

## The role of physical exercise as a prevention towards dementia

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### Abstract

**Background:** Indonesia as a country with an aging population structure is highly potential to develop an increase in dementia cases. Dementia is known as a syndrome of decreased cognitive function that can affect emotions, behavior, and daily activities, thus affecting the patient's quality of life. The management of dementia remains limited until this day, so it is necessary to prevent dementia by improving lifestyle, one of which is through exercise and physical activity.

**Methods:** This study used a literature review method using 18 scientific articles as online data sources which were then further analyzed.

**Results and Discussion:** Physical activity and exercise are important non-pharmacological interventions in reducing the risk of dementia. The risk of dementia is related to the intensity of the activity - the higher the intensity, the greater the role it has in reducing risk of dementia. Activities of moderate to vigorous intensity can improve cognitive function, induced by neurogenesis and neurotrophic factors expression that prevent brain atrophy. Aerobic exercise is predominantly done, supported by a combination of resistance training or other forms of exercise.

**Conclusion:** Exercise or physical activity plays a role in the prevention of dementia through the mechanism of neurogenesis and preventing brain mass reduction. The delay in the progression of neurocognitive disorders by doing exercise or physical activity is influenced by the type and intensity of exercise, combined with lifestyle improvements such as nutritional diet and cognitive exercise. This intervention needs to be recommended for elderly adults to prevent dementia and other neurocognitive diseases.

**Keywords:** Exercise; Physical Activity; Healthy Lifestyle; Dementia Prevention

### 1. Introduction

Dementia is a syndrome characterized by symptoms of decreased cognitive function, such as memory, thinking ability, orientation, and several other things [1]. The course of symptoms is progressive, chronic, and persistent. The severity of dementia symptoms has the potential to cause a person's limitations in carrying out daily activities [2]. Although dementia generally affects the elderly population, this syndrome is not part of the aging process and should be avoided [1]. According to Infodatin data from the Ministry of Health of the Republic of Indonesia [3], Indonesia is a country with an aging population, where the elderly population is high because life expectancy is increasing. This phenomenon has the potential to increase the incidence of dementia in Indonesia. Research in Jogjakarta, 2016 showed that 20.1% of elderly people had dementia [4]. Meanwhile, research in Bali, 2018 showed a higher figure, namely, 32.6%, based on

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SurveyMETER Indonesia [5]. This shows a significant increase of cases in Indonesia over the years. So, it is estimated that by 2050, the dementia rate in Indonesia could reach 4 million people [6]. Of the many cases of dementia, according to WHO, the type of dementia with 60-70% of cases in the world is Alzheimer's dementia.

Alzheimer's dementia or commonly called senile dementia is a degenerative disease where there is a decrease in brain function that affects emotions, behavior, memory, decision making, and others so that daily activities are disrupted [7]. Dementia affects cognitive function and behavior. The clinical symptoms experienced by each individual are different. Decreased cognitive function can make patients experience memory loss, impaired communication and language, impaired executive functions such as reasoning, judgment, and planning, agnosia, and apraxia. Agnosia is a person's inability to recognize objects, while apraxia is a person's inability to do something that has been previously learned [8]. Of course, things like this interfere with a person's daily activities and affect the quality of life of the patients. Until now, the treatment for dementia patients is still limited. Pharmacological treatment options are also limited. The drugs used such as cholinesterase inhibitors, memantine, cholinergic precursors only slow the progression of dementia [9].

World Health Organization explained that quality of life is an individual's perception of the achievements, standards, and expectations of the welfare of life [10]. According to Krahn [11], quality of life according to health consists of physical health, mental health, social health, and life satisfaction. So, it can be concluded that physical activity can improve the quality of life of individuals. This theory is in line with research on 142 communities and 142 students with the result that most respondents think that physical activity ranks first in terms of its full contribution to health and quality of life and mental health is in second place. Most people understand the efforts that can be made to improve the quality of life by maintaining a positive health cycle [12].

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## 2. Material and methods

This study uses a literature review method using online data sources. The online data sources that will be used are PubMed, Sciondirect, Springerlink, SAGE journals, and Google Scholar. The keywords used in the article search were "physical exercise/sports" and "dementia prevention". The articles involved are articles published in the period 2011-2021 and discuss the role of exercise in dementia prevention. Of the many articles that appear from the search results, screening is done first by looking at the title and abstract of the article. In the end, 18 suitable scientific articles were found and would be analyzed further.

