# Exercise, Brain Health, and Alzheimer's Risk

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## Abstract

Alzheimer's is the most common kind of dementia, a disorder that typically happens in older people. Many factors play a role in the development of Alzheimer's, such as getting older, diet, the amount of physical activity we get, how healthy our heart and blood vessels are, and much more. Moving our bodies is a key way to keep our brain healthy. Researchers have actually confirmed that moving our bodies isn't just good for us physically but also for our brains to grow healthier, as Alzheimer's revolves around reducing our brains' capabilities associated with memory and learning. Exercise might cause neurogenesis in the hippocampus, elevate blood flow to the brain, stimulate the production of BDNF, and possibly lower inflammation, all of which contribute to keeping our brain healthier. Daily routines, other than exercise, might involve a healthy diet, daily mentally stimulating tasks, and controlling existing cardiovascular problems, such as heart disease or diabetes, which could increase the chances of developing Alzheimer's disease. There is a strong understanding among Alzheimer's researchers, as seen in trials such as the FINGER trial, that we may not be able to completely prevent the disease, but instead switching to healthier habits can still play a part in preventing and slowing Alzheimer's.

## Introduction

Dementia is the seventh leading cause of death globally, and Alzheimer's makes up 60-70% of all dementia. Alzheimer's is a neurodegenerative disease where the ability to remember and think decreases slowly, as a result, limiting the capacity to perform simple everyday actions. There is no cure for Alzheimer's, although there are treatments focused on slowing its progression and helping control symptoms.

This review aims to examine the beneficial effects of physical activity on the brain, the effects of physical inactivity on brain structure and function, and the impact of physical inactivity on the development of Alzheimer's. This paper will highlight the way physical inactivity can increase the risks of developing Alzheimer's and the preventive steps that need to be taken. It will also provide useful insights to individuals, helping them understand one of the greatest risk factors for Alzheimer's disease and gain an understanding of the importance of physical activity as a leading preventive lifestyle choice.

## Benefits of Physical Activity on the Brain

Exercise is one of the ideal ways to preserve brain health. The body can receive both mental and physical benefits from exercise, as it functions to increase our brain functionality. Research has proven the benefits of exercising consistently, as it positively impacts specific areas of the brain, including our memory, learning, attention abilities, problem-solving, and much more.

In their study, Erickson et al. (2011) tested elderly people who underwent aerobic exercise, such as walking, and compared them to a control group made up of elderly people who did non-aerobic physical activity like stretching. They noticed that subjects from the aerobic exercise group had increased 2.12% of their left and 1.97% of their right hemispheres in their hippocampus as compared to the control group, which lost 1.40% and 1.43% of their left and right hemispheres in their hippocampus, respectively. These results indicate that aerobic exercise can improve the volume of the hippocampus through increasing amounts of a protein called BDNF (Brain-Derived Neurotrophic Factor). BDNF is associated with neuron growth, survival, and communication, which leads to neurogenesis, the process in which new neurons are formed in the brain. As BDNF is responsible for creating new neurons, the increase in its quantity has a positive relationship with hippocampus volume, which is part of the brain that helps experiences transform into long-term memories. This appears to be an important idea for aerobic exercise, as it can increase memory and learning capacity.

Another experiment was carried out by Kleinloog et al. (2019), where 17 healthy 60-70-year-old males exercised on an 8-week randomized aerobic exercise program and were compared against a male control group with no physical activity. The researchers tested blood flow, fitness, metabolism, and cognitive ability and found that blood flow within the frontal areas of the brain (the anterior cingulate cortex and subcallosal cortex specifically) played a key role in directing important cognitive functions like attention, decision-making, problem-solving, and self-control, which had increased by 27%. Increased blood flow means oxygen and nutrient supplies will be delivered to the brain cells more effectively, so they will function at their best level. Aging is often accompanied by reduced blood flow and a reduction of cognitive function, so it is suggested that aerobic exercise can help prevent the brain from aging too fast and can also enhance cognition. The experimenters also found improvements in the brain’s control skills and concluded that it could be that blood flow within the frontal area of the brain contributes to enhanced cognitive function, but further long-term studies need to be done, as the study only lasted eight weeks.

**Consequences of Physical Inactivity**

Physical inactivity may impair the brain in many ways, which may lead to an increase in the risk of developing cognitive diseases. Physical inactivity could impair blood flow, cause inflammation, and even slow the production of glucose. All these effects of physical inactivity make the functions of the brain weaken while increasing its risk of diseases.

In a study carried out by Carter et al. (2018), they compared three groups of adults. One group sat for four hours with no break, the second sat for four hours and was interrupted every 30 minutes with a brief two-minute walk on a treadmill, and the third sat for four hours with an eight-minute break on the treadmill every 120 minutes. They then recorded the blood flow of the middle cerebral artery, which supplies a large portion of the brain's blood flow, and found that more frequent walking helped maintain cerebrovascular function (the body's ability to maintain brain blood flow). It was also found that the groups that took a walking break had stabilized or even slight increases in brain blood flow, while the groups that sat for long periods showed decreased brain blood flow. These findings indicate that even short walks every 30 minutes could prevent the adverse effects of sedentary behavior, because it maintains blood flow to the brain. Those who walked maintained or increased their blood flow in the mid-cerebral artery

during rest, but the seated subjects experienced a decrease in their blood flow. Because blood is needed to get nutrients to the brain, maintaining cerebral blood flow may allow the brain to function normally and effectively. The data was only gathered for four hours, so it is unknown if this actually benefits cognitive function for long-term cognitive risks.

Goran Papenberg et al. (2016) performed an observational study with 414 older adults by asking them how physically active they were, as well as giving them a brain scan and taking samples of their blood for signs of inflammation. The results indicated that less active people have less gray matter (part of the brain responsible for helping us think, remember, and process information) in the brain and were shown to have a smaller amount of brain tissue, specifically in their prefrontal cortex and hippocampus, areas which are involved in decision making and memory. While inflammation itself may not be an accurate indicator of brain size alone, when it's combined with low physical activity and specific high levels of inflammation markers (specifically IL-12p40), participants experienced a reduction in brain volume and cognitive function that got worse over the years. This suggests that physical inactivity is associated with reduced brain volume and cognitive decline, and may also make the brain more susceptible to the damaging effects of inflammation. The results suggest that a combination of both physically inactive behavior and high inflammatory activity is associated with a quicker rate of brain decline and a rapid path to cognitive deterioration.

**Physical Activity as a Contributing Factor To Alzheimer's**

Physical inactivity is also a key risk factor for all types of dementia, especially Alzheimer's. It has been proven by scientists that exercise improves circulation, increases brain BDNF, and decreases brain inflammation. These effects work together in maintaining optimal functioning of brain cells throughout the aging process. Exercise protects against Alzheimer's and could potentially push the progression of the disease back.

According to Xiaoqian Zhang and colleagues, they have constructed meta-analyses through multiple studies, which have suggested that as much as 28% of Alzheimer's cases might be prevented among people with the highest physical activity as compared to those who are physically inactive. In a collection of studies, many different mechanisms have worked together to explain the potential preventive effect against Alzheimer's. In greater amounts, brain-derived neurotrophic factor, or BDNF, protects the brain. That's because it helps brain cells mature and thrive; it makes them more active and enhances their ability to make stronger connections, all of which contribute to a healthy brain that's able to change and grow, an important process in the development of memory. Additionally, exercise boosts the amount of blood flowing to your brain, and with that flow comes the oxygen and nutrients to encourage thinking and memory areas of the brain. It is also believed to decrease brain inflammation, which might also prevent the buildup and progression of the signs of Alzheimer's, like amyloid beta plaques and tangles. For these reasons, the overall benefits of exercise appear to come from the relationship of the biological mechanisms in improving brain health and preventing the onset of Alzheimer's disease.

Using a combination of data taken from 19 different cohort studies including over 400,000 people, Kivimaki and his research team were able to identify relationships between Alzheimer's and physical activity. During the ten-year-long study, different groups of adults were split based

on their exercise level, from no activity at all to regular exercise. This study showed that not doing physical activity throughout the ten-year study increased your chances of developing Alzheimer's compared to being physically active, but this was only seen in cases where the Alzheimer's developed within ten years of measurements. Other things that the study looked into were measuring whether a patient had developed certain diseases over the ten years and whether inactivity causes metabolic disease such as diabetes and cardiovascular disease such as heart disease. These diseases are known to affect the brain through creating vascular dysfunction and inflammation, which is then linked to Alzheimer's related development of amyloid beta and tau protein accumulation. A buildup of this much beta-amyloid and tau protein in the brain causes the formation of plaques and tangles, which can disrupt neuronal communication and possibly cause Alzheimer's. Regular exercisers maintain overall health, since they possess healthy cardiovascular and metabolic systems, which are linked to risk factors of Alzheimer's, even if there is not a direct connection.

**Preventive Measures**

Despite the impossibility of completely preventing the development of Alzheimer's disease, due to some genetic factors contributing to the cause of the disease, there are certain modifications in our everyday habits that we can make to decrease the chances of developing Alzheimer's. An example of these kinds of activities is having a balanced diet with high intake of vegetables, fruits, and fats, engaging in exercise on a regular basis, and challenging the brain through cognitive engagement. Furthermore, the treatment of cardiovascular diseases such as diabetes and high blood pressure has also been shown to decrease the risk of acquiring Alzheimer's disease.

The Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability was conducted by Ngandu and other researchers who recruited 1200 elderly participants for their study. The older adults received standard health advice or a multidomain lifestyle through random assignment. The older adults received lifestyle adjustments, which included regular exercise and a healthy diet, cognitive training, and their cardiovascular and metabolic risk factors were evaluated. The study results showed that older adults who underwent the multidomain lifestyle adjustments demonstrated better memory, thinking speed, and cognitive abilities than those who received standard health advice. The research shows that Alzheimer's disease can be prevented through a multidomain lifestyle program that combines exercise with nutritional diets and cognitive development exercises. These modifications protect the brain against Alzheimer's disease through multiple pathways, including improving blood flow to the brain, which ensures enough oxygen and nutrient delivery to neurons involved in memory and cognition, reducing inflammation, supporting the growth of neurons, and improving metabolic and cardiovascular health.

According to Adrian De La Rosa and her colleagues, exercising regularly will help reduce the risk of developing Alzheimer's disease as well as prevent the condition from becoming worse. When physical exercise is incorporated into people’s daily routine on a regular basis, it can positively influence the brain’s functions. Research has shown that people with low levels of physical activity are more likely to develop Alzheimer's disease than those who exercise regularly. Promoting brain health through increased blood flow to the brain, reduced

inflammation, and the regulation of the production and removal of amyloid beta and tau proteins are all positive impacts of exercise. Regular exercise increases the amount of neurotrophic factors, which are a family of proteins that provide support to the health of neurons, like BDNF. They also help promote brain plasticity, which is the ability for the brain to create and continue to develop new neural connections that support memory. These neurotrophic factors are stimulated through binding with receptors that activate certain signaling pathways to produce gene expression for growth and healing. Whenever a lack of exercise occurs, there is less blood being pumped to the brain, which tells the chemical signals to turn off, preventing the production of growth proteins. In summary, regular exercise can help lower the risk of developing Alzheimer's disease and slow its progression by improving blood flow to the brain and protecting brain cells.

## Conclusion

This review paper concludes that lifestyle choices could reduce the risks of developing Alzheimer's. Researchers have successfully proven that Alzheimer's is not completely avoidable, but some factors are controllable. Some factors, such as mentally stimulating your brain, dietary control, tracking cardiovascular health, and exercise, are all ways to reduce the risks of developing Alzheimer's. Exercise, for instance, is a main influence in developing Alzheimer's, as physical activity can improve our brain’s functionality in both learning and memory aspects. Exercise has many beneficial factors in general, from reducing inflammation in our brain, increasing blood flow and neurotrophic factors in our brain, and promoting neurogenesis. All these positive impacts are related to Alzheimer's, as the neurodegenerative disease affects our mental capabilities of learning and memory. Overall, living a generally healthy lifestyle, including not just being active but many other habits, might be protecting our brains from the effects of aging and potentially reducing the risks of developing Alzheimer’s.

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