

The Effect of Balance Strategy Exercise and Tandem Walking Exercise on Dynamic Balance in the Elderly

Cindy Kartika Arimbi¹, Arif Pristianto^{2*}

^{1,2}Prodi Fisioterapi, Fakultas Ilmu Kesehatan, Universitas Muhammadiyah Surakarta

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ABSTRACT

Introduction: Elderly is an age group that has entered the final stage of its life. This elderly group will experience an aging process. Aging is the final stage in human development. The elderly experience a degenerative phase which is marked by a decrease in psychological, anatomical and balance abilities. Dynamic balance disorder is a major risk factor for falls in the elderly. To overcome this, it is important to carry out a series of exercise programs to improve body balance. The exercise programs to choose from are Balance Strategy Exercise and Tandem Walking Exercise. This study aims to find out the effect Balance Strategy Exercise and Tandem Walking Exercise on dynamic balance in the elderly. **Method:** the method used in this research is Quasi Experimental with a Two Group Pretest-Posttest Design. The dynamic balance measurement used is Time Up and Go Test. **Results:** test the effect of using the test Paired Sample T-Test on groups BSE shows that the significance value (2-tailed) 0,000 p-value <0.05 until Ha is accepted. Test Wilcoxon on groups TWE showed that the significance value(2-tailed) 0,003 p-value <0.05 until Ha is accepted. **Conclusion:** there is influence Balance Strategy Exercise and Tandem Walking Exercise on dynamic balance in the elderly.

Corresponding Authors: (*)

Prodi Fisioterapi, Fakultas Ilmu Kesehatan, Universitas Muhammadiyah Surakarta, Surakarta, Jl. A. Yani Tromol Pos I, Pabelan Kartasura, Sukoharjo 57169, Indonesia

Email: arif.pristianto@ums.ac.id

INTRODUCTION

Developments and progress in various fields, especially in technology, economics and health, have led to the development of people's lifespans. Indonesia's elderly population is estimated to reach 30.1 million in 2021 (Suadnyana *et al.*, 2015). Judging from its population structure, Indonesia is currently in a transition phase towards an aging population structure. This is reflected in the proportion of the elderly population reaching 9.6% or around 25 million people (BPS, 2019). Common problems in the elderly are characterized by a decline in anatomy, physiology, psychological abilities and balance (Widodo, 2018).

Balance is the body's ability to maintain a balanced position while maintaining a stable body position (Kibele *et al.*, 2015). Stable position where the body position is controlled when static or dynamic (Kisner *et al.*, 2017). Body balance is an important aspect in daily life to support human activities.

Balance disorders are a common health problem in the elderly. Decreased balance in the elderly occurs due to decreased muscle strength, especially in the lower extremities,

joint stiffness or pain, and slow sensory and motor responses (Komalasari *et al.*, 2023). Body balance is regulated through a very complex sensorimotor control. This system includes sensory input through vision, proprioception and the vestibular system (movement, balance) (Watson *et al.*, 2016). According to WHO, 22% of the elderly population in Italy aged 65 years and over suffered from balance disorders in 2015 and this figure is expected to increase by 33% by 2065 (Covotta *et al.*, 2018).

The increased risk of falls due to balance disorders in the elderly is closely related to dynamic balance, because dynamic balance is the most important component of movement and the basis of daily activities (Suadnyana *et al.*, 2015). The risk of injury due to loss of balance increases significantly, especially with challenging tasks, such as walking on uneven walkways or slippery surfaces, as well as walking and passing through doorways or other thresholds (Susilo *et al.*, 2022).

Problems related to dynamic balance include several factors such as decreased muscle strength, changes in muscle structure, poor postural stability, cognitive and sensory impairment, and weak movement reaction speed. To overcome this, it is important to carry out a series of exercise programs to improve body balance. From several studies, the exercise programs that can be selected are the Balance Strategy Exercise and Tandem Walking Exercise programs.

According to Choi & Kim (2015), BSE can maintain a better anatomical position because this exercise which is centered on the ankle strategy will control movement and activate postural muscles optimally from distal to proximal. Thus, it can provide balance and strength to increase activity. The ability of leg muscles and core muscles is an important factor in keeping the body stable and balanced (Melani *et al.*, 2021).

Tandem Walking Exercise is intended for postural training, muscle coordination, balance control and body movement. Tandem walking exercise is one of the exercises to improve proprioception which plays a role in delivering information to the information system (including visual, vestibular and somatosensory) about the accuracy of movement and balance that develops a sense of joint movement and activates motor skills in the central nervous system to form dynamic joint stabilization (Riyanto & Wahyuni, 2019).

