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The Effect of Physical Activity on Alzheimer's Disease

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ABSTRACT

Dementia, particularly Alzheimer's disease (AD), is a growing global health concern, with an estimated 50 million people affected worldwide. The prevalence of AD is projected to increase significantly with aging populations. Despite the absence of a cure, early intervention during the prodromal phase can slow the progression of AD, highlighting the importance of identifying modifiable risk and protective factors. Physical inactivity is one of the leading modifiable risk factors, contributing to approximately 40% of dementia cases. This review explores the role of physical exercise, particularly resistance training (RET), aerobic exercises, and dance movement interventions (DMI), as therapeutic approaches for AD prevention and treatment. Evidence suggests that regular physical activity enhances cognitive function, reduces neuroinflammation, improves brain structure, and supports neuroplasticity. Both RET and aerobic exercise have been shown to delay the onset of cognitive decline, with RET also reducing amyloid plaque formation and promoting neuroprotection. DMI further benefits individuals with AD by improving cognitive function, mood regulation, social interaction, and physical coordination. Additionally, the review examines the relationship between obesity and

AD. Although obesity is traditionally seen as a risk factor for cognitive decline, recent studies suggest that obesity in late life may have protective effects, potentially due to factors like lower amyloid-beta levels and larger hippocampal volume. This review emphasizes the importance of physical exercise and its potential to mitigate cognitive decline and improve quality of life in individuals at risk of or living with Alzheimer's disease.

MATERIALS AND METHODS

An extensive examination of articles published in scientific journals was carried out through online research platforms PubMed and Google Scholar. We searched for articles by entering keywords in appropriate configuration: "Alzheimer's disease", "cognition and memory loss", "brain aging", "dementia" ,"physical activity", "resistance exercise training", "aerobic exercises".

KEYWORDS: Alzheimer's disease; physical activity; modifiable risk factors; resistance exercise training; aerobic exercise

INTRODUCTION AND PURPOSE

Currently, approximately 50 million people worldwide are affected by dementia, a number that the WHO predicts will rise to 139 million by 2050. [1] Alzheimer's disease (AD) is currently the most prevalent form of dementia and one of the most common neurodegenerative disorders among the elderly, accounting for approximately 90% of dementia cases in this age group. [2] AD is marked by its irreversible nature and a gradual decline in cognitive, functional, and behavioral abilities. It is typically associated with a range of brain disorders, including amnesia, agnosia, apraxia, and aphasia. [3] As life expectancy grows and populations age, the global prevalence of Alzheimer's disease is projected to rise, resulting in a significant and costly disease burden. Current treatment approaches for Alzheimer's disease primarily alleviate symptoms, with no effective cure available. However, AD has a prolonged prodromal phase, during which early intervention is crucial to slowing its progression. As such, epidemiological research is vital to identify key risk and protective factors that significantly impact cognitive

health. As a matter of fact, estimated one-third of AD cases may be influenced by modifiable risk factors. [4] Physical inactivity is one of the 12 potentially modifiable risk factors believed to contribute to approximately 40% of cases. [5] A meta-analysis involving 16 studies with over 160,000 participants found that regular physical activity was associated with a 45% reduction in the risk of developing Alzheimer's disease (hazard ratio = 0.55, 95% confidence interval: 0.36–0.84, p = 0.006). [6] In this review, we primarily focus on the role of physical exercise as a therapeutic approach for the prevention and treatment of Alzheimer's disease (AD).

PHYSICAL ACTIVITY AND COGNITIVE FUNCTION

Physical inactivity is responsible for approximately 5 million deaths globally each year due to noncommunicable diseases. [7] The protective effect of physical activity against the risk of cognitive decline is well-established. [8] Recent study conducted on middle-aged trained individuals and sedetary subjects found a significant memory improvement in the first group. [9] The beneficial effect of long-term exercise training in delaying the onset of age-related memory decline highlights its potential as an effective preventive strategy against memory loss and neurodegeneration. It is important to note that even late-onset exercise interventions have demonstrated positive effects in delaying brain aging. For instance, a study published in 2011 found that one year of moderate-intensity exercise (40 minutes per session, 3 days a week) led to an increase in hippocampal volume and improved spatial memory in healthy older adults. [10] Some other research has shown that 6 months of exercise (60 minutes per session, 3 days a week) is enough to increase both gray and white matter in the anterior cingulate cortex, as measured by magnetic resonance imaging, in older adults with normal cognitive function. [11] However, some intervention studies have found that exercise does not have a significant effect on cognition. [12,13] These conflicting results may be attributed to differences in the duration, frequency, and/or intensity of the interventions.

