the ankle dorsiflexor and plantarflexor muscles alternately to stretch the ankle dorsiflexor and plantarflexor muscles. The elderly move the ankle in the direction of dorsiflexion and plantarflexion until it reaches the maximum joint range of

motion, then immediately returns to its original position without resistance. Do it alternately on the right and left legs and repeat the stretching movement according to the predetermined dose of exercise.

Figure 4. Dynamic Stretching Dorsiflexor And Plantarflexor

Dynamic stretching hip extensors and hamstrings. The elderly in a supine sleeping position then do stretching movements by contracting the hip flexor, knee extensor and ankle dorsiflexion muscles to stretch the hip extensor and hamstring muscles. The elderly move their legs up until they reach the maximum joint range of motion, then immediately return to their original position without resistance. Do it alternately on the right and left legs and repeat the stretching movement according to the predetermined dose of exercise.

Figure 5. Dynamic Stretching Hip Extensors And Hamstrings

Dynamic stretching hip flexors. The elderly are in a prone sleeping position, then do stretching movements by contracting the hip extensor, knee flexor and ankle dorsiflexor muscles to stretch the hip flexor muscles. Elderly move the leg in the direction of hip hyperextension until it reaches maximum joint range of motion, then immediately return to its original position. Do it alternately on the right and left legs and repeat the stretching movement according to the predetermined dose of exercise.

Figure 6. Dynamic Stretching Hip Flexors

The duration of the dynamic stretching exercise is five sets in each movement, where one session of the movement consists of 20 repetitions and is interrupted with rest for 10 seconds in each set. All exercises begin with a 5-minute warm-up and a 5-minute cool-down. Exercise is done 3 times a week for 6 weeks.

Examination of balance in the elderly is carried out using the Balance Berg Scale (BBS) which has 14 measurement items. Balance measurements were carried out before and after 6 weeks of exercise using the BBS using 14 measurement items with a score of 0–4 for each item. A score of 0 was given if the patient was unable to perform the assigned task, and a value of 4 was given if the patient could complete the task

according to the criteria, which is given. The maximum value for this measurement is 56. For the score 0 – 20 means high fall risk, for the score 21 – 40 means medium fall risk, and for the score 41 – 56 means low fall risk. The test is relatively easy to perform and only requires a stopwatch, a ruler, two chairs, and a small stool (for stepping).

BMI measurement is carried out using a special BMI calculation formula for the elderly. All examinations were carried out before being given training and 6 weeks after being given training.

The parametric statistical tests that was used in this study were the Paired Sample T-test to determine whether there was a significant difference in the Berg Balance Scale (BBS) mean pre-test score and bbs mean post-test score in each group and the Independent T-test to determine whether there was a significant difference in the bbs mean post-test score between the two groups.

Examination data that has been collected, then analyzed using statistical analysis using SPSS version 16.0.

RESULTS AND DISCUSSION

Table 1 shows the characteristics of the subjects in this study, totaling 24 elderly people. Subjects in this study were dominated by women. All subjects in this study had no history of lung, heart and blood vessel disease. All subjects have BMI in the normal category.

The BBS pre-test score data in this study were normally distributed and homogeneous (Table 2), so the hypothesis test that used was a parametric statistical test.

Table 1. Characteristics of the subjects

Characteristic	Group 1	Group 2
Gender (n)		
Male	3	4
Female	9	8
Age (years), mean±SD	65.17±4.821	67.58±3.528
BMI (kg/m^2), mean±SD	22.28±2.043	23.44±1.021
BBS pretest (mean±SD)	34.17±1.586	33.08±1.782

Table 2. The Distribution of Normality and Homogeneity Data

The Data Group	The Distribution of Normality Data with the Shapiro Wilk Test				The Distribution of Homogeneity Data with Levene's Test
	Group 1		Group 2		
	Mean± SD	p value	Mean± SD	p value	
BBS Score Before Exercise	34.17± 1.586	0.100	33.08± 1.782	0.635	0.130

The Paired Sample T-test in the Table 3 for each group obtained a p<0.005 which indicated that there was a significant difference in the BBS mean pre-test and post-test in each group.

Table 3. Paired Sample T-test

Group	The average of BBS pre-test score (Mean±SD)	Mean average of BBS post-test score (Mean±SD)	p value
Group 1	34.17±1.586	37.92±1.379	0.000
Group 2	33.08±1.782	34.67±1.923	0.000

Furthermore, in the Table 4 shows a p value <0.005 which indicates that there

is a significant difference in the post-test mean between the two groups.

Table 4. Independent T-test

	Group	Mean±SD	p value
Post Test	Group 1	37.92±1.379	0.000
	Group 2	34.67±1.923	

Table 5 shows that group 1 experienced an increase in balance of 10.9% and group 2 experienced an increase in balance of 4.8%. Based on the calculation of the percentage, it can be concluded that the type of exercise in group 1 is more effective in improving the body balance for the elderly compared to group 2.