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## 3. Results and discussion

### 3.1. Physical exercise and its relation to reduced risk of dementia

World Health Organization defines physical activity or sports as body movements that require and produce energy produced by skeletal muscle performance [13]. Sports or physical activity consists of four types, namely endurance, strength, balance, and flexibility [14]. Endurance or aerobic activity is the form of repeated isotonic contractions of muscle groups at a certain time. This activity is directly related to the heart, lungs, and circulatory system. Examples include running, swimming, and cycling [15]. Strength activity is the form of muscle contraction when holding a load. Examples of activities can be in the form of lifting weights and push-ups [16]. Balance activities are effective and efficient body movements in the form of maintaining and stabilizing the center of the body so that it is balanced against the fulcrum with minimal risk of falling when the body or body parts are stationary or moving. Activities can include walking sideways, standing on one leg, and walking in balance [17]. Flexibility activities are body movements in the form of stretching muscle groups as wide as possible with the help of joints, for example, wearing clothes and neck rotation [18].

According to research followed by respondents aged > 50 years in the Campobasso Region, Italy, it was found that exercise or physical exercise in the form of aerobics carried out for a certain time according to the dose can prevent or at least slowdown memory decline in subjects at risk of dementia [19]. Another meta-analysis study that also supports the provision of more than one type of physical exercise in the form of aerobics, strength, balance, and flexibility gives the best results on cognitive function, compared to giving one type of activity, namely aerobic exercise [20, 21]. The actual mechanism of physical exercise that affects cognitive function has not yet been proven, but several theories have been found that support this explanation, namely that physical activity can prevent the onset of dementia due to the reversible improvement of several cardiovascular risk factors, such as diabetes, hypertension, obesity, and symptoms of depression. In addition, physical exercise also exerts a beneficial effect on neurogenesis [22] and supports neuroplasticity [23].

### 3.2. The proper duration and intensity of physical exercise

Physical activity and exercise are important non-pharmacological interventions in reducing the risk of dementia. The risk of dementia in a person is related to their activities, where the more inactive a person is, the higher the risk of dementia [24]. Inactivity is referred to as a risk factor that can be modified by doing various physical activities [25]. In carrying out physical activity, a certain intensity and duration are required to achieve the goals of preventing dementia and preventing injury. As mentioned in most studies, moderate to vigorous intensity activities can improve cognitive function, including memory, speed of thought processing, and executive function as effort [24, 26]. However, the higher the intensity of physical activity, the greater its role in reducing the risk of Alzheimer's dementia and all-cause dementia [27].

In a meta-analysis study, regular physical activity with a duration of >1 hour 2 times a week can reduce the risk of dementia [24]. Another study described the duration of physical activity based on its intensity, where moderate intensity exercise was carried out for 150 minutes/week and heavy intensity for 75-150 minutes/week [28]. Based on a 24-month randomized controlled trial in Australia, 150 minutes/week of home physical activity not only has an effect on health but can also increase adherence to activities [29]. By increasing adherence to physical activity, the risk of dementia can be reduced.

A study has shown that we can take steps to reduce the risk of developing dementia. Prospective studies have found that even light to moderate physical activity can reduce the risk of developing dementia and Alzheimer's disease. One potential way of lifestyle intervention to help reduce the occurrence of dementia and Alzheimer's disease is exercise. The type of exercise will be adjusted to the physical condition of each person. In general, regular exercise for 6-8 weeks reduces the risk of developing dementia [28]. Recent studies have shown that about 3% of all cases of dementia can be prevented by increasing physical activity [30,31]. The literature shows the importance of physical activity and exercise to prevent or slow down the pathological process and dementia-related problems [32]. In large meta-analyses, including multiple cohort studies and 33,816 individuals, higher levels of physical activity were associated with a significant reduction in the onset of dementia [33].