CURRENT STATE OF KNOWLEDGE

Research has shown that physical activity not only contributes to slowing down general brain aging but also plays a key role in the prevention and progression of diseases like Alzheimer’s. Physical activity exerts a beneficial impact on individuals with Alzheimer’s disease, playing a crucial role in both its prevention and the management of associated symptoms. In terms of prevention, physical activity influences various biological and physiological mechanisms that reduce the risk of developing Alzheimer’s disease. Regular exercise promotes neuroplasticity and neurogenesis, facilitating the creation of new nerve cells and enhancing brain plasticity.

Studies indicate that physical activity increases the levels of neurotrophic factors, such as Brain-Derived Neurotrophic Factor (BDNF), which support brain health and protect against neurodegeneration.[14] Moreover, regular physical exercise improves mental well-being by reducing the risk of depression and anxiety, both of which are significant risk factors for the development of Alzheimer's. [15] Physical activity also improves cerebral blood flow, promoting better oxygenation and nutrient delivery to neurons, which enhances the brain's capacity to cope with the degenerative processes that underlie Alzheimer's disease. [14]

In addition to its preventive effects, physical activity plays a vital role in the treatment of individuals already affected by Alzheimer's disease. Regular exercise, particularly moderate-intensity physical activity, has been shown to slow the progression of the disease by enhancing cognitive function and motor skills. It is also associated with a reduction in beta-amyloid levels, which are implicated in the formation of plaques in the brains of Alzheimer's patients. [15] Exercise has been demonstrated to improve cognitive abilities, including memory, concentration, and problem-solving skills, especially when combined with cognitive training. [14] Furthermore, physical activity contributes to improved mood and alleviates depressive symptoms, which are common among Alzheimer's patients and exacerbate the disease's symptoms. By promoting the release of endorphins, exercise helps to reduce stress and enhance overall well-being. [15] Finally, physical activity helps maintain mobility and enhances the quality of life for individuals with Alzheimer's. It improves muscle strength, balance, and coordination, which reduces the risk of falls and supports daily functioning, thereby contributing to greater independence and quality of life. [14]

THE EFFECTS OF RESISTANCE EXERCISE TRAINING

Resistance Exercise Training (RET), also known as strength training or weight training, is a form of physical exercise designed to improve muscular strength, endurance, and size by using resistance against muscle contraction. This resistance can be provided through various means, including free weights (dumbbells, barbells), weight machines, resistance bands, or even bodyweight exercises. RET involves several key elements that contribute to its effectiveness. The primary component is resistance, which refers to the external load or force that muscles must work against. This resistance forces muscles to contract, leading to muscle growth (hypertrophy), increased strength, and improved endurance over time. Another important aspect is repetition (rep), which denotes a single complete movement, such as lifting a weight from its starting position to the end and back. A set is a group of repetitions performed consecutively, for example, performing 10 repetitions of an exercise constitutes one set. The intensity of

resistance exercise refers to how heavy the weight or resistance is in relation to a person's maximum capacity. Higher intensity typically results in greater strength gains, while lower intensity with higher repetitions can enhance muscular endurance. Finally, progressive overload is a fundamental principle in RET, involving the gradual increase of resistance or weight in an exercise program. Over time, increasing the load challenges the muscles, stimulates growth, and encourages adaptation, leading to continuous improvement in strength and endurance.