Research conducted by Ramadhani & Arivia (2021) concluded that Ankle Strategy Exercise has an effect on static balance in the elderly and according to research findings Valentin *et al.* (2016) This study concluded that Tandem Walking Exercise is more influential than One Legged Stance in improving dynamic balance in the elderly.

There are many forms of measurement to assess the balance of the elderly, one of the instruments to measure the balance of the elderly is TUG (Time Up and Go Test) and researchers have conducted preliminary studies in several Posyandu and elderly homes. This study was conducted at Posyandu Sejahtera Abadi IX and the elderly home Aisyiyah Surakarta because there has never been research on balance in these places and the elderly there are very enthusiastic about their fitness and health.

With the background of the problems above, the researcher is interested in studying, understanding and proving whether the form of static exercise, namely Balance Strategy Exercise, also has an effect on dynamic balance and how the results compare with Tandem Walking Exercise on dynamic balance in the elderly.

LITERATURE REVIEW

Dynamic Balance

Balance is defined as the body's ability to maintain the center of mass of the body by being able to maintain position without changing from the base of support. Standing balance is defined as the ability to stand without assistance (Muladi *et al.*, 2022).

There are two types of balance, namely static and dynamic balance. Dynamic balance is the body's ability to maintain body balance while moving, such as when walking and running. Balance control is also the basis of a person's ability to move and function independently. However, balance control declines with age, and balance disorders, especially dynamic balance disorders, are a major risk factor for falls among older adults.

Falls can result in serious injuries, such as fractures, causing prolonged pain, lower quality of life, disability, and even death (Halvarsson *et al.*, 2015).

Balance measurement using the Time Up and Go Test (TUGT). The Time Up and Go Test acts as a tool to measure the ability to maintain balance in moving or dynamic conditions. The Time Up and Go Test has met the criteria as a good balance measurement tool because the TUGT is valid, reliable and efficient (Nurmalasari *et al.*, 2018). The use of TUGT in dynamic balance measurement also measures the respondent's locomotive ability (gait ability) and the ability to change position from sitting to standing (Rofi'atin & Perdana, 2020).

Balance Strategy Exercise

The movements that occur in this exercise can activate postural muscles to function optimally. Postural muscles have a better effect on body balance when functioning optimally. With BSE training, you can maintain a better posture because it is in line with the anatomical position. In the ankle strategy, controlling the movement whose movement is centered on the ankle can activate postural muscles optimally from distal to proximal and mobility in the extremities can be effective and then provide balance and local strength to increase activity (Choi & Kim, 2015).

Tandem Walking Exercise

In Tandem Walking Exercise, which is an exercise that involves proprioceptive with slow movements in every position and movement change. In Tandem Walking Exercise, this walking movement is done slowly to increase proprioceptive response, sensory input is then processed in the brain as a central processor that forms good postural control, activates the sensorimotor response needed by the body and the brain will forward the impulse to the effector so that the body can form a good posture and stability when moving (Suadnyana *et al.*, 2015).

METHOD

In conducting the research, the researcher used an experimental research design that used a quasi-experimental approach. With a two-group pretest-posttest design, namely comparing two groups, in the first group given Balance Strategy Exercise and then in the second group given Tandem Walking Exercise treatment. Examination of dynamic balance in the elderly with the Time Up and Go Test measuring instrument.

The study was conducted from November 2022 to December 2022 at the Posyandu Lansia Sejahtera Abadi IX and the Aisyiyah Surakarta elderly home for 4 weeks with a frequency of 5 times a week of training. With the research population of all elderly people at the Posyandu Lansia Sejahtera Abadi IX and the Aisyiyah Surakarta elderly home.

The sampling technique uses purposive sampling by selecting samples that prioritize certain criteria and objectives. The selected sample is adjusted based on the sample aspects determined by the inclusion and exclusion criteria. The inclusion criteria are: (1) Respondents aged 65-75 years (2) Have a TUG score above 10 seconds (3) Respondents are willing to follow a series of studies and are able to follow the series of studies until the end (4) Respondents are not currently following an exercise program that improves balance. Exclusion criteria: (1) Respondents have physical disabilities (2) Respondents have pathological walking disorders such as: vertigo, stroke, Parkinson's and others. The drop out criteria are elderly respondents who are unable to follow the study until completion. This research was conducted based on Ethical Clearance issued by Hospital TK.II 04.05.01 dr. Soedjono Magelang numbered 090/EC//XII/2022.