### 3.3. Neurocognitive effects of physical exercise

Brain neuroplasticity is a fundamental mechanism for learning, memory, and general cognition. Many literatures suggest that there are multiple mechanisms by which exercise can facilitate this neuroplasticity in rats and mice. Thus, exercise has been shown to increase the expression of synaptic plasticity genes, gene products such as synapsin I and synaptophysin, and various neuroplasticity-associated transcription factors such as adenosine monophosphate response element-binding cycles and intracellular kinases. Hippocampal dendritic length and spinal dendritic complexity are increased with exercise. Neurogenesis in the hippocampus dentatus gyrus is also induced by exercise. Neurotrophic factors are involved primarily in learning and neuroplasticity. Brain-derived neurotrophic factor (BDNF) has been extensively studied and, in vitro, modulates brain plasticity, including enhancing neuritic growth and synaptic function. Also promotes in vitro survival of a large number of neurons affected by neurodegenerative conditions, including Alzheimer's Dementia (AD). The hippocampus is critical for memory and progressively degenerates in patients with AD and its effects are seen in the earliest stages of dementia. Gyrus dentatus of the hippocampus is most susceptible to aging. Only a small part of the brain assists in neurogenesis and in studies conducted in mice and rats, neurogenesis of gyrus dentatus is facilitated by exercise. A prospective study in adolescents showed that 3 months of aerobic exercise resulted in a significant increase in gyrus dentatus hippocampus blood volume, but the rest of the hippocampus did not change. This is interpreted as a reflection of gyrus dentatus angiogenesis as well as neurogenesis [34].

In theory, neurotrophic factors are important in fighting brain atrophy due to aging and possibly neurodegenerative diseases. BDNF is highly expressed in the human brain and is significantly decreased in patients with AD. Patients with AD whose condition rapidly deteriorated had significantly low serum BDNF concentrations. In healthy young adults, BDNF is produced by the human brain with short-term vigorous exercise and long-term endurance training [34]. Studies in humans have been mostly limited to the measurement of serum BDNF. Both increased serum BDNF and physical activity correlate with maintaining hippocampal volume, which has been reported to improve memory and reduce the risk of dementia and AD. Human studies have shown that the effects of exercise on hippocampal size and cognitive function are mediated by the increased of BDNF expressions. This mechanism is strongly supported by animal studies [35]. However, research on BDNF levels in humans needs further research. Serum BDNF levels, which are often used as an indicator of brain function, have a lot of uncertainty regarding what BDNF levels can be considered normal, how stable these values are over time, and whether measurements of serum BDNF levels are reliable [36].

Insulin-like growth factor 1 is widely expressed in the human brain, and IGF-1 insufficiency may be a risk factor for AD. Meta-analysis of most cross-sectional studies assessing circulating IGF-1 levels and cognition in the elderly revealed highly significant positive associations. Patients with AD had significantly lower circulating IGF levels than controls in a small cross-sectional study, and these levels were inversely correlated with the degree of cognitive impairment [34].

### 3.4. Physical exercise as a potential intervention on dementia prevention

Along with the development of the concept of preventive neurology, multi-domain interventions in the effort to prevent dementia and improve cognitive function are expected to be realized [25]. One of these intervention efforts can be done through exercise. Physical inactivity is one of the most important modifiable risk factors in AD patients with a prevalence of 13% [37]. Physically active adults with normal cognitive function are less likely to suffer from cognitive decline or dementia than inactive adults. With exercise, the risk of cognitive decline in healthy adults decreases and has the potential to improve cognitive function in individuals who have been diagnosed with MCI or dementia [25]. The risk of progression of cognitive impairment is influenced by the presence or absence of prevention efforts with physical activity. A previous meta-analysis by Hamer et al [38], found a reduced risk of AD progression due to regular exercise. Buchman et al [39], also found that individuals who have low physical activity habits are 53% more at risk of suffering from AD compared to physically active individuals. Aerobic exercise is associated with structural endurance of the brain and cognitive function, so it is thought to be a prominent exercise for dementia prevention efforts [37, 40]. Although the results are not as significant as aerobic exercise, resistance training can also be performed as a support exercise and has been shown to improve domains of memory, attention, and executive function, and the effect lasts 12 months after the intervention period ended [41].

Making lifestyle changes in the pre-symptomatic and pre-dementia stages has the potential to delay one-third of dementia worldwide. Although physical exercise programs appear to be effective, these activities still need to be accompanied by other multimodal interventions such as diet, physical activity, and cognitive exercise. Multimodal interventions that include the adoption of an active lifestyle need to be recommended for the late-adult population as an effort to prevent dementia and other neurocognitive diseases [40].

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## 4. Conclusion

The delay in the progression of neurocognitive disorders with exercise or physical activity is influenced by the type and intensity of exercise combined with lifestyle improvements such as nutritional diet and cognitive exercise. Dementia prevention with physical exercise should be recommended for the elderly adult population as an effort to prevent dementia and other neurocognitive disorders.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

There is no conflict of interest.

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