There are several types of resistance exercise. Free weights involve using dumbbells, kettlebells, or barbells to perform exercises like squats, bench presses, or deadlifts.. Weight machines provide resistance through pulleys, hydraulics, or other mechanisms, designed to isolate specific muscle groups, such as the leg press or lat pulldown. Bodyweight exercises utilize the individual's own body weight as resistance, such as push-ups, pull-ups, lunges, and squats. Resistance bands are elastic bands that provide resistance during stretching and contraction. Lastly, isometric training involves holding a position against resistance, such as planks or wall sits, where the muscle remains contracted without changing length. RET has emerged as a promising therapeutic strategy for individuals with AD. Several studies have highlighted the beneficial effects of RET on various aspects of Alzheimer's pathology, from cognitive function to neuroinflammation and amyloidogenesis. Below, we summarize key findings from the literature regarding the influence of resistance exercise on Alzheimer's disease:

1. Cognitive Function Improvement

RET has been shown to improve cognitive function in Alzheimer's disease patients. Studies suggest that resistance training can enhance memory, executive function, and attention, particularly in older adults who are at risk of neurodegeneration. The molecular mechanisms underlying these improvements may involve increased neuroplasticity, enhanced synaptic function, and elevated brain-derived neurotrophic factor (BDNF) levels, all of which are crucial for maintaining cognitive health. These effects are especially beneficial in the early stages of AD, where neurodegeneration has not yet reached an advanced stage. [16]

2. Reduction of Neuroinflammation

One of the hallmark features of Alzheimer's disease is neuroinflammation, which contributes significantly to the progression of the disease. Resistance exercise has been shown to reduce neuroinflammation, primarily by modulating inflammatory cytokines and the activation of glial cells, such as microglia and astrocytes. In animal models of AD, short-term resistance exercise has been found to inhibit neuroinflammation, which may attenuate the neurodegenerative processes associated with Alzheimer's disease. [17]

3. Amyloidogenesis and Amyloid Plaque Formation

Amyloid plaques, primarily composed of beta-amyloid proteins, are a defining characteristic of Alzheimer's disease. Resistance exercise has been shown to impact amyloidogenesis— the process by which amyloid plaques form in the brain. Some studies indicate that RET can reduce the accumulation of beta-amyloid plaques, potentially by enhancing the clearance of these toxic proteins. This effect is thought to be mediated through improved blood-brain barrier function and increased clearance of amyloid-beta by glial cells. [16]

4. Structural Brain Changes and Neuroprotection

Several studies have examined the structural changes in the brain induced by resistance training. In older adults, RET has been associated with increases in gray matter volume, particularly in brain regions that are typically affected by Alzheimer's, such as the hippocampus and prefrontal cortex. These structural changes may reflect neuroprotective effects, helping to preserve brain function and reduce the risk of developing dementia. RET also promotes the release of neurotrophic factors that support neuronal survival and function. [18]

5. Molecular Mechanisms

At the molecular level, resistance exercise can activate several signaling pathways that contribute to neuroprotection. These include the PI3K/Akt pathway, which plays a role in cell survival and metabolism, and the mTOR pathway, which regulates protein synthesis and cellular growth. These pathways help promote neuronal health and enhance synaptic plasticity, potentially reversing or slowing the neurodegenerative processes seen in Alzheimer's disease. [19]

6. Preventive and Therapeutic Role

Resistance exercise not only holds promise for preventing Alzheimer's disease but also for slowing its progression. Regular engagement in RET, especially in the preclinical or early stages of Alzheimer's, may help delay the onset of cognitive decline. Furthermore, RET may be beneficial for individuals already diagnosed with Alzheimer's, offering a non-pharmacological approach to improve quality of life, reduce cognitive impairment, and mitigate other behavioral and psychological symptoms of dementia. [19]

THE EFFECTS OF AEROBIC EXERCISES

Aerobic exercise has emerged as a promising intervention for Alzheimer's disease (AD), demonstrating potential benefits in both preventing and managing its symptoms. Numerous studies have explored its effects on cognitive function, brain structure, and neurobiological

mechanisms, providing valuable insights into how aerobic activity may influence the course of Alzheimer's disease.