RESULT AND DISCUSSION

Based on the Table 1, in the BSE group, the results showed that the age of 65 years was 3 people, 66 years were 2 people, 69 years were 2 people, 70 years were 2 people and the last 71 years was only 1 person. While in the TWE group, the results showed that the age of 65 years was 2 people, 66 years were 2 people, 67 years were 1 person, 70 years were 2 people, 71 and 74 years were only 1 person, and the last age of 75 years was 2

people. So, the number of BSE respondents was 10 people and TWE respondents were 11 people.

Table 1. Distribution of Sample Data Based on Age

Age (Years)	Group I (Balance Strategy Exercise)		Group II (Tandem Walking Exercise)	
	n	Percentage (%)	n	Percentage (%)
Middle Age (45-59)	0	0	0	0
Elderly (60-74)	10	100	9	82
Old Age (75-90)	0	0	2	18
Very Old Age (>90)	0	0	0	0

Table 2 shows that in the first group, there were 3 male respondents (30%) and 7 female respondents (70%). In the second group, all 11 respondents were female (100%).

Table 2. Distribution of Sample Data Based on Gender

Gender	Group I (Balance Strategy Exercise)		Group II (Tandem Walking Exercise)	
	n	Percentage (%)	n	Percentage (%)
Male	3	30	0	0
Female	7	70	11	100

In Picture 1, it shows that there is an increase in dynamic balance by looking at the TUG score. In both groups, from the first examination (pre-test) in week 1 to the last examination (post-test) there was an acceleration in the travel time in doing the TUG test. In the first group experiencing an increase in balance, the average TUG pre-test results in week 1 was 18.357 seconds. Then, in the last week, namely week 5 (post-test), the TUG results were obtained with an average of 15.839 seconds. In the second group, there was also an increase in balance, the average TUG pre-test results in week 1 was 21.535 seconds. Then, in the last week, week 5 (post-test), the TUG result was obtained with an average of 17.89 seconds.

The Shapiro Wilk test is used to determine the results of the data normality test for the first and second groups. The pre and post results are normally distributed in the first group because ($p\text{-value} > 0.05$). Then for the pre-post results, the distribution is not normal in the second group because ($p\text{-value} < 0.05$) (Table 3).

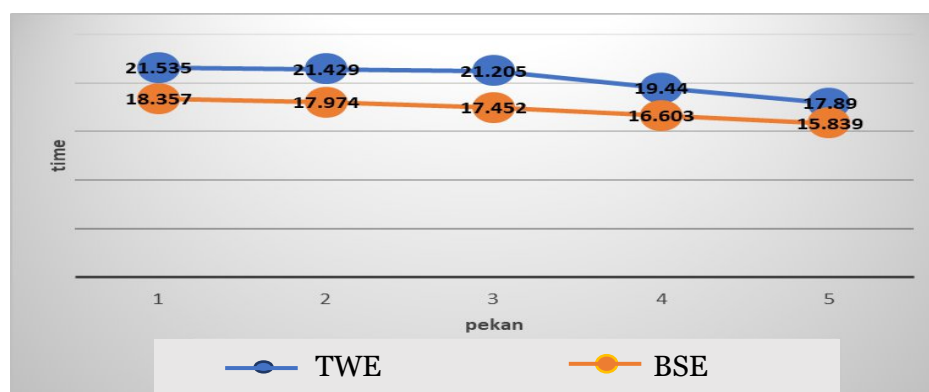


Table 3. Data Normality Test Results

	Treatment I (Balance Strategy Exercise)	Treatment II (Tandem Walking Exercise)
Pre Test	0.122	0.001
Post Test	0.168	0.002

Based on Table 4, with normally distributed data, the paired sample t-test is used for statistical testing and the results obtained ($p\text{-value} < 0.05$) so that H_a is accepted. Thus, it can be concluded that Balance Strategy Exercise has an effect on the dynamic balance of the elderly.

Table 4. Results of the Paired Sample T-Test on BSE

Group	n	Mean		Sig. (2-tailed)	Conclusion
		Pre	Post		
Balance Strategy Exercise	10	18.3570	15.8390	0.001	Influential

Based on Table 5, with data that is not normally distributed, the Wilcoxon test is used for statistical testing and the results obtained ($p\text{-value} < 0.05$) so that H_a is accepted. Thus, it can be concluded that Tandem Walking Exercise has an effect on the dynamic balance of the elderly.

