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THE ROLE OF PHYSICAL ACTIVITY AND NUTRITION IN THE PREVENTION AND MANAGEMENT OF ALZHEIMER'S DISEASE

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ABSTRACT

Introduction and Purpose: Alzheimer's disease is a developing public health concern with significant social and economic interference. Given the limited capability of current drug therapies, attention is shifting to the preventive strategies. The goal of this article is to review the evidence supporting multimodal lifestyle interventions—combining physical activity, dietary changes, and cognitive stimulation—as effective methods for reducing the risk and progression of Alzheimer's disease.
Materials and Methods: This narrative review draws upon recent clinical studies, meta-analyses, and guidelines related to non-pharmacological interventions for Alzheimer's disease. Sources include peer-reviewed articles focusing on physical exercise, dietary patterns, nutrient supplementation, and their combined impact on cognitive health.
Results: Evidence indicates that regular physical activity—especially aerobic and resistance training—supports memory, executive function, and cognitive performance, even in early stages of Alzheimer's disease. Malnutrition is common in individuals with AD due to factors such as poor appetite, swallowing difficulties, and behavioral symptoms. Deficiencies in B vitamins, vitamin D, and omega-3 fatty acids are frequently observed and linked to faster cognitive decline. Tailored nutritional interventions, including adequate protein and caloric intake, may help stabilize cognitive and functional outcomes.
Conclusion: Multimodal lifestyle interventions—including regular physical activity, brain-healthy diets, and targeted nutritional support—offer a promising strategy for the prevention and management of Alzheimer's disease. These approaches enhance cognitive function, address modifiable risk factors, and are most effective when implemented early and tailored to individual needs. Integrating such strategies into clinical care and public health policies could play a crucial role in reducing the future burden of Alzheimer's disease.

KEYWORDS

Alzheimer's Disease, Physical Activity, Nutrition, Brain-Healthy Diet, Dementia Prevention

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Introduction

Alzheimer's disease is a progressive, irreversible neurodegenerative disorder of the brain that accounts for 60–80% of dementia cases, primarily affecting individuals over 65 years old. With the global population aging rapidly, Alzheimer's disease is becoming a major public health challenge worldwide. It is estimated that this debilitating disorder currently affects approximately 50 million people globally and indirectly impacts the lives of tens of millions family members who deal with years of cognitive decline in their loved ones. [1]

While pharmacological treatments can offer only limited benefits, lifestyle interventions – such as regular physical activity, smoking cessation, change in alcohol consumption, and adherence to a healthy diet - have been increasingly recognized for their potential in reducing the risk of developing Alzheimer's disease. [2]

Epidemiology and Characteristics of Alzheimer's Disease

The hallmark pathological features of Alzheimer's disease include the accumulation of abnormal proteins in the brain, primarily beta-amyloid plaques and tau tangles. These pathological proteins contribute to the death of nerve cells. The resulting neuronal loss leads to a decrease in the production of neurotransmitters, which are essential for normal brain function. [3]

As the global population ages, the prevalence of Alzheimer's disease is expected to rise significantly. According to Alzheimer's Disease International (ADI), the number of people living with the disease could reach 13.8 million by the year 2060. [1]

The onset of Alzheimer's disease is typically insidious, with early symptoms such as difficulty remembering recent events or newly acquired information. As the disease progresses, individuals may experience increasing challenges with language, including trouble finding or recalling words. Other symptoms

may include disorientation in time and place, mood swings, loss of motivation, self-neglect, and noticeable behavioral changes. In the later stages, the disease leads to significant cognitive and functional decline, ultimately resulting in a loss of independence and the need for full-time care. [4,5]

Risk Factors for Alzheimer's Disease

The exact etiology of Alzheimer's disease remains uncertain. However in cases of familial Alzheimer's disease, genetic predisposition plays a significant role in a development of disease. [6]

Among the non-modifiable risk factors associated with the onset of Alzheimer's disease are female sex and advanced age. Research shows that women are more frequently affected, and the disease mostly affects individuals over the age of 65. Additionally, a higher risk of developing Alzheimer's disease is linked to a history of brain injuries - such as concussions or post-traumatic amnesia - as well as to conditions like diabetes, obesity, and hypertension during middle age, and a positive family history of Alzheimer's disease. [7]

Nonetheless, particular attention should be given to modifiable risk factors that may help lower the likelihood of developing Alzheimer's disease. These include educational attainment, physical activity, sleep quality, dietary habits, smoking, and alcohol consumption. Each of these elements influences the risk of cardiovascular disease, which in turn is a providing factor to Alzheimer's disease. Impaired cardiovascular health can reduce cerebral blood flow and, consequently, the delivery of essential nutrients to the brain. [8]

Scientific evidence suggests that regular physical exercise, efforts to prevent obesity, diabetes, and cardiovascular disease, along with a healthy diet — rich in neuroprotective substances, i.e., antioxidants, B vitamins, and polyunsaturated fatty acids — may have a protective effect on cognitive function and help reduce the risk of Alzheimer's disease. [8,9]

Physical Activity and Brain Function

Physical inactivity is a major global health issue, contributing to approximately 5 million deaths annually due to noncommunicable diseases. Among the various health risks associated with a sedentary lifestyle, cognitive decline is of particular concern, especially as the global population ages. Increasing evidence supports the notion that a physically active lifestyle is associated with a reduced risk of cognitive deterioration, positioning exercise as a promising strategy in the prevention of age-related neurological decline and diseases such as dementia. [10,11,12]

Aerobic Exercise and Brain Health

Aerobic exercise has been the most extensively studied form of physical activity in relation to brain health. Since the 1970s, studies have demonstrated that individuals who engage in regular aerobic activity tend to perform better on cognitive tasks, especially those involving psychomotor speed and executive functioning, compared to their sedentary individuals. For instance, one early study showed that middle-aged athletes outperformed age-matched sedentary adults on tasks that required psychomotor coordination. [13]

More recent research further supports these findings. One notable study demonstrated that middle-aged individuals who engaged in regular aerobic training demonstrated significantly better memory performance on the Free and Cued Immediate Recall test, compared to those who were sedentary. This finding aligns with the broader body of research indicating that long-term aerobic training can delay the onset of physiological memory loss, suggesting that such exercise may serve as a preventive intervention against neurodegenerative diseases. [12]

Importantly, the benefits of aerobic exercise are not limited to those who begin early in life. Even late-onset exercise interventions have been shown to yield substantial cognitive benefits. For example, a landmark 2011 study revealed that one year of moderate-intensity aerobic exercise (three 40-minute sessions per week) resulted in measurable increases in hippocampal volume - a brain region essential for memory - and improvements in spatial memory among older adults. MRI-based studies have further corroborated these results, revealing that six months of aerobic training can increase both gray and white matter volumes in key brain areas such as the anterior cingulate cortex. [14]

Furthermore, long-term aerobic interventions (up to three years) have also been associated with improvements in reaction time, motor skills, and processing speed, even in previously sedentary older women. These findings suggest that aerobic exercise not only slows cognitive decline but may also reverse certain age-related impairments. [15]

Resistance Training and Cognitive Function

In recent years, attention has also been turned to the cognitive effects of resistance training, such as weightlifting. A recent meta-analysis of over 24 studies concluded that resistance training positively affects specific cognitive domains, particularly executive functions and early detection of cognitive impairment. However, unlike aerobic exercise, resistance training does not appear to have a consistent impact on working memory. Variability in study outcomes may be due to differences in methodology, participant demographics, and intervention designs. Despite these inconsistencies, the overall consensus is that resistance training remains a valuable component in maintaining cognitive health, especially for preserving executive functions in older adults. [16]

Given the cumulative evidence, a combined exercise regimen incorporating both aerobic and resistance training may offer the most comprehensive cognitive benefits. Programs featuring moderate-intensity exercise for at least 45 minutes per session, performed multiple times per week, consistently support cognitive health in aging populations. [17]

Physical Activity and Reduced Risk of Alzheimer's Disease

Dementia is not an inevitable outcome of aging or retirement, rather, it is influenced by a combination of modifiable lifestyle factors that can either increase or decrease an individual's risk of developing the disease. Current research suggests that approximately 35% of dementia cases can be attributed to nine key risk factors: low education level, midlife hypertension, midlife obesity, hearing loss, later-life depression, diabetes, smoking, social isolation, and - crucially - low physical activity. This underscores the importance of lifestyle modifications, particularly physical activity, in reducing dementia risk. [18]

A large meta-analysis of 16 studies involving over 160,000 participants found that regular physical activity was associated with a 45% reduction in the risk of developing Alzheimer's disease (AD) (hazard ratio = 0.55, 95% CI: 0.36−0.84, p = 0.006). Similarly, a longitudinal study following 716 older adults over 3.5 years showed that those with low daily physical activity were 53% more likely to develop AD than their more active counterparts. These findings underscore the role of physical activity as a powerful preventive measure against Alzheimer's disease. [19,20]

Although results vary, an increasing body of evidence supports the benefits of physical activity for individuals already diagnosed with mild cognitive impairment (MCI) or early-stage AD. Several intervention studies have documented improvements in executive functions, memory, and overall cognitive performance following aerobic exercise programs among people with MCI. These improvements are clinically significant, as slowing cognitive decline during MCI may delay or even prevent progression to AD. [21,22]

In patients with Alzheimer's disease, aerobic exercise - especially when combined with cognitive stimulation - has shown potential in enhancing memory and executive function. Although not all studies yield consistent outcomes, the general trend suggests that exercise interventions can offer cognitive benefits even after diagnosis, particularly in early stages of the disease. [23]

Resistance Training in Cognitive Aging

While fewer studies have investigated resistance training in individuals with MCI or AD, emerging findings are promising. A notable randomized, double-blind trial involving 100 participants aged 55 to 86 with MCI found that six months of resistance training led to significant improvements in memory, attention, and executive function. Remarkably, these cognitive benefits were sustained for up to 12 months post-intervention. This trial, known as the SMART (Study of Mental and Resistance Training) study, highlights the potential for resistance training to serve as a complementary therapeutic option alongside aerobic activity in mitigating cognitive decline. [24]

Diet in Alzheimer's Disease

In addition to physical activity, dietary habits also play a crucial role in the prevention and progression of Alzheimer's disease. Although it is widely acknowledged that nutrition affects cognitive health, the existing literature remains limited and often controversial. Nonetheless, applying principles of rational nutrition for the elderly is recommended in the context of Alzheimer's. A diet rich in neuroprotective nutrients—such as antioxidants, B vitamins, and polyunsaturated fatty acids—may offer beneficial effects. [25]

In contrast, diets with high intake of saturated fats and sugar are associated with an increased risk of diabetes and cardiovascular disease, both of which are known contributors to AD susceptibility. [26,27]

Dietary Patterns and Neurodegeneration

Emerging evidence highlights how specific dietary deficiencies and excesses may influence AD risk. Low intake of antioxidant vitamins (e.g., vitamins E and C), folate, vitamin B6, and vitamin B12 has been associated with elevated oxidative stress and homocysteine levels—both implicated in neurodegenerative processes. These nutrients play key roles in neuronal protection, β-amyloid detoxification, and DNA methylation. [26]

On the other hand, excessive consumption of saturated fats and cholesterol may promote insulin resistance and the accumulation of harmful compounds such as oxysterols in the brain, contributing to cognitive decline. Animal studies show that such diets can induce Tau hyperphosphorylation and negatively impact memory. Moreover, environmental factors like heavy metal exposure (e.g., lead and cadmium) are being investigated for their potential neurotoxicity, though current data remain inconclusive. [27]

Nutritional Status and Alzheimer's Disease

Malnutrition is a prevalent yet frequently underrecognized issue among older adults, particularly those living with Alzheimer's disease (AD). As the disease advances, various factors—including diminished appetite, dysphagia (swallowing difficulties), alterations in taste and smell, and behavioral symptoms such as apathy or agitation—can contribute to insufficient dietary intake. This nutritional decline may, in turn, accelerate cognitive deterioration and loss of functional independence. [28]

Deficiencies in key nutrients—most notably B vitamins, vitamin D, and omega-3 fatty acids—have been consistently linked to poorer cognitive outcomes. Individuals with AD often present with lower serum levels of folate, vitamin B12, and vitamin D when compared to cognitively healthy counterparts. Evidence suggests that early supplementation with these nutrients may help slow cognitive decline by reducing homocysteine concentrations and mitigating oxidative stress. [29,30]

In addition, unintentional weight loss and muscle wasting (sarcopenia) are common among Alzheimer's patients and are associated with a more rapid disease progression and poorer prognosis. Ensuring adequate caloric and protein intake, as well as proper hydration, is therefore essential not only for maintaining physical health but also for preserving cognitive abilities and overall quality of life. Multidisciplinary nutritional interventions—including individualized meal planning and caregiver education—have shown promise in stabilizing or even modestly improving cognitive and functional outcomes in individuals with AD. [31]

Fat Intake and Alzheimer's Disease

While direct research on fat intake in AD patients is limited, animal models offer some insights. High-fat diets have been linked to obesity, insulin resistance, and cognitive decline, though findings vary. Some studies show increased β-amyloid deposition and impaired glucose tolerance in response to high-fat diets, while others suggest potential protective effects, such as reduced blood–brain barrier disruption. [26]

Importantly, the type of fat consumed appears to matter more than the total amount. Saturated fatty acids (SFAs) are generally associated with increased cognitive risk, whereas unsaturated fats—especially omega-3 fatty acids—have neuroprotective effects. Studies like the AIDE project link high SFA intake to mild cognitive impairment, while frequent fish consumption correlates with improved cognitive outcomes. [32]

Ketogenic diets, particularly those based on medium-chain triglycerides (MCTs), have shown promise in improving memory in people with mild cognitive impairment or early AD. These diets provide ketone bodies as an alternative brain energy source. However, small sample sizes and mixed results necessitate further study. WHO guidelines for elderly nutrition recommended total fat intake below 30% of daily energy, with SFAs limited to 10% and a daily omega-3/6 fatty acid intake of at least 250 mg. [33,34]

Carbohydrate Intake and Cognitive Health

Impaired glucose metabolism, such as in type 2 diabetes or persistent hyperglycemia, is strongly associated with increased Alzheimer's risk. Diets high in simple carbohydrates—especially those with a high glycemic index—have been linked to greater β-amyloid accumulation and poorer cognitive function. [35,36]

Studies suggest that substituting carbohydrates with proteins or healthy fats may improve cognition. Not all carbohydrates are detrimental; dietary fiber, for instance, appears to protect against cognitive decline and type 2 diabetes. Research in animals also indicates that fiber deficiency can negatively impact hippocampal structure and function, as well as gut microbiota composition.

Current nutritional guidelines for older adults recommend that carbohydrates provide 45–65 % of daily energy, with simple sugars limited to 10% and fiber intake set at a minimum of 20 grams per day. [37,38]

Micronutrients and Brain Health

Antioxidant vitamins (E and C) help combat oxidative stress—a key mechanism in Alzheimer's pathology—though clinical trials have yielded mixed results, likely due to differences in dosing, timing, and patient characteristics. B vitamins (B6, B9, B12) are essential for homocysteine metabolism, with supplementation showing potential in reducing brain atrophy. [39,40]

Minerals such as calcium and magnesium are also vital. While excessive calcium influx can be neurotoxic, magnesium offers protective effects by modulating calcium channels and reducing excitotoxicity. [41]

Omega-3 fatty acids, particularly DHA and EPA, are integral to neuronal structure and function, supporting neuroplasticity and reducing inflammation. While observational studies highlight benefits, supplementation trials in diagnosed patients remain inconclusive. [42]

Polyphenols—found in fruits, vegetables, tea, and cocoa—are gaining attention for their antioxidant, anti-inflammatory, and cognitive benefits. Flavonoids and catechins can cross the blood–brain barrier and positively influence neuronal signaling and blood flow. [43]

Multimodal Intervention Strategies

While physical activity alone is effective, comprehensive, multimodal interventions may offer the best protection against dementia. These approaches combine exercise with dietary changes, cognitive training, and other lifestyle modifications. Given the multifactorial nature of dementia, such integrated strategies may outperform single-component interventions. [44]

The greatest potential lies in early intervention - during presymptomatic or predementia stages - where lifestyle changes can delay or even prevent up to one-third of dementia cases. [45,46]

Conclusions

Alzheimer's disease poses a profound and escalating global health challenge, with its prevalence expected to rise sharply as populations continue to age. Although the disease is irreversible and progressive, growing evidence underscores the significant role of modifiable lifestyle factors—particularly physical activity and diet—in reducing the risk and potentially delaying its onset and progression.

Regular physical activity, including both aerobic and resistance training, has consistently been shown to support cognitive function, enhance brain structure, and improve memory and executive functioning—even in individuals with mild cognitive impairment or early-stage Alzheimer's. At the same time, diets rich in neuroprotective nutrients and low in harmful components such as saturated fats and added sugars may offer additional protective benefits.

Importantly, a multimodal approach—integrating exercise, nutrition, cognitive training, and other healthy lifestyle behaviors—emerges as the most promising strategy for preventing or delaying dementia, particularly when adopted early in life. While pharmacological treatments offer limited benefits, these non-pharmacological interventions are cost-effective, widely accessible, and associated with numerous health advantages beyond cognition.

In light of these findings, public health initiatives should prioritize lifestyle-based prevention strategies to address the growing burden of Alzheimer's disease and help aging populations maintain cognitive vitality and quality of life.

Disclosure

Author's contribution

Conceptualization – Anita Janda, Jan Drzymała, Radosław Pastuszek
Formal analysis – Sylwia Bartolik, Marcin Durowicz, Iwona Górnicka
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