1. Cognitive Function Improvement

Aerobic exercise has been shown to have significant positive effects on cognitive function in individuals with Alzheimer's disease. Research indicates that regular engagement in activities such as walking, cycling, or swimming can improve memory, attention, and executive function. In particular, a systematic review and meta-analysis of randomized controlled trials (RCTs) found that aerobic exercise was associated with moderate improvements in cognitive function, especially in the domains of executive control and processing speed. These cognitive enhancements are particularly important in individuals with early to moderate stages of Alzheimer's, as they can help slow down the progression of cognitive decline. [20]

2. Neurobiological Mechanisms

The benefits of aerobic exercise for Alzheimer's disease go beyond cognitive improvements; it also appears to influence various neurobiological mechanisms that are central to the disease's progression. Aerobic exercise has been linked to increased BDNF levels. Moreover, aerobic exercise has been shown to reduce neuroinflammation, which is a significant contributor to the neurodegenerative processes in Alzheimer's. By modulating inflammatory markers and activating anti-inflammatory pathways, aerobic exercise can help mitigate the chronic neuroinflammation observed in Alzheimer's disease, potentially slowing disease progression. [21]

3. Brain Structural Changes

One of the most compelling findings regarding aerobic exercise and Alzheimer's disease is its potential to induce structural changes in the brain. Regular aerobic activity has been associated with increases in hippocampal volume, a region of the brain crucial for memory and spatial navigation. In individuals with Alzheimer's disease, the hippocampus is one of the first areas to experience significant atrophy, leading to memory impairments. Aerobic exercise appears to counteract this atrophy, helping to preserve or even enhance hippocampal volume. These structural changes are believed to reflect the brain's plasticity in response to regular physical activity, highlighting the neuroprotective effects of aerobic exercise. [22]

4. Prevention and Delaying Onset

Aerobic exercise also plays a crucial role in the prevention of Alzheimer's disease, particularly in those at risk of developing the disease due to genetic or lifestyle factors. Studies suggest that regular aerobic exercise can reduce the risk of dementia by improving cardiovascular health,

enhancing brain function, and promoting neuroprotective mechanisms. In people with mild cognitive impairment (MCI), a precursor to Alzheimer's disease, aerobic exercise has been shown to delay the onset of Alzheimer's by improving cognitive performance and maintaining functional independence. [23]

5. Overall Impact on Quality of Life

In addition to its cognitive and neurobiological effects, aerobic exercise contributes to an overall improvement in the quality of life for individuals with Alzheimer's disease. Regular physical activity can reduce symptoms of depression and anxiety, which are common in Alzheimer's patients. It also enhances mobility, balance, and physical function, promoting greater independence and reducing the risk of falls, which are a significant concern for those with Alzheimer's. [23]

EFFECTS OF DANCE MOVEMENT

Dance movement interventions (DMI) have emerged as a promising non-pharmacological approach for managing AD and related neurodegenerative disorders, demonstrating significant benefits for cognitive function, mood regulation, and physical coordination. Numerous studies have examined the effects of dance on individuals with Alzheimer's, showing that it engages a variety of brain areas involved in memory, executive function, motor skills, and social interaction.

Cognitive Benefits

One of the primary effects of dance on Alzheimer's patients is its positive influence on cognitive function. Dance involves complex motor and cognitive tasks, requiring synchronization, memory, attention, and spatial awareness. Studies have shown that DMI can improve cognitive abilities, such as executive function, memory, and processing speed. These benefits stem from the engagement of brain networks that are often compromised in Alzheimer's, including the hippocampus and prefrontal cortex.

For instance, dance improvisation, which involves spontaneous movement, relies heavily on the frontal lobes—regions of the brain associated with executive function, decision-making, and planning [24]. Movement-based tasks also require visual tracking and path integration, which engage spatial memory networks, including the entorhinal cortex and hippocampus—areas that are particularly vulnerable to the neurodegenerative changes characteristic of Alzheimer's disease [25]. A systematic review found that DMI positively affected spatial memory, which is often severely impaired in AD, by stimulating these critical brain structures [26].