Table 5. Wilcoxon Test Results on TWE

Group	n	Z	Sig. (2-tailed)	Conclusion
Tandem Walking Exercise	11	-2.934	0.003	Influential

The normality test for the difference data between Balance Strategy Exercise and Tandem Walking Exercise is normal, so the independent t-test is used for statistical testing and the results obtained ($p\text{-value} > 0.05$) (Table 6).

Table 6. Normality test of BSE and TWE difference data

	df	Shapiro Wilk Test Sig. (2-tailed)
TUG	10	0.300

Based on Table 7, the results show that ($p\text{-value} < 0.05$) so that there is a difference in the influence between BSE and TWE on dynamic balance in the elderly. The results showed that the mean BSE value was lower than the average TWE value with the measurement used, namely TUG, the greater the value, the worse the balance. It can be concluded that the average dynamic balance value shows that BSE has a more significant effect than TWE on dynamic balance in the elderly.

Table 7. Results of the Independent T-Test

	Group	Mean	Sig. (2-tailed)	Conclusion
TUG	BSE	17.2450	0.007	Influential
	TWE	20.2998		

It can be seen that the age of respondents in both groups is 65-75 years old (Table 1). Good balance is a requirement to prevent the risk of falling. As the elderly age, they experience a degeneration process, namely a decrease in the ability to carry out activities in daily life so that their flexibility decreases. This can increase the risk of falling. As we age, our body balance will decrease and we can experience repeated falls. Falls are a direct result of imbalance. Balance in the elderly is influenced by several factors such as decreased proprioception, balance system, slow postural reflexes and decreased muscle strength which is very important for maintaining and preserving body posture, resulting in poor balance (Munawwarah & Nindya, 2015).

Both groups are almost entirely female. In body balance, there is a difference between male and female elderly. This difference can be caused by different anthropometric factors. Thus, female elderly have a greater risk of falling which is caused by decreased estrogen hormone in postmenopausal elderly which can cause and risk osteoporosis (Lupa *et al.*, 2017). The decrease in estrogen hormone can also cause bones to lose calcium and decrease the effectiveness of metabolism so that fear occurs more often in elderly women than in men. In elderly women, there is a greater disturbance of balance because at the age of 45 to 50 years women experience menopause (Senolinggi *et al.*, 2015). Menopause is the cessation of menstrual cycles experienced by all women and is inevitable as women age. This can cause physical changes in women (Silalahi, 2016).

The measuring instrument in this study used TUG, which is a measuring instrument used to measure balance in the elderly. In the study conducted by Utomo & Takarini (2009), Dynamic Gait Index (DGI) as a standard balance measuring tool for the elderly which is a reference for developing other measuring tools such as the Time Up and Go Test. The results of TUGT are valid because the results of TUGT measurements are related to the results of DGI measurements ($p < 0.05$) and the relationship between TUGT and DGI is strong ($r = -0.754$). These results can be concluded that TUGT can be used as a balance measurement tool in the elderly. The results of TUG measurements with this research graph show that there is an increase in dynamic balance in the elderly. In the first group and the second group.

The result showed that the TUG value of the first group (Balance Strategy Exercise) began to show a significant change in the average value from week 3, namely 17.452 seconds to 16.603 seconds in week 4, which shows a decrease in travel time until the last week, namely in week 5, the average became 15.839 seconds. Then, in the second group (Tandem Walking Exercise), a significant change in the average value was also obtained, starting from week 3, namely 21.205 seconds to 19.44 seconds in week 4, which shows a decrease in travel time until the last week, namely in week 5, the average became 17.89 seconds.

In both groups, there was a change or decrease in the TUG value in the balance. A significant increase can be seen in the 4th to 5th week of the BSE group and the TWE group. This is because the program is progressive. So, the exercises can be done at different levels (basic, intermediate, and advanced), making it increasingly challenging for each individual throughout the program. Each individual's development can improve their skills, which means that the intensity, difficulty, or complexity of the exercises will need to be increased as the body adapts to the exercise over time (Halvarsson *et al.*, 2015).

Balance training is included in low-level training (low intensity) this level of training can be done as often as possible because of the low risk of lactic acid accumulation, soft tissue injury, or other conditions that require a long recovery phase. Balance training that is done regularly and consistently every day can increase leg muscle strength and can improve balance (Farlie *et al.*, 2015). Training that is done 5 days per week for 4 weeks is the optimal frequency and postural balance in the elderly increases (Keeratithaworn *et al.*, 2015).

