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Article

Effect of Combined Balance Exercise and Tandem Walking on Elderly Stability in Nursing Homes

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Abstract

Balance disorders pose a significant risk for falls among the elderly and can greatly diminish their quality of life. This study seeks to inspect the impact of incorporating balance exercises with tandem walking on enhancing balance in the elderly demographic. A quasi-experimental design with pre-test and post-test control groups was utilized. A total of thirty-two elderly participants from two nursing homes in East Java were chosen through purposive sampling. The independent variable comprised the combination of balance exercises and tandem walking, while the dependent variable was the balance level, evaluated using the Time Up and Go Test (TUGT). Statistical analyses were operated utilizing the Paired t-Test, Wilcoxon Sign Rank Test, and Mann Whitney U Test with a significance level established at $p < 0.05$. In the intervention group, the average TUGT score before the intervention was 21.35 seconds (indicating unstable mobility), which improved to 16.01 seconds (indicating good mobility) after the intervention (p=0.000). Conversely, the control group, which did not undergo the combined intervention, showed average scores of 26.67 seconds before and 25.38 seconds after the intervention, both categorized as unstable mobility (p=0.326). The intervention group revealed a greater enhancement in balance with a average improvement of 5.33 seconds, compared to 1.28 seconds in the control group (p=0.002). These outcomes demonstrate that the combination of balance exercises and tandem walking is significantly effective in enhancing balance in the elderly. This intervention has the potential to minimize the danger of falls and enhance the overall quality of life among older adults.

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Introduction

Falls among the elderly represent a critical health concern that frequently arises and can greatly impact their quality of life. Falls may result in physical injuries such as fractures or head trauma, and can also trigger an excessive fear of movement, ultimately reducing physical activity, worsening balance, and increasing the risk of further falls. The risk of balance disorders in the elderly rises significantly with age. This condition is often referred to as a geriatric syndrome, in which impaired balance increases the risk of falling by up to three times compared to those without such impairment.

In addition to physical injuries like fractures, falls can also lead to psychological issues such as fear of falling, depression, and decreased self-confidence, which in turn make elderly individuals more dependent on others, and reduce their independence and quality of life. As a result, they become more frequently immobilized, increasing the risk of pressure ulcers that may lead to infections [1], [2].

Conforming to data from the World Health Organization [3], around 28-35% of individuals aged 65 and older encounter falls annually, with this percentage rising to 32-42% among those above 70 years of age. Southeast Asia and the Western Pacific contribute 60% of deaths due to falls. According to the Central Statistics Agency [4] data, Indonesia has 30.16 million elderly people. Many districts or cities in East Java have more than 7% of the population over 65 years old [5]. [6], the occurence of falls in people above 65 years old reaches 30% to 50% and it is reported that men fall more often and encounter many injuries. In East Java, the incidence of fall-related injuries is 9.12%, with rates of 7.70% among individuals aged over 55, 7.89% among those over 65, and 9.13% for those over 75 years old [7].

Health problems that often arise in the elderly in nursing homes are joint pain and balance disorders[8]. Factors that contribute to the danger of falls in the elderly include decreased sensory function, muscle weakness, fiber damage, and minimize strength, elasticity, flexibility of muscles and joints, use of certain drugs that affect consciousness or blood pressure[9]. Balance disorders in the elderly are often the main cause of falls[10]. Falls in the elderly can cause long-term disability, minimize quality of life, and raises the risk of death [11].

Balance exercises aim to strengthen the muscles in the lower extremities and enhance vestibular function, thereby promoting overall body stability [12]. Tandem walking or tandem walking exerciseis a walking technique that is done straight up to three to six meters with the heel of one foot stepping the tip of the other toe[13]. The study conducted by [14] indicates that balance exercise interventions are highly effective in increasing muscle strength in the lower extremities, particularly among elderly individuals experiencing balance disorders. Furthermore, studies conducted by [15], [16], [17], indicate that tandem walking exercises can enhance stability and markedly minimize the likelihood of falls among older adults. The combination of balance exercises with tandem walking is expected to provide greater advantages in improving balance in the elderly, as both activities can be executed simultaneously, thus maximizing training effectiveness and time efficiency. As a result, the researchers intend to explore the effects of integrating balance exercises with tandem walking on enhancing balance in elderly individuals residing in nursing homes.