Mood and Emotional Well-being

In addition to cognitive improvements, dance has significant benefits for mood regulation. Alzheimer's disease is frequently accompanied by symptoms of depression, anxiety, and agitation, which can exacerbate cognitive decline and diminish quality of life. Dance interventions have been shown to enhance emotional well-being by increasing the production of endorphins, which promote feelings of joy and relaxation. Moreover, DMI can provide a sense of accomplishment and improve social engagement, counteracting the isolation and apathy that often accompany Alzheimer's. Studies have shown that dance can significantly reduce agitation and improve mood in individuals with AD, leading to better overall emotional health [27; 28].

Social Interaction and Engagement

Dance is inherently social and encourages interaction with others, which is a key factor in improving the quality of life for individuals with Alzheimer's. Social engagement is crucial for people with AD, as it can help reduce feelings of isolation and support cognitive function through sustained interactions. Dance activities, especially those conducted in group settings, foster social connections and provide a platform for self-expression, which can boost self-esteem and create a sense of community. Group dance interventions have been shown to improve both social well-being and cognitive outcomes by fostering positive social bonds and reducing the emotional distress commonly experienced by individuals with Alzheimer's [24].

Physical Coordination and Mobility

Dance also has a beneficial impact on physical function in individuals with Alzheimer's disease. Regular participation in dance improves motor skills, balance, and coordination, which are often compromised as the disease progresses. Dance-based interventions, particularly those involving rhythm and movement, help enhance motor control by engaging both cognitive and physical processes. As a result, dance can reduce the risk of falls, a major concern for people with AD, and help maintain functional independence for a longer period. Furthermore, dance helps to preserve muscle strength and joint flexibility, which is essential for maintaining mobility and overall physical health in Alzheimer's patients [26].

Mechanisms of Action

The neurobiological mechanisms underlying the positive effects of dance on Alzheimer's disease are complex and multifactorial. Dance movements stimulate brain areas involved in motor control, sensory processing, and cognitive tasks, leading to increased brain plasticity and neurogenesis. Regular participation in dance has been shown to increase levels of BDNF [26] and reduce neuroinflammation.

OBESITY AND ITS IMPLICATIONS

It is widely accepted that insufficient amount of physical activity may lead to problems with maintaining a healthy weight. This is important to note as obesity is another proven risk factor for Alzheimer's disease. [29] The association between obesity and cognitive impairment has gained significant attention in recent years. For a long time, the relationship between these two conditions was not thoroughly explored. However, contemporary epidemiological research has provided compelling evidence that supports a strong connection between obesity and cognitive decline, particularly in the context of Alzheimer's disease (AD). Meta-analyses have shown that individuals with obesity or other metabolic disorders, such as diabetes and hypertension, are at nearly double the risk of developing Alzheimer's disease. [30] In obesity, white adipose tissue serves not only as a storage site for excess energy but also disrupts endocrine function. WAT releases a variety of substances known as adipokines, which have autocrine, paracrine, and endocrine effects both throughout the body and within the central nervous system (CNS). [31] Obesity has been associated with cognitive impairments, reduced long-term potentiation and synaptic plasticity, and a decrease in brain volume, all of which elevate the risk of developing Alzheimer's disease (AD) and other forms of dementia. [32] Obesity induces a state of low-grade chronic inflammation in adipose tissue, disrupting homeostatic systems and contributing to the development of various diseases, including neurodegenerative disorders. During this process, adipose tissue increases the production of pro-inflammatory adipokines, such as interleukin 1 beta (IL-1β), interleukin 6 (IL-6), tumor necrosis factor alpha (TNF-α), and leptin, while decreasing the levels of anti-inflammatory adipokines like adiponectin. [31] In addition, increased risk of developing AD can be attributed to several factors associated with obesity, such as chronic inflammation, insulin resistance, and altered brain metabolism, all of which may contribute to the degeneration of neural tissue. Additionally, obesity-related conditions like high blood pressure and dyslipidemia can further exacerbate the risk of cognitive decline. However, some studies show that obesity in late-life might have protective effects on cognition. [33] The hazard ratio (HR) for Alzheimer's disease (AD) was 0.89 (95% CI 0.81–0.98) among individuals with high late-life BMI. In contrast, there was a 20% increased risk of AD (95% CI 1.09–1.33) in those who experienced significant BMI loss from midlife to late-life. Interestingly, obese elderly individuals tended to have lower amyloid-beta (Aβ) load and larger hippocampal volumes. [34] It's important to note the role of age when evaluating the relationship between obesity and AD. Young adults should aim to maintain or lose weight within the healthy range

(18.5–24.9 kg/m²), while older adults should avoid excessive weight loss, as this could have negative implications.