The Effect of Balance Strategy Exercise on Dynamic Balance in the Elderly

The first group test with BSE training has been statistically tested using the paired sample t-test and the results obtained $p = 0.000$ ($p < 0.05$) so that H_a is accepted. Thus, it can be concluded that Balance Strategy Exercise has an effect on dynamic balance in the elderly. In BSE training, it is effective in increasing muscle strength and ankle flexibility, because the movements in this exercise strengthen postural control. So that postural balance and body mobility can be improved (Riyanto & Wahyuni, 2019).

Based on the data on the characteristics of respondents in the first group with BSE training, it can be seen that the elderly experience balance disorders with an average age of respondents being 65 to 70 years. This can be proven by an assessment using TUG which shows that there are balance disorders in the elderly. The average TUG pre-post value in

week 1 is 18.357. The interpretation of this value shows that respondents in treatment group I have a risk of falling so that there are disorders in their balance.

In the first treatment group, it was seen that almost all were women as many as 7 people and men 3 people. Female respondents had worse balance scores than men. There is a significant difference in balance between elderly men and women because women generally tend to experience a faster decline in the musculoskeletal system. In addition to the decline in female hormonal function, men are also at risk of experiencing skeletal decline as they age. However, the decline in male hormone levels is not as fast as in women because women experience menopause. Men are not as fast as in women because women experience menopause. This happens because male hormones tend to experience a skeletal decline of around 10-15%, while in women the skeletal decline is around 25-30% (Lupa *et al.*, 2017).

Balance Strategy Exercise consists of 2 movements involving the ankle and hip that provide the effect of neural adaptation. In ankle strategy training, the plantar muscles and dorsiflexors are activated which are used to move the body's center of mass. Hip strategy activates the hip flexor muscles and trunk muscles (Sibley *et al.*, 2015).

The movements that occur in this exercise can activate postural muscles to function optimally. Postural muscles have a better effect on body balance when functioning optimally. With BSE training, you can maintain a better posture because it is in line with the anatomical position. In the ankle strategy, controlling the movement whose movement is centered on the ankle can activate postural muscles optimally from distal to proximal and mobility in the extremities can be effective and then provide balance and local strength to increase activity (Choi & Kim, 2015).

Research on BSE has also been conducted by Nugraha *et al.* (2016) that the dose used when doing the exercise was 3 sets with each set of 10 repetitions per movement, which can increase balance. According to Kisner *et al.* (2013) in Nugraha *et al.* (2016) Exercises with 10-15 repetitions will train the elderly's endurance because they will affect the elderly's balance.

This BSE movement is useful for improving balance and muscle strength, especially in the elderly, with each exercise done in 2-3 sets and each 1 set of exercises is done 10 times. It is done as many as 2 sets in the first and second weeks, then 3 sets in the third week to the fourth week (Choi & Kim, 2015).

The Effect of Tandem Walking Exercise on Dynamic Balance in the Elderly

Testing on the second group with TWE training has been statistically tested using the Wilcoxon test and the results obtained $p = 0.003$ ($p < 0.05$) so that H_a is accepted. Thus, it can be concluded that Tandem Walking Exercise has an effect on dynamic balance in the elderly.

Based on the data on the characteristics of respondents in the second group who were given Tandem Walking Exercise, it can be seen that all respondents in the Tandem Walking Exercise group were female. Respondents 1 and 2 had the highest balance disorders with an age of 75 years. This can be proven by the pre-assessment using TUG showing balance disorders in respondents 1 and 2. Interpretation shows that these respondents have a high risk of falling so that there are disorders in their balance.

As a person gets older, they have a higher risk of developing health problems, for example due to cell regeneration and aging factors, so they can experience physical, cognitive, spiritual and psychological changes (Utami & Syah, 2022). Balance training such as some types of exercises, such as gait, balance, coordination are quite effective in improving balance in the elderly. Exercises that focus on standing and walking can be prioritized over sitting exercises to make the program more specific to balance performance during walking and standing, so that it better reflects the balance tasks in everyday life (Halvarsson *et al.*, 2015).

In Tandem Walking Exercise, which is an exercise that involves proprioceptive with slow movements in every position and movement change. In Tandem Walking Exercise,

this walking movement is done slowly to increase proprioceptive response, sensory input is then processed in the brain as a central processor that forms good postural control, activates the sensorimotor response needed by the body and the brain will forward the impulse to the effector so that the body can form a good posture and stability when moving (Suadnyana *et al.*, 2015).