Materials and Method

Research Design and Location

This study used a quasi-experimental design with a pretest-posttest design with a control group, without randomisation (non-randomised). The study was conducted for one month, from 14 January to 14 February 2025, in two nursing homes, namely Bhakti Luhur Nursing Home in Sidoarjo Regency and Anugerah Nursing Home in Surabaya City, East Java Province.

Population and Sampling Technique

The population in this study were all elderly people who experienced balance disorders and lived in the two nursing homes. Of the total population of 34 elderly, 32 people were selected as research samples using purposive sampling technique. This technique was chosen so that only elderly people who fulfilled the inclusion criteria were involved in the intervention consistently. The inclusion criteria included: age 60-80 years, able to walk without the help of tools, in a cooperative condition, and willing to follow the entire series of intervention programmes. The sample was divided into two groups, the intervention group (n=16) and the control group (n=16). To minimise bias, matching was done between the two groups based on age and baseline mobility ability.

Intervention Procedure

The intervention group was given a combination of balance training and tandem walking for four weeks, with a frequency of three times per week and the duration of each training session was about 20 minutes. Balance training focused on strengthening the muscles of the lower extremities and core

muscles of the body, and aimed to improve proprioceptive function and neuromuscular coordination. Meanwhile, tandem walking exercises are performed using a straight walking technique using the heel of the front foot attached to the toe of the back foot (heel-to-toe walk), which aims to train dynamic balance and vestibular response. Each training session was conducted under the supervision of trained personnel to ensure proper execution of the technique and maintain the safety of the participants.

Measurement of Variables and Research Instruments

The independent variable in this study is the combination of balance training and tandem walking, while the dependent variable is the level of balance of the elderly. To measure balance, the Time Up and Go Test (TUGT) instrument was used, which is a functional mobility assessment method that measures the time (in seconds) it takes participants to stand up from a chair, walk three metres, turn around, return to the chair, and sit back down. The TUGT score interpretation criteria are as follows: 0-10 seconds (normal mobility), 11-20 seconds (good mobility), 21-30 seconds (unstable mobility), and >30 seconds (high fall risk). Measurements were taken at the beginning (pretest) and end (posttest) of the intervention period.

Data Analysis

Data were analysed using SPSS software version 25. Normality test was conducted using Shapiro-Wilk test. In the intervention group, which showed normal distribution, the Paired t-test was used to determine differences before and after the intervention. While in the control group, which was not normally distributed, the Wilcoxon Signed-Rank test was used. To compare the results between the two groups after the intervention, the Mann-Whitney U test was used, because the data between the groups were not homogeneous and not entirely normally distributed. The significance value was determined at a confidence level of $p < 0.05$.

Research Ethics

This study has obtained ethical approval from the Health Research Ethics Committee (KEPK) of the Surabaya Ministry of Health Polytechnic, in accordance with WHO ethical standards in 2011, with approval number EA/3167/KEPK-Poltekkes_Sby/V/2025. During the implementation of the study, ethical principles such as respect for research subjects, principles of beneficence and non-maleficence, and justice were upheld. Each participant was given a full explanation of the purpose, benefits, and procedures of the study before being asked to sign an informed consent form. Participants' personal data was kept confidential and used only for the purpose of this study.

Results

1. Respondent Characteristics

The distribution of respondent characteristics among 32 elderly participants, divided into two groups at Bhakti Luhur Nursing Home in Sidoarjo and Usia Anugerah Nursing Home in Surabaya, is presented in the following table :

Table 1. Characteristics of the Elderly Participants in Bhakti Luhur Nursing Home and Usia Anugerah Nursing Home

Respondent Characteristics		Intervention		Control	
		f	%	F	%
Age	60-70 Years	10	63	5	31
	71-80 Years	6	37	11	69
	Total	16	100	16	100
Length of Stay in Nursing Home	1 Years	2	12	7	44
	2 Years	7	44	4	25
	3 Years	6	38	3	19
	4 Years	1	6	2	13
	Total	16	100	16	100
	Muscle weakness	3	19	4	25

Factor Reason Balance Disorders	Joint disorders	9	56	5	31
	Lack of balance control	0	0	4	25
	Changes in body posture	4	25	3	19
	Total	16	100	16	100

The intervention group revealed that most (63%) were aged 60-70 years, almost half (44%) had lived in a nursing home for 2 years, and most (56%) had balance disorders due to joint disorders. While the control group revealed that most (69%) were aged 71-80 years, almost half (44%) had lived in a nursing home for 1 year, and almost half (31%) had balance disorders due to joint disorders.

2. Balance Level of Elderly in Intervention Group Before and After Intervention Combination of Balance Exercise and Tandem Walking

The results of the Time Up and Go Test (TUGT) assessment in the elderly within the intervention group before and after receiving the combined balance exercise and tandem walking intervention are presented in the table below :

Table 2. Results of Balance Level Using Time Up and Go Test (TUGT) in Intervention Group

Inspectment Category Time Up and Go Test	**Pre Test n=16**		**Post Test n=16**	
	f	**%**	**f**	**%**
0-10 seconds	0	0	3	19
11-20 seconds	7	44	11	69
21-30 seconds	8	50	2	13
> 30 seconds	1	6	0	0
Total	16	100	16	100

Derived from table 2, the outcomes pre test revealed that half (50%) of the intervention group had a balance level of 21-30 seconds (unstable mobility), while the outcomes post test revealed that the majority (69%) of the intervention group had a balance level of 11-20 seconds (good mobility).

Table 3. Results of Intervention Group Based on Age

Respondent Characteristics		**Mark Time Up and Go Test (TUGT)**			
		Pre Test (Seconds) n=16		**Post Test (Seconds) n=16**	
		f	**Mean**	**f**	**Mean**
Age	60-70 Years	10	19.2020	10	14.7720
	71-80 Years	6	24.9467	6	18.0950

Based on table 3, elderly participants in the intervention group aged 60–70 years had an average TUGT time of 19.20 seconds in the pretest and 14.77 seconds in the posttest. Both fall into the 11–20 second category, which indicates good mobility. Meanwhile, those aged 71–80 years had a pretest average of 24.94 seconds (categorized as unstable mobility) and a posttest average of 18.09 seconds (categorized as good mobility).

Table 4. Results of Intervention Group Based on Length of Stay in Nursing Home

Respondent Characteristics		**Mark Time Up and Go Test (TUGT)**			
		Pre Test (Seconds) n=16		**Post Test (Seconds) n=16**	
		f	**Mean**	**f**	**Mean**
Length of Stay in Nursing Home	1 Years	2	18.0750	2	12.6600
	2 Years	7	19.4771	7	14.9571
	3 Years	6	21.8950	6	16.7367
	4 Years	1	37.8400	1	25.8500

Derived from table 4. elderly participants in the intervention group who had stayed in the nursing home for 1 year had an average TUGT time of 18.07 seconds in the pretest and 12.66 seconds in the posttest. both falling into the good mobility category (11–20 seconds). Those who had stayed for 2 years showed an average pretest time of 19.47 seconds and posttest time of 14.95 seconds. also within the good mobility category. Participants who had stayed for 3 years had a pretest average of 21.89 seconds (unstable mobility) and a posttest average of 16.73 seconds (good mobility). Meanwhile. those who had stayed for 4 years recorded a pretest average of 37.84 seconds (high risk of falling) and a posttest average of 25.85 seconds (unstable mobility).

Table 5. Paired Sample t-Test Results for Balance Level Using Time Up and Go Test (TUGT) in Intervention Group

Variable	Mean ± SD		*p Value*
	Pre Test (Seconds)	Post Test (Seconds)	
Balance Level in Elderly in Intervention Group	21.3563 ± 6.29567	16.0181 ± 4.76375	0.000

Based on the results of the Paired Sample t-Test shown in table 5. there was a significant difference in the balance levels of elderly participants in the intervention group before and after receiving the combined balance exercise and tandem walking intervention. This test uses the criterion of $p < 0.05$ to indicate a significant difference. The average TUGT time before the intervention was 21.35 seconds. which decreased to 16.01 seconds after the intervention. The *p-value* of 0.000 indicates that the intervention had a significant effect on improving the balance of the elderly.

3. Balance Level of Elderly Control Group Before and After No Intervention Combination of Balance Exercise and Tandem Walking

The results of the Time Up and Go Test (TUGT) assessment in the elderly within the control group before and after. without receiving the combined balance exercise and tandem walking intervention. are presented in the table below :

Tabel 6. Results of Balance Level Utilizing Time Up and Go Test (TUGT) in Control Group

Inspectment Category Time Up and Go Test	Pre Test n=16		Post Test n=16	
	f	%	f	%
0-10 seconds	0	0	0	0
11-20 seconds	6	38	6	37.5
21-30 seconds	5	31	6	37.5
> 30 seconds	5	31	4	25
Total	16	100	16	100

Derived from table 6. the outcomes obtained pre test balance level utilizing Time Up and Go Test (TUGT) in the elderly in the control group revealed that nearly half (38%) of the control group had a balance level of 11-20 seconds (stable mobility). while the outcomes post test revealed that almost half (37.5%) of the control group had balance levels of 11-20 seconds (stable mobility) and 21-30 seconds (unstable mobility).

Table 7. Results of Control Group Based on Age

Respondent Characteristics		Mark Time Up and Go Test (TUGT)			
		Pre Test (Seconds) n=16		Post Test (Seconds) n=16	
		f	*Mean*	f	*Mean*
Age	60-70 Years	5	19.1660	5	18.4380
	71-80 Years	11	30.0818	11	28.5382

Based on table 7. elderly participants in the control group aged 60–70 years had an average TUGT time of 19.16 seconds in the pretest and 18.43 seconds in the posttest. both falling into the good mobility category (11–20 seconds). Meanwhile. those aged 71–80 years had an average pretest time of 30.08 seconds and a posttest time of 28.53 seconds. both categorized as unstable mobility (21–30 seconds).

Table 8. Results of Control Group Based on Length of Stay in Nursing Home

Respondent Characteristics		Mark Time Up and Go Test (TUGT)			
		Pre Test (Seconds) n=16		Post Test (Seconds) n=16	
		f	*Mean*	f	*Mean*
Length of Stay in Nursing Home	1 Years	7	18.9514	7	19.1843
	2 Years	4	29.7925	4	29.8850
	3 Years	3	34.8133	3	29.2633
	4 Years	2	35.2300	2	32.2450

Derived from table 8. elderly participants in the control group who had stayed in the nursing home for 1 year had an average TUGT pretest time of 18.95 seconds and a posttest time of 19.18 seconds. both categorized as good mobility (11–20 seconds). Those who had stayed for 2 years had a pretest average of 29.79 seconds and a posttest average of 29.88 seconds. both falling into the unstable mobility category (21–30 seconds). For residents who had stayed for 3 years. the pretest average was 34.81 seconds (high risk of falling). which decreased to 29.26 seconds in the posttest (unstable mobility). Meanwhile. those who had stayed for 4 years had a pretest average of 35.23 seconds and a posttest average of 32.24 seconds. both categorized as high risk of falling (>30 seconds).

Table 9. Wilcoxon Sign Rank Test Results for Balance Level Utilizing Time Up and Go Test (TUGT) in Control Group

Variable	Mean ± SD		*p Value*
	Pre Test (Seconds)	Post Test (Seconds)	
Balance Level in Elderly in Control Group	26.6706 ± 10.57287	25.3819 ± 9.32719	0.326

Based on the results of the Wilcoxon Sign Rank Test shown in table 9. there was no significant difference in the balance levels of elderly participants in the control group after receiving the tandem walking intervention. This test uses the criterion of $p < 0.05$ to determine statistical significance. The average TUGT time before the intervention was 26.67 seconds. which decreased to 25.38 seconds after the intervention. A *p-value* of 0.326 indicates that tandem walking alone did not result in a statistically significant improvement in balance among the elderly in the control group.

4. Differences in Balance Levels Between the Intervention and Control Groups in Assessing the Effect of Combined Balance Exercise and Tandem Walking in Elderly Residents of Nursing Homes

Table 10. Mann Whitney U Test Results for Balance Level of Intervention Group and Control Group

Group	N	Mean Rank	Δ Mean	% Δ	Sig.
Intervention	16	11.25	-5.3382	-24.99%	0.002
Control	16	21.75	-1.2887	-4.83%	

Based on the results of the Mann-Whitney U test in table 10. the Asymp. Sig. (2-tailed) value was 0.002. Since the p-value is less than 0.05. it indicates a significant difference between the intervention and control groups in improving balance among the elderly. The intervention group. which received a combination of balance exercises and tandem walking. showed a decrease in TUGT

scores with an average difference of -5.33 seconds or a percentage change of -24.99%. indicating a significant improvement in balance. In contrast. the control group showed an average difference of only -1.28 seconds or a -4.83% change. indicating a non-significant improvement. Therefore. it can be concluded that the combination of balance exercises and tandem walking is significantly more effective in improving balance among elderly residents in nursing homes compared to tandem walking alone.

Discussion

The results of this study indicate that the provision of a combination of balance exercises and tandem walking significantly improved the balance of the elderly. as evidenced by a reduction in the Time Up and Go Test (TUGT) scores in the intervention group from 21.35 seconds to 16.01 seconds. Physiologically. balance training enhances the function of the sensorimotor and vestibular systems. which play a crucial role in maintaining postural control and body stability. This mechanism works by strengthening core and lower extremity muscles. enhancing proprioception. and improving motor coordination. which typically decline due to degenerative processes in the elderly [2]. [12]. Tandem walking. a heel-to-toe walking exercise. contributes to the development of dynamic balance and improves visual-motor coordination and body reflexes in response to balance disturbances [15]. [18].

The improvement in balance in the intervention group occurred because the combined training provided multisystem stimulation to the neurological and musculoskeletal components that decline with aging. Elderly individuals who engaged in this training experienced better postural control due to the reintegration of visual. vestibular. and proprioceptive inputs that were consistently stimulated [19]. [20]. The decline in these systems is a major contributor to imbalance and fall risk in the elderly. thus interventions targeting all components are more effective than single-mode exercises.

This study aligns with findings from [14]. which stated that environmental factors and lack of physical stimulation worsen balance in elderly residents of nursing homes. Therefore. structured and continuous training is key to preventing further decline. The study also shows that elderly individuals in the younger age bracket (60–70 years) exhibited greater improvements compared to the older group. indicating that physiological adaptability to exercise decreases with age [11]. [21].

Moreover. in terms of effectiveness. tandem walking alone did not show a significant improvement in balance. as seen in the control group. which experienced only a 1.28-second average reduction in TUGT score. This supports the theory that single-mode exercises like tandem walking require sufficient intensity. duration. and the participant's physical condition to be effective[20]. [22]. Combined training proved to be more effective as it provides a more complex and functional stimulus tailored to the mobility needs of the elderly [23]. [24].

In conclusion. the combined intervention of balance exercises and tandem walking effectively addresses various physiological causes of balance disorders in the elderly. These findings reinforce the importance of structured. continuous. and evidence-based physical rehabilitation programs in nursing homes to improve quality of life and reduce the risk of falls among the elderly population[25].

There are several limitations in this study that need to be considered. First. the study was conducted in only two nursing homes. so the results cannot be generalized to the entire elderly population in Indonesia. Second. the study sample was limited to elderly individuals who met the inclusion criteria. thereby excluding those with specific health conditions that might affect balance. Third. the intervention was carried out over a limited duration. which may have influenced the results. considering that balance training typically requires a longer period to produce significant effects. In addition. limitations in controlling external factors such as dietary patterns and daily activities of the elderly may have served as confounding variables that were not fully managed in this study. Therefore. further research with larger sample sizes. longer intervention durations. and broader geographic coverage is needed to validate these findings.

In clinical practice. this combined intervention can be recommended as part of a preventive program for elderly individuals at risk of falling. especially in nursing home settings. The training can be carried out by nurses. physiotherapists. or caregivers using simple methods and without the need for expensive equipment. For future research. it is recommended to conduct studies with a longer intervention duration and a larger sample size. while also considering additional variables such as cognitive status. daily physical activity. and quality of life. Moreover. long-term evaluations of the sustainability of the intervention effects should also be explored. in order to strengthen its clinical and statistical effectiveness.

Conclusions

In summary. it can be concluded that there are variations in balance levels between the two groups. The elderly participants in the intervention group. who practiced a mix of balance exercises and tandem walking. demonstrated more significant enhancements in balance than those in the control group who did not partake in this integrated training. The intervention group revealed more stable mobilization after training. while the control group did not encounter significant improvements. This reveals that the combination of exercises is more effective and has an effect on enhancing balance in the elderly and minimalizing the danger of falls.

Conflicts of Interest

The authors declare that there are no conflicts of interest related to this research.

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