SUMMARY

Dementia, particularly Alzheimer's disease (AD), is a growing global issue, currently affecting around 50 million people and projected to rise to 139 million by 2050. AD is characterized by progressive cognitive, functional, and behavioral decline, with no effective cure available. Early intervention is crucial, and epidemiological research suggests that modifiable risk factors, including physical inactivity, play a significant role in AD development. Regular physical activity has been shown to reduce the risk of AD and improve cognitive function, with both aerobic and resistance exercises playing key roles.

Aerobic exercise, such as walking and cycling, has been associated with improvements in memory, attention, and executive function, while resistance exercise training (RET) helps reduce neuroinflammation, amyloid plaque formation, and enhances brain structure, particularly in the hippocampus. Both types of exercise promote neuroplasticity, increase neurotrophic factors like BDNF, and improve overall brain health, which are crucial in preventing or managing AD symptoms. Exercise also improves mental well-being, reduces depressive symptoms, and enhances quality of life by boosting mobility, muscle strength, and reducing the risk of falls.

Dance movement interventions (DMI) have also shown promise in AD management. Dance improves cognitive function, mood, and motor skills by engaging key brain areas involved in memory and coordination. Additionally, it promotes social engagement, reducing isolation and boosting emotional well-being. Obesity is another risk factor for AD, contributing to cognitive decline through mechanisms like chronic inflammation and altered brain metabolism. Weight management, especially in midlife, plays an important role in mitigating AD risks.

In summary, regular physical activity, including exercise and dance, significantly benefits AD prevention and management by improving cognitive function, brain structure, and overall quality of life.

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References

[1] Patterson C. World Alzheimer report. London: Alzheimer's Disease International, 2018.

[2] Ballard, C., Gauthier, S., Corbett, A., Brayne, C., Aarsland, D., & Jones, E. (2011). Alzheimer's disease. The Lancet, 377(9770), 1019–1031. https://doi.org/10.1016/S0140-6736(10)61349-9 PMID: 21215747

[3] Yesavage J.A., Brooks J.O., Taylor J., Tinklenberg J. Development of aphasia, apraxia, and agnosia and decline in Alzheimer's disease. Am J Psychiatry. 1993;150:742–747. doi: 10.1176/ajp.150.5.742. PMID: 8349129

[4] Norton, S., Matthews, F. E., Barnes, D. E., Yaffe, K., & Brayne, C. (2014). Potential for primary prevention of Alzheimer's disease: An analysis of population-based data. The Lancet Neurology, 13(8), 788–794. https://doi.org/10.1016/S1474-4422(14)70136-X PMID: 25002388

[5] Livingston G, Huntley J, Sommerlad A, et al. Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. Lancet. 2020;396(10248):413–46. doi: 10.1016/S0140-6736(20)30367-6. PMID: 32770262.

[6] Hamer M, Chida Y. Physical activity and risk of neurodegenerative disease: a systematic review of prospective evidence. Psychol Med. 2009;39(3):3–11. doi: 10.1017/S0033291708003681. PMID: 18485223.

[7] Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet. 2012;380(9838):219–29. doi: 10.1016/S0140-6736(12)61031-9. PMID: 22735394.

[8] Laurin D, Verreault R, Lindsay J, MacPherson K, Rockwood K. Physical activity and risk of cognitive impairment and dementia in elderly persons. Arch Neurol. 2001;58(3):127–144. doi: 10.1001/archneur.58.3.498. PMID: 11255472.

[9] De la Rosa A, Solana E, Corpas R, Bartrés-Faz D, Pallàs M, Viña J. Long-term exercise training improves memory in middle-aged men and modulates peripheral levels of BDNF and Cathepsin B. Sci Rep. 2019;9(1):3337. doi: 10.1038/s41598-019-40040-8. PMID: 30876031.