In research Keeratithaworn *et al.* (2015), TWE can improve postural balance and this tandem walking exercise is a balance improvement exercise by walking, the heel touching the other toe in a straight line with a distance of 3 to 6 meters without footwear, done 1 set as far as 3 meters in the first week, 4 meters in the second week, 5 meters in the third week, and continued with 6 meters in the fourth week.

Differences in the Effects of Balance Strategy Exercise and Tandem Walking Exercise on Dynamic Balance in the Elderly

In BSE and TWE have similarities in improving dynamic balance in the elderly, namely improving balance by improving balance control components that deteriorate with age in the elderly. Balance Strategy Exercise turns out to be useful and has advantages in improving dynamic balance. Thus, BSE is more influential than TWE.

Tandem Walking Exercise is a form of exercise that aims to control balance, body movement and muscle coordination. This exercise can also improve proprioception which plays a role in informing precision of movement. The purpose of proprioceptive training in Tandem Walking Exercise is to develop a sense of joint movement (Riyanto & Wahyuni, 2019).

However, in Balance Strategy Exercise, it can support the limit of stability and support the body to move the body's center of gravity and control balance without changing the point of support, but body stability can change the center of gravity as far as possible in the anteroposterior and mediolateral directions (Sibley *et al.*, 2015).

Poor balance and decreased muscle strength will cause decreased gait speed when walking in the elderly. If the gait speed slows down, it will cause mobility in daily activities to be limited. According to research Choi & Kim (2015) that Balance Strategy Exercise can increase stride length and stride speed in the elderly. The movements in this ankle strategy are centered on the ankle which helps activate the muscles of the lower extremities to the muscles of the trunk so that the performance of the postural muscles is activated well and can create the ability to maintain posture and body balance to be better.

Ankle strategy and hip strategy focus on controlling the movement of the ankle and then the foot that maintains the center of gravity on the body. Muscle activity will proceed from distal to proximal gradually. When rocking forward, this exercise activates the trunk extensor muscles, hamstrings and gastrocnemius in response to rocking backward, then the tibialis anterior, quadriceps and abdominal muscles will be activated to support the body so that it will experience body stability when performing anteroposterior and mediolateral position movements (Pristianto *et al.*, 2018).

Dynamic balance increases with the given exercise is an exercise that is actually static, namely Balance Strategy Exercise. Making this one of the findings that static exercise can also improve dynamic balance. Because, dynamic balance is basically from good static balance. With poor static balance, dynamic balance is also bad. In the process of walking, in the Time Up and Go Test there is also a static phase and not just dynamic in the process of moving places. Because, when the foot steps or when getting up from sitting which is static, it will require activation of certain muscles.

In providing static exercises, it can also increase postural adjustments. Increasing the ability of anticipatory postural adjustments, the body will regulate optimal postural muscle contractions in the process of maintaining balance. Anticipatory postural adjustments are the ability to control body position to remain balanced when the body experiences changes in balance in making a movement. This ability is also a preparation for body stabilization when doing functional movements. With the form of static exercise, the ability of Anticipatory postural adjustments on the trunk side of the body is used as a

support. This will strengthen the postural muscles that will be used in maintaining dynamic balance (Widayanto *et al.*, 2017).

Balance is essential in everyday life, in both static and dynamic balance. When you want to start moving, whether it is walking, jogging, jumping or throwing, the demands placed on the body are greater so that better dynamic balance is needed. With the form of static exercise, it has an effect on dynamic balance in the elderly which can improve the ability to control and maintain body position both in a still or moving state and will reduce the risk of falling in the elderly (Muladi & Kushartanti, 2018).

Failure of normal movements and attempts to restore balance after an imbalance occurs causes problems such as slipping, tripping, and even the risk of falling. Dynamic balance factors, such as when walking, are affected by the condition of the base or floor because uneven surfaces can disrupt the distribution of body weight and adjust posture to maintain balance. Floors that are too hard or too soft (such as sand or a mattress) affect stability because the body must readjust to adjust to the changing surface response to pressure (Pristianto *et al.*, 2024).

CONCLUSION

Based on the results of the study, it can be concluded that Balance Strategy Exercise has an effect on the dynamic balance of the elderly. Tandem Walking Exercise has an effect on the dynamic balance of the elderly. The effect of BSE and TWE on the dynamic balance of the elderly is different, namely Balance Strategy Exercise has a more significant effect compared to Tandem Walking Exercise.

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