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Tandem walking exercise to improve cognitive function in the elderly

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Abstrak: Decreased cognitive function in the elderly is the leading cause of inability to carry out normal daily activities, as well as a high level of reliance on others in caring for themselves. The many problems that arise due to decreased cognitive function require a healthy aging process so that decreased cognitive function does not cause health problems in the lives of the elderly. Decreased cognitive function in the elderly is the biggest cause of inability to carry out normal daily activities and is also the cause of the elderly experiencing a high level of dependence on others in caring for themselves. The purpose of this study was to determine the effectiveness of tandem walking exercises in improving the cognitive function of the elderly. This research is experimental with a one-group pre and post-test design. Target population in this study were the elderly who experienced cognitive impairment in Dangin Puri Kauh Village, Denpasar Utara District. Sampling method used in this research is purposive sampling. The research sample consisted of 24 people who were given tandem walking exercise. Measurement of cognitive function was carried out using the Mini Mental State Examination (MMSE), which was measured before and after being given training. Data obtained were analyzed using the SPSS Version 25.0 application. The results of testing the hypothesis using the wilcoxon rank test obtained an average before training of 22.46 and an average after training of 27.08 with a value of p = 0.000. From the results of this study, it can be concluded that tandem walking exercises can improve cognitive function in the elderly

Keywords: elderly, tandem walk, cognitive function, MMSE

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INTRODUCTION

Indonesia's geriatric population is becoming increasing yearly. The number of citizens 60 years of age or older or elderly people in Indonesia has reached 25.7 million people, or about 9.6 percent of the total population. The number of elderly people is predicted to continue to rise to around 10 percent in 2020 and 20 percent by 2040 (Widianto et al., 2020). The government must pay close attention to Indonesia's growing older population, particularly from a health perspective. It is hoped that the increasing number of elderly populations will not become a burden in society and it is hoped that the elderly should be able to be more productive (Widianto et al., 2020).

The aging process is the age when there will be a decrease in ability or a process of aging that occurs naturally which will cause anatomical, physiological and biochemical changes in the body's tissues as well as the functions and abilities of the body as a whole. In the elderly there is also a decrease in the ability of tissues to repair and maintain functional body tissues (Van Beek et al., 2016). The elderly experience a process of changing their ability to function including physical, social and psychological changes. This process usually occurs naturally and normally. These changes occur in each person at a different pace and depend on life circumstances. Changes that occur in the elderly include physical changes and mental changes so that the body can experience various health problems (Amarya et al., 2018).

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In the elderly there are physiological changes in both the musculoskeletal system and the nervous system such as decreased brain performance or what is known as decreased cognitive function. Cognitive function is a mental process in obtaining knowledge or intelligence abilities which include ways of thinking, memory, understanding, planning, and implementation (Kujawski et al., 2021). Decreased cognitive function in the elderly is the biggest cause of inability to carry out normal daily activities and is also the cause of the elderly experiencing a high level of dependence on others in caring for themselves. Impaired cognitive function can include decreased attention (awareness and concentration), memory and information storage, language disorders such as sensory and motor aphasia, visouspatial (unable to recognize directions), impaired executive functions such as counting, decision making and abstract thinking (Shen et al., 2021).

The many problems that arise due to decreased cognitive function require a healthy aging process so that decreased cognitive function does not cause health problems in the life of the elderly such as the risk of developing dementia which is a reflection of decreased cognitive function which is not good (Klimova et al., 2017). Cognitive function has various relationships with the mobility of the body, one of which is walking speed where the mechanism of walking involves the relationship between cognitive and motoric function. Slow or fast walking speed can predict cognitive impairment or motor capability which is associated with an increased risk of death in the elderly (Barnes, 2015).

Physiotherapy as a health worker has a very important role in providing services that aim to improve cognitive function. One of the efforts made to improve cognitive function is by providing tandem walking training (Quigley et al., 2020). Tandem walking exercise is a test as well as an exercise performed in the position of the heel of the foot touching the other toes in a straight line which aims to train the proprioceptive system and is a method of controlling body posture and step by step which is carried out with the help of cognition and coordination of trunk muscle, lumbar spine, pelvic, hip and abdominal muscles up to the ankle (Setyawan et al., 2022).

The results showed that the brain images of individuals who did physical exercise with moderate intensity could significantly increase brain volume in the most important areas such as memory, knowledge and planning compared to individuals who were not active (Longhurst et al., 2020). Physical exercise can also improve connections between parts of the brain so that it has better cognitive function (Untari et al., 2019). This is because brain cells that are many and interconnected with others can help the brain to function very effectively. The proprioceptive exercises contained in this tandem walking exercise use techniques that generate activation of the pronator and supinator muscles of the foot and the ankle stabilizer muscles. The co-contraction activation is attempted to occur semi-automatically because the stabilization activity is a system that takes place in the Central Pattern Generator (CPG) (Setyawan et al., 2022). Physical exercise that is carried out continuously can improve the cognitive function of the elderly because it stimulates brain plasticity (Lee et al., 2016).

Based on the problems above and the many benefits that can be obtained through tandem walking training, researchers are interested in knowing the effect of tandem walking training on increasing cognitive function in the elderly.

METHODS

This study used an experimental method with a one group pre and post test design. The sampling method used in this research is purposive sampling. The study was conducted in Dangin Puri Kauh Village, Denpasar Utara District with sampling from the population carried out according to inclusion and exclusion criteria. The time for research and data collection was carried out from March 2022 - May 2022.

The target population in this study were the elderly who experienced cognitive impairment in Dangin Puri Kauh Village, Denpasar Utara District. The number of samples in this study were 24 people. The inclusion criteria for this study: a) Elderly men and women aged 60-80 years. b) Have cognitive function measured in MMSE <25. c) Having static and dynamic balance is measured using the TUG (Time Up and Go Test) with good mobility category including speed ≤ 20 seconds. Exclusion criteria: a) Using assistive devices in walking, b) Having a history of knee pain and impaired mobility according to the inspection examination, c) Having a history of cardiovascular disorders according to the doctor's statement. Tandem walking exercises are carried out for 4 weeks 10 times with 1 set in the first week

and increased to 3 sets in the second, third and fourth weeks. Measurement of cognitive function was carried out using the Mini Mental State Examination (MMSE) measuring instrument.

The data obtained were analyzed using the SPSS Version 25.0 application. Descriptive data is used to analyze age, gender and educational background. The normality test used the Shapiro-Wilk test, the homogeneity test used Levene's test. Test the hypothesis using Wilcoxon rank test.

RESULT AND DISCUSSION

To present a more complete research result and strengthen the interpretation of hypothesis testing, a description of the data in the form of the characteristics of the research sample is presented in tabular form. The following is a description of the characteristics of the sample consisting of gender, age and educational history.

Table 1. Distribution of Sample Data Based on Gender

No.	Gender	Frequency	Percent (%)
1.	Men	8	33.3
2.	Woman	16	66.7
3.	Total	24	100

Based on Table 1 it shows that there were 8 male subjects (33.3%) and 16 female subjects (66.7%).

Table 2. Distribution of Sample Data Based on Age

Characteristics	Average and Standard Deviation
Age	66.38±3.47

Table 2 above shows that the research subjects have an average age of 66.38±3.47 years.

Table 3. Distribution of Sample Data Based on Educational Background

No.	Educational Background	Frequency	Percent (%)
1.	Junior high school	14	58.3
2.	Senior high school	6	25.0
3.	Bachelor	4	16.7
	Total	24	100

Based on Table 3, it shows that 14 (58.3%) junior high school subjects, 6 (25.0%) senior high school subjects and 4 (16.7%) bachelor degrees subject.

Table 4. Frequency Distribution of Subjects Walking Tandem Before Participating in Training

No.	Category	N	Percent (%)
1.	Severe Cognitive Impairment	0	0
2.	Moderate Cognitive Impairment	3	12.5
3.	Mild Cognitive Impairment	21	87.5
4.	Normal	0	0
	Total	24	100

Based on Table 4, it shows that subjects who experienced cognitive impairment before the intervention were 3 (12.5%) experienced moderate cognitive impairment and 21 (87.5%) experienced mild cognitive impairment.

Table 5. Frequency Distribution of Tandem Walking Subjects After Participating in Training

No.	Category	N	Percent (%)
1.	Severe Cognitive Impairment	0	0
2.	Moderate Cognitive Impairment	0	0
3.	Mild Cognitive Impairment	0	0
4.	Normal	24	100
	Total	24	100

Based on Table 5, it shows that 24 (100%) subjects who experienced cognitive impairment after being given the intervention did not experience cognitive impairment.

Table 6. Normality and Homogeneity Test Results

No.	Data Group	Normality Test with the Shapiro Wilk Test		Homogeneity test (*Levene's Test*)
		Statistik	p	p
1.	Before training	0.882	0.009	0.217
2.	After training	0.896	0.017	

Based on Table 6, it can be seen that the results of the normality test using the Shapiro Wilk Test obtained a probability value for the data group before the intervention where the value of p = 0.009 (p <0.05) and after the intervention the value of p = 0.017 (p <0.05). These results indicate that the data is not normally distributed. Meanwhile, in the homogeneity test using the Levene's test, the value of p = 0.217 (p <0.05) was obtained which showed that the data was homogeneous.

Table 7. Differences in Improved Cognitive Function Before and After Exercise

Category	Before training	After Training	p
MMSE			
Severe Cognitive Impairment	0	0	
Moderate Cognitive Impairment	3	0	
Mild Cognitive Impairment	21	0	
Normal	0	24	0.000
Mean	22.46	27.08	
Standard Deviation	1.31	1.06	
Total Sample	24	24	

Based on Table 7, the results showed that the mean difference in cognitive function improvement was analyzed using the Wilcoxon sign rank test before and after exercise with a value of p = 0.000 (p <0.05), which means that there is a significant difference in the increase in cognitive function before and after exercise.

Identification of Sample Characteristics

Based on Table 1 it shows that there were 8 male subjects (33.3%), 16 female subjects (66.7%) and had an average age of 66.38 ± 3.47 years. Based on educational background data, it was shown that 14 subjects (58.3%) had a history of junior high school education, 6 (25.0%) senior high school subjects and 4 (16.7%) undergraduate degrees.

Theories about cell, senescence, or cell death related to the nucleotide structure at the ends cannot be separated from the aging process (Qin et al., 2022). Telomeres are the ends of chromosomes found in the nucleus of eukaryotic cells. Telomere shortening occurs in normal somatic cells along with aging, including stem cells intended for cell renewal (Song et al., 2022). The function of the organs of the body will be affected by the aging and death of cells in the organs. Based on the results of research from Robertson et al., 2014 showed that there is a relationship between physical weakness and cognitive function. In the cycle of decline associated with aging, cognitive function and weakness interact. Physical and mental health is directly linked to brain health. As we age, our cognitive abilities will decrease. According to the findings from the study above, age and cognitive function in the elderly are significantly correlated. Cognitive function in the elderly is affected by decreased organ function or damage to organ function due to aging. Cognitive abilities will continue to decline with age (Mandolesi et al., 2018).

According to research findings from Okamoto et al., 2021, empirical analyses showed that women's lower cognitive functioning was partly explained by the endowment effect. Moreover, a shorter duration of formal education and a larger proportion with their longest occupation being domestic worker accounted for steeper cognitive decline and more prevalent mild cognitive impairment in women than in men. According to the evidence mentioned above, it is clear that older women are more likely to be affected by cognitive impairment than men.

According to a study by Sahab-Negah et al., 2020, estradiol and cognitive impairment in women are more closely related than in men. Because of the importance of endogenous sex hormones, particularly estrogen, in altering cognitive function, women appear to be more prone to experiencing cognitive decline. Due to the longer life span of women than men, women are more likely than men to experience cognitive dysfunctions, such as Alzheimer's dementia, while men are more likely to develop

vascular dementia. This is thought to occur because men are more likely to smoke and drink alcohol, two behaviors that can cause blood vessel problems (Hara et al., 2015).

Based on research findings Kobayashi et al., 2017, there is a substantial correlation between education and cognitive function in the elderly. Respondents with lower levels of education are 4 times more likely to experience cognitive impairment. The findings of this study are also in line with research by Lövdén et al., 2020 which looked at the factors that affect cognitive function in the elderly and found a significant correlation between education and cognitive function. The capacity to withstand age-related ecological changes in the brain varies from person to person. Education can increase cognitive reserve so that Alzheimer's disease only becomes clinically evident in people with higher levels of education once the brain pathology becomes sufficiently severe. Education, job complexity, reading ability, IQ, and dementia are all described in terms of cognitive reserve. This reserve is thought to be the result of modifications to the internal structure and functional organization of the brain. Education can increase cognitive reserves through neuroplasticity and the development of more complex brain networks that can replace higher levels of neuropathology later in life (Hara et al., 2015).

Analysis of the Effectiveness of Tandem Walking Exercise in Improving Elderly Cognitive Function

Based on Table 7, the results showed that the mean difference in cognitive function improvement was analyzed using the Wilcoxon sign rank test before and after exercise with a value of $p = 0.000$ ($p < 0.05$) which means that there is a significant difference in the increase in cognitive function before and after exercise.

A person's physiological and psychological functions decline with age as a result, daily routines can be disrupted, the individual usually reacts slowly to events around him, and his creative abilities and initiative gradually diminish. Memory impairment is the most common age-related condition, manifested by self-recognition of memory loss and objective decline in memory tests when compared to younger individuals (Kumar et al., 2022).

Memory, attention, executive function, perception, language, and psychomotor functions are all components of cognitive function, which is a complex function. Each component is detailed in detail, such as the mechanism for encoding, storing and retrieving information in the memory component itself, which can develop into short-term memory, long-term memory and working memory (Harvey, 2019). Early intervention, such as preventive measures or initiatives to support cognitive function in old age, should be carried out to reduce cognitive decline. The process can be slowed down by practicing disease prevention or by engaging in social activities that require thought (Kumar et al., 2022).

Tandem walking is a balance exercise that is safe for the elderly to do and can improve cognitive function. Age-appropriate physical activity includes balance, mobility, aerobics, stretching, and strengthening exercises. Regular exercise helps increase blood flow to the brain (Boere et al., 2023). To prevent the breakdown of connections between brain cells, increasing blood flow to the brain can help create brain cell plasticity. Exercise increases neurotransmitter metabolism, creates conditions that encourage neurogenesis, and can increase molecular and cellular stimulation in the brain and affect cognitive function (Teleanu et al., 2022).

Tandem walking exercise can stimulate neurotrophic factors so that it can stimulate a number of molecular processes that may function in the brain (Elmquist et al., 2016). Brain Derived Neurotrophic Factor (BDNF) is a very important neurotrophic factor. BDNF helps certain types of neurons become more resilient and develop. It serves as the main mediator of synaptic effectiveness, connectivity, and plasticity in nerve cells (Kumar et al., 2022). If the BDNF level is low, it will cause senility. Tandem walking can increase the brain's capacity to produce new cells, especially dentate gyrus cells which are the resident cells of the hippocampus which is a part of the brain that plays a role in memory processes (Quigley et al., 2020).

There are several mechanisms that link the effectiveness of tandem walking which is part of physical exercise with increased cognitive function, including blood pressure control, increased lipoprotein levels, formation of endothelial nitricoxide, and strong brain tissue perfusion (Kumar et al., 2022). This has the effect of maintaining nerve structure and increasing the growth of nerve fibers, synapses, and capillaries which have a direct impact on the brain. In addition, trophic factors and neuronal growth are hypothesized to be stimulated by physical exercise, which may prevent cognitive performance decline related to dementia (Castells-Sánchez et al., 2019). Physical exercise can increase

brain vascularization, increase dopamine levels, and change the chemical structure of neutrophil factors, all of which have neuroprotective effects (Quigley et al., 2020).

After doing physical exercise, blood vessels will dilate and heart rate will increase, allowing blood to circulate throughout the body, including the brain (Gallardo-Gómez et al., 2022). Increased blood flow results in optimal brain function, continuous supply of nutrients and oxygen, improved short-term memory, and increased activity of nerve growth factor (NGF), which is a protein that is essential for the development and maintenance of nerve cells. Therefore, physical activity such as tandem walking is very important for maintaining good memory (Mandolesi et al., 2018).

According to studies from Xu et al., 2023, vasoconstriction and relaxation function imbalances as well as alterations in carotid artery elasticity can worsen the degree of cognitive impairment. These modifications will have a substantial impact on the body's capacity to provide blood and oxygen to brain tissue, leading to a considerable build up of oxygen free radicals that will harm brain tissue. Exercise can therefore enhance cardiovascular health, raise cerebral blood flow and oxygen supply capability, provide more nutrients to brain tissue cells, support brain function, and ultimately slow down or stop the progression of neurodegenerative diseases (Pertiwi et al., 2022).

According to Li et al., 2021 moderate exercise training can increase an older person's body metabolism, allowing them to breathe in more oxygen and expel more carbon dioxide and other metabolic pollutants. Additionally, it can enhance the performance of the heart, lungs, and digestive system as well as cell metabolism, which can effectively halt the aging process and prevent diseases that affect the elderly. Exercise training can improve older physical function by reducing the severity of inflammatory reactions and sensitivity to disease, as well as by slowing the accumulation of chronic inflammatory mediators like TNF-, IL-10, and IL-6.

According to previous research, exercise enhances memory and inhibition control in older persons, enhancing cognitive performance (Northey et al., 2018). Exercise is a successful treatment and intervention for cognitive decline in older persons. Some strong evidence for exercise's effectiveness as a non-drug intervention comes from studies that indicated exercise interventions could improve elderly cognitive function (Xu et al., 2023).

CONCLUSSION

This study shows that the implementation of tandem walking exercise for 4 weeks can improve the cognitive function. There is an influence on the cognitive function of the elderly before and after participating in tandem walking exercise which stimulates neurotrophic factors so that it can stimulate a number of molecular processes that may function in the brain. After doing physical exercise, blood vessels will dilate and heart rate will increase, allowing blood to circulate throughout the body, including the brain. Increased blood flow results in optimal brain function, continuous supply of nutrients and oxygen, improved short-term memory, and increased activity of nerve growth factor. The recommendation of this study is to further increase the cognitive function, it is better to do tandem walking exercise because the result of this study result is tandem walking exercise can improve cognitive function.

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