[10] Erickson KI, Voss MW, Prakash RS, Basak C, Szabo A, Chaddock L. Exercise training increases size of hippocampus and improves memory. Proc Natl Acad Sci U S A. 2011;108(7):3017–3022. doi: 10.1073/pnas.1015950108. PMID: 21245305.

[11] Colcombe SJ, Erickson KI, Scalf PE, Kim JS, Prakash R, McAuley E. Aerobic exercise training increases brain volume in aging humans. J Gerontol A Biol Sci Med Sci. 2006;61(11):1166–1170. doi: 10.1093/gerona/61.11.1166. PMID: 17077199.

[12] Blumenthal JA, Emery CF, Madden DJ, Schniebolk S, Walsh-Riddle M, George LK. Long-term effects of exercise on psychological functioning in older men and women. J Gerontol. 1991;46(6):P352–P361. doi: 10.1093/geronj/46.6.p352. PMID: 1776906.

[13] Panton LB, Graves JE, Pollock ML, Hagberg JM, Chen W. Effect of aerobic and resistance training on fractionated reaction time and speed of movement. J Gerontol. 1990;45(1):M26–M31. doi: 10.1093/geronj/45.1.m26. PMID: 2292065.

[14] Meng Q, Lin MS, Tzeng IS. Relationship Between Exercise and Alzheimer's Disease: A Narrative Literature Review. Front Neurosci. 2020 Mar 26;14:131. doi: 10.3389/fnins.2020.00131. PMID: 32273835; PMCID: PMC7113559.

[15] De la Rosa A, Olaso-Gonzalez G, Arc-Chagnaud C, Millan F, Salvador-Pascual A, García-Lucerga C, Blasco-Lafarga C, Garcia-Dominguez E, Carretero A, Correas AG, Viña J, Gomez-Cabrera MC. Physical exercise in the prevention and treatment of Alzheimer's disease. J Sport Health Sci. 2020 Sep;9(5):394-404. doi: 10.1016/j.jshs.2020.01.004. Epub 2020 Feb 4. PMID: 32780691; PMCID: PMC7498620.

[16] Azevedo CV, Hashiguchi D, Campos HC, Figueiredo EV, Otaviano SFSD, Penitente AR, Arida RM, Longo BM. The effects of resistance exercise on cognitive function, amyloidogenesis, and neuroinflammation in Alzheimer's disease. Front Neurosci. 2023 Mar 2;17:1131214. doi: 10.3389/fnins.2023.1131214. PMID: 36937673; PMCID: PMC10017453.

[17] Liu, Y., Chu, J.M.T., Yan, T. et al. Short-term resistance exercise inhibits neuroinflammation and attenuates neuropathological changes in 3xTg Alzheimer’s disease mice. J Neuroinflammation 17, 4 (2020). https://doi.org/10.1186/s12974-019-1653-7

[18] Nicola L, Loo SJQ, Lyon G, Turknett J, Wood TR. Does resistance training in older adults lead to structural brain changes associated with a lower risk of Alzheimer's dementia? A narrative review. Ageing Res Rev. 2024 Jul;98:102356. doi: 10.1016/j.arr.2024.102356. Epub 2024 May 31. PMID: 38823487.

[19] Sepúlveda-Lara A, Sepúlveda P, Marzuca-Nassr GN. Resistance Exercise Training as a New Trend in Alzheimer's Disease Research: From Molecular Mechanisms to Prevention. Int J Mol Sci. 2024 Jun 27;25(13):7084. doi: 10.3390/ijms25137084. PMID: 39000191; PMCID: PMC11241132.

[20] Zhang S, Zhen K, Su Q, Chen Y, Lv Y, Yu L. The Effect of Aerobic Exercise on Cognitive Function in People with Alzheimer's Disease: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Int J Environ Res Public Health. 2022 Nov 25;19(23):15700. doi: 10.3390/ijerph192315700. PMID: 36497772; PMCID: PMC9736612.