Table 5. The percentage of improved balance in the elderly after exercise

Analysis Results	Group 1	Group 2
BBS Score Before Exercise	34.17	33.08
BBS Score After Exercise	37.92	34.67
Difference	3.75	1.59
Percentage (%)	10.9%	4.8%

The decreased of balance in the elderly occur as a result of a degenerative process which causes a decrease in physiological function which is characterized by disturbances in sensory input and processing, sensory motor integration and the motor system which causes a decrease in the stability and balance of the elderly body (Kisner & Colby, 2017). Balance control can be achieved optimally when the optimal components of muscle strength and muscle flexibility and the speed of the right reaction time are fulfilled (Sari, 2016). The components that support this balance decrease with age in the elderly. Thus, a combination of balance exercises that have benefits in increasing muscle strength and muscle flexibility is urgently needed to improve balance in the elderly.

The addition of dynamic stretching exercise to the balance strategy exercise has been proven to improve the balance of the elderly. This is evidenced by the results of this study. The results of the study showed that there was a significant difference in the increase in balance, where group 1 had a greater percentage of increase in balance compared to group 2. The increase in balance produced in group 1 was caused by a combination of dynamic stretching exercises with balanced strategy exercises.

Dynamic stretching exercise is a stretching exercise that is carried out independently, in which the movements are carried out rhythmically, slowly and smoothly without stomping, and controlled and repeated without any restraint. There are 3 types of dynamic stretching exercise movements in this study, namely dynamic stretching on the dorsi flexors and plantar flexors of the ankles, hip extensors and hamstrings, and hip flexors. Dynamic stretching exercise training is carried out in a supine and prone position, so that the implementation of stretching is maximized

and prevents the risk of falling that occurs during exercise.

Rhythmic and repetitive muscle activation and contractions performed in dynamic stretching exercises will increase muscle temperature which in turn will increase the rate of impulse transmission, increase force speed and reduce muscle tension (Grieve et al., 2015). In addition, there is also a neuromuscular phenomenon arising from dynamic stretching which is a contributing factor to increased muscle strength, namely post-activation potentiation (PAP) (Pamboris, 2018).

PAP is a phenomenon in which the force exerted by the muscles increases due to the previous contraction. This mechanism is a theory which states that the history of muscle contraction affects the mechanical performance of subsequent muscle contractions (Blazevich & Babault, 2019). The main mechanism of PAP is an increase in myosin light chain phosphorylation which allows the interaction between actin and myosin to become more sensitive to Ca^{2+} released from the sarcoplasmic reticulum which leads to an increase in the rate of cross-bridge formation in actin - myosin during muscle contraction. Increased Ca^{2+} sensitivity has the effect of increasing muscle performance. In doing so, it triggers events that lead to increased muscle strength. The greater the muscle activation, the longer the availability of Ca^{2+} ions in the muscle cell environment, and the greater the myosin light chain phosphorylation (Pamboris, 2018).

The next mechanism that occurs during dynamic stretching exercise is the magnitude of the myotatic reflex which is related to the speed of stretching. Increasing the amplitude of the Hoffmann reflex (H-reflex) by increasing the speed of stretching as in dynamic stretching exercise causes an increase in the recruitment of motor units. This causes a greater increase in muscle strength (Pamboris, 2018). The role of muscle strength is the driving force of any physical activity. Muscle strength must be strong to maintain body balance when there is an external force. The muscle strength is directly related to the ability of the muscles to resist the force of gravity and other external loads that continuously affect body position. Based on the results of the study it was concluded that there was a significant relationship between leg muscle strength and balance (Budiwibowo & Setiowati, 2015).

This is in accordance with research conducted by (Lee et al., 2020) who examined the effect of giving dynamic stretching exercise on hamstring muscle activation and strength with a value of p = 0.018 and quadriceps muscle strength with an acquisition value of p = 0.000, so that dynamic stretching exercise is effective in

increase muscle strength and muscle activation.

The combination of dynamic stretching exercise and balance strategy exercise will increase the flexibility and strength of the lower extremity muscles, increase joint stability, increase limits of stability and the automatic postural response of the body. Therefore, this combination of exercises is appropriate for the elderly to improve balance, especially the elderly with decreased muscle strength and flexibility. Thus, giving a combination of dynamic stretching exercise and balance strategy exercise is effective in improving balance in the elderly.

CONCLUSION AND SUGGESTIONS

The results of this study indicate that the addition of dynamic stretching exercise to the balance strategy exercise is effective in improving balance in the elderly. The addition of dynamic stretching exercise and balance strategy exercise can increase the flexibility and strength of the lower extremity muscles, as well as other components of balance so as to improve balance in the elderly. In this study did not examine the physical activity of the elderly. Suggestions for future researchers to examine the physical activity of the elderly to determine the level of physical activity of the elderly.

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