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Analysis of the relationship between physical activity and cognitive function among elderly residents in nursing homes

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Abstract

This study aims to analyze the relationship between physical activity and cognitive function in elderly residents at a nursing home in Surabaya. The research employed a cross-sectional design with a sample of 76 respondents selected randomly. Physical activity was measured using the Physical Activity Scale for the Elderly (PASE), while cognitive function was assessed using the Mini-Mental State Examination (MMSE). The results indicated that the majority of respondents had moderate levels of physical activity (55%) and cognitive function (45%). Spearman Rank correlation analysis revealed a significant relationship between physical activity and cognitive function ($p = 0.003$). This relationship suggests that increased physical activity is associated with improved cognitive function in the elderly. These findings underscore the importance of implementing structured physical activity programs as a non-pharmacological approach to maintaining cognitive health and enhancing the quality of life among the elderly.

Keywords: Physical Activity; Cognitive Function; Elderly; Cognitive Decline

1. Introduction

Aging is a continuous natural biological process accompanied by functional decline, particularly in the central nervous system, which can impair cognitive function. Cognitive decline is a major concern among the elderly as it negatively impacts memory, spatial orientation, and the ability to process new ideas. If left unaddressed, this decline can increase the risk of dementia, ultimately resulting in a significant burden both at the individual and societal levels[1, 2].

Globally, the population of older adults aged 60 years and above has been rapidly increasing. It is projected to reach 1.4 billion by 2030[3, 4]. Similarly, in Indonesia, the elderly population has increased significantly over the past 30 years. Data from the World Bank (2020) and the Central Bureau of Statistics (2021) indicate that the proportion of individuals aged 65 years and older has risen from 3.5% in 1960 to 6.3% in 2020. Furthermore, the United Nations (2019) projects that by 2050, Indonesia's population aged 60 years and above will reach 70 million (20% of the total population) [5]. This demographic shift has significant implications for the healthcare system, particularly in addressing age-related non-communicable diseases (NCDs) such as hypertension, diabetes, and cognitive disorders, including dementia [6, 7]

Cognitive decline in the elderly is influenced by various factors, including the aging process, lack of physical activity, mental health disorders, and unhealthy lifestyle habits. Age-related brain changes, such as reduced prefrontal cortex volume and hippocampal atrophy, contribute to executive dysfunction and memory decline. Research indicates that physical activity plays a crucial role in maintaining cognitive function. Regular physical activity can stimulate the production of Brain-Derived Neurotrophic Factor (BDNF), a protein that supports neural health and enhances neuroplasticity [8-10].

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However, despite its proven benefits, many elderly individuals reduce their physical activity due to perceived physical limitations or a lack of motivation. This phenomenon is particularly evident in Indonesia, where the prevalence of cognitive function impairment among the elderly reaches 54.6%[11]. A local survey conducted in Surabaya revealed that out of 182 elderly individuals, approximately 62 experienced cognitive decline, emphasizing the urgent need for intervention. Physical activity has been identified as an effective non-pharmacological strategy to delay cognitive decline. Activities such as walking, cycling, gardening, and elderly-specific exercises (e.g., senior aerobics) have been shown to improve cognitive function, reduce stress, and alleviate symptoms of depression [1, 12, 13]. Nevertheless, there remains a limited number of studies directly exploring the relationship between physical activity and cognitive function among elderly individuals residing in nursing homes in Surabaya. Therefore, this study aims to examine the relationship between physical activity and cognitive function in elderly residents of nursing homes in Surabaya. The findings of this research are expected to contribute to the development of evidence-based interventions to maintain cognitive health, thereby enhancing the quality of life of the elderly population in Indonesia.

2. Material and Method

This study employed a cross-sectional design with a correlational analytic approach. The aim was to evaluate the relationship between physical activity as the independent variable and cognitive function as the dependent variable among the elderly. Data collection was conducted at a single point in time, with a sample size of 76 participants. The inclusion criteria included elderly individuals aged ≥60 years and those with cognitive decline (categorized as independent care or partial care). The sampling technique used was simple random sampling, where each member of the population was assigned a numerical code, and samples were randomly selected.

2.1. Instruments

Physical Activity Measurement: Physical activity was assessed using the Physical Activity Scale for the Elderly (PASE) questionnaire, which includes: Leisure activities (e.g., walking, exercise) Household activities (e.g., cleaning, gardening), Volunteer activities (e.g., volunteering work).

Physical activity levels were categorized as: Mild: Scores 0–18, Moderate: Scores 19–36, Severe: Scores 37–54, Cognitive Function Measurement: Cognitive function was assessed using the Mini-Mental State Examination (MMSE) questionnaire, which evaluates: Orientation, Registration, Attention and calculation, Recall, Language MMSE scores were categorized as follows: Mild: 24–30, Moderate: 17–23, Severe: 0–16

2.2. Data Collection

Data were gathered through interviews using the PASE and MMSE questionnaires. Each interview session lasted 20–50 minutes per respondent.

2.3. Data Analysis

Bivariate analysis was conducted to examine the relationship between physical activity and cognitive function using the Spearman Rank correlation test, with a significance level of $\alpha = 0.05$

3. Results and discussion

Table 1 Participant's characteristics (n = 76)

variable	Frequency	Percentage (%)
Age (year)		
Elderly (60-74 years)	44	58
Old (75-89 years)	32	42
Gender		
Male	32	42
Female	44	58
Education		

Out-of-school status	16	21
Elementary school	30	40
Secondary School	14	18
Senior High School	6	8
diploma, undergraduate, and postgraduate degrees	10	13
Physical Activity		
Mild	30	40
Moderate	42	55
Severe	4	5
Cognitive Function		
Mild	22	29
Moderate	34	45
Severe	20	26

Based on Table 1, the results from 76 respondents showed the highest age group was the elderly (60–74 years) with 44 respondents (58%). The majority were female, totaling 44 respondents (58%). The highest educational level was elementary school, with 30 respondents (40%). The highest level of physical activity was moderate, reported by 42 respondents (55%). The highest level of cognitive function was moderate, with 34 respondents (45%).

Table 2 The Relationship Between Physical Activity and Cognitive Function Among Elderly Residents in Nursing Homes in Surabaya (n=76)

Variable	**Cognitive Function**						***p-value****
Physical Activity	Mild		Moderate		Severe		
	n	%	n	%	n	%	
Mild	2	2.6	14	18.4	14	18.4	0,003
Moderate	18	23.7	18	23.7	6	7.9	
Severe	2	2.6	2	2.6	0	0.0	

Table 2 shows the results of the Spearman rank statistical test, with a p-value of 0.003, indicating a significant relationship between physical activity and cognitive function among elderly residents in nursing homes in Surabaya. The findings reveal that the majority of elderly individuals engage in moderate physical activity (55%), followed by light physical activity (40%) and vigorous activity (5%). Moderate physical activity includes activities such as light aerobics, walking, and household chores, which remain manageable for the elderly despite age-related limitations. A decline in physical activity is often associated with physiological factors such as skeletal muscle weakness, reduced cardiovascular capacity, and mobility impairments, as explained by Nelson et al. (2007) in the physical activity guidelines for older adults issued by the American College of Sports Medicine (ACSM)[14]

Several factors can influence physical activity among the elderly, including key risk factors for chronic diseases, disabilities in older adults, and other factors such as low educational attainment. In this study, 40% of respondents had only an elementary school education, which may be associated with limited knowledge about the importance of regular physical activity. This aligns with the findings of Gomes et al. (2016), which identified a relationship between low education levels and minimal participation in structured physical activity programs. Gender also plays a role, as elderly women (58%) tend to have lower activity levels than men, due to social perceptions and physical limitations associated with postmenopausal changes[15].

This study also showed that 45% of the elderly participants exhibited moderate cognitive function, followed by mild cognitive function (29%) and severe cognitive function impairment (26%). Cognitive decline in the elderly is associated

with physiological brain changes due to aging, such as hippocampal atrophy and prefrontal cortex shrinkage, which play a crucial role in memory and decision-making[16]. Cabeza et al. (2002) explained that the brain's capacity to adapt to physiological changes decreases with age, contributing to cognitive decline [17-19]. Furthermore, research by Miranda & Alvina (2019) indicates that women have a higher risk of experiencing cognitive impairment due to the decline in estrogen levels, which has neuroprotective effects. [20].

These findings are also supported by research from Buchman et al. (2012), which demonstrated that low physical activity increases the risk of cognitive decline due to reduced blood flow to the brain, leading to deficits in oxygenation and nutrient supply [21-23]. The level of education is also a contributing factor, as explained by Stern (2002) in the concept of Cognitive Reserve, which states that individuals with higher education levels have greater cognitive adaptability to cope with neurodegenerative processes[24].

The statistical analysis revealed a significant relationship between physical activity and cognitive function, with a p-value of 0.003. This indicates that higher levels of physical activity are associated with better cognitive function in the elderly. Physical activity plays a crucial role in increasing Brain-Derived Neurotrophic Factor (BDNF), a protein that supports neurogenesis and neural connectivity in the hippocampal region, which is essential for short-term memory and learning[25]. This study aligns with the findings of Colcombe et al. (2006), which demonstrated that regular physical activity reduces the risk of cognitive impairment in the elderly. An intervention study on physical activity in older adults found that a 6-month aerobic exercise program significantly increased hippocampal volume and improved cognitive function[26].

Furthermore, a meta-analysis by Northey et al. (2018) demonstrated that moderate to vigorous physical activity for at least 150 minutes per week can improve executive function, memory, and cognitive processing speed in older adults. Physical activity stimulates cerebral blood flow, enhances the supply of oxygen and nutrients, and prevents the accumulation of β-amyloid plaques, which are a key contributor to dementia[27, 28]. This study confirms that physical activity is an effective non-pharmacological intervention for preventing and slowing cognitive decline in older adults. Therefore, programs focusing on regular physical activities, such as senior aerobics, light stretching, and balance exercises, should be implemented consistently at least three times per week, as recommended by the WHO. Additionally, education on the benefits of physical activity should be enhanced, particularly for older adults with lower educational attainment.

4. Conclusion

This study indicates a correlation suggesting that increased physical activity is associated with improved cognitive function. Regular physical activities, such as light exercises and walking, play a crucial role in maintaining neuroplasticity by enhancing Brain-Derived Neurotrophic Factor (BDNF) levels, increasing cerebral blood flow, and preventing neuronal degeneration in the elderly. These findings strengthen the evidence that physical activity is an effective non-pharmacological intervention to slow cognitive decline. Therefore, structured physical activity programs and continuous education are essential to improving the quality of life among the elderly, particularly in nursing home settings. This effort aligns with WHO recommendations, which advocate for a minimum of 150 minutes of physical activity per week to maintain physical and cognitive health in the aging population.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest

Statement of ethical approval

This study was approved by the Ethics Committee of Muhammadiyah University (Surabaya, Indonesia; 0411/KEPK/2023).

Statement of informed consent

The informed consent form included statements ensuring that participants could withdraw their participation at any time, data would be used exclusively for research purposes, and participants' anonymity would be protected. Participation was voluntary, and consent was obtained after a thorough explanation

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