[21] Abdullahi A, Wong TW, Ng SS. Understanding the mechanisms of disease modifying effects of aerobic exercise in people with Alzheimer's disease. Ageing Res Rev. 2024 Feb;94:102202. doi: 10.1016/j.arr.2024.102202. Epub 2024 Jan 23. PMID: 38272266.

[22] Graff-Radford NR. Can aerobic exercise protect against dementia? Alzheimers Res Ther. 2011 Feb 28;3(1):6. doi: 10.1186/alzrt65. PMID: 21392412; PMCID: PMC3109415.

[23] Morris JK, Vidoni ED, Johnson DK, Van Sciver A, Mahnken JD, Honea RA, Wilkins HM, Brooks WM, Billinger SA, Swerdlow RH, Burns JM. Aerobic exercise for Alzheimer's disease: A randomized controlled pilot trial. PLoS One. 2017 Feb 10;12(2):e0170547. doi: 10.1371/journal.pone.0170547. PMID: 28187125; PMCID: PMC5302785.

[24] Tao D, Supriya R, Gao Y, Li F, Liang W, Jiao J, Huang WY, Dutheil F, Baker JS, 2021. Dementia and Dance: Medication or Movement. Phys. Act. Health 5 (1), 250–254. 10.5334/paah.138.

[25] Ho RTH, Fong TCT, Chan WC, Kwan JSK, Chiu PKC, Yau JCY, Lam LCW, 2020. Psychophysiological effects of dance movement therapy and physical exercise on older adults with mild dementia: a randomized controlled trial. J. Gerontol. - Ser. B Psychol. Sci. Soc. Sci 75 (3), 560–570. 10.1093/geronb/gby145.

[26] Tao D, Awan-Scully R, Ash GI, Gu Y, Pei Z, Gao Y, Cole A, Supriya R, Sun Y, Xu R, Baker JS, 2023. Health policy considerations for combining exercise prescription into noncommunicable diseases treatment: a narrative literature review. Front. Public Health 11 (October), 1–10. 10.3389/fpubh.2023.1219676.

[27] Tao D, Gao Y, Cole A, Baker JS, Gu Y, Supriya R, Tong TK, Hu Q, Awan-Scully R, 2022. The physiological and psychological benefits of dance and its effects on children and adolescents: a systematic review. Front. Physiol 13 (June), 1–13. 10.3389/fphys.2022.925958.

[28] Yamada, Miho and Tomoyo Kawano. “Emerging wisdom through a traditional bon dance in group dance/movement therapy: A single case study of dementia.” Arts in Psychotherapy 75 (2021): 101822.

[29] Profenno LA, Porsteinsson AP, Faraone SV. Meta-analysis of Alzheimer's disease risk with obesity, diabetes, and related disorders. Biol Psychiatry. 2010;67(6):505–512. doi: 10.1016/j.biopsych.2009.02.013. PMID: 19230744.

[30] Gudala, K., Bansal, D., Schifano, F., & Bhansali, A. (2013). Diabetes mellitus and risk of dementia: A meta-analysis of prospective observational studies. Journal of Diabetes Investigation, 27(640–650). https://doi.org/10.1111/jdi.12087. PMID: 24575878.

[31]Forny-Germano L., De Felice F.G., Do Nascimento Vieira M.N. The Role of Leptin and Adiponectin in Obesity-Associated Cognitive Decline and Alzheimer's Disease. Front. Neurosci. 2019;12:1027. doi: 10.3389/fnins.2018.01027. PMID: 30713702.

[32] Sai C.L., Pan C.Y., Chen F.C., Huang T.H., Tsai M.C., Chuang C.Y. Differences in neurocognitive performance and metabolic and inflammatory indices in male adults with obesity as a function of regular exercise. Exp. Physiol. 2019;104:1650–1660. doi: 10.1113/EP087862. PMID: 31238153.

[33] Olsson AM, Ngandu T, Kareholt I, et al. Midlife and late-life body mass index and late-life dementia: results from a prospective population-based cohort. Journal of Alzheimer's Disease: JAD. 2014;38:201–209. doi: 10.3233/JAD-140393. PMID: 25124275.

[34] Sun Z, Wang Z-T, Sun F-R, et al. Late-life obesity is a protective factor for prodromal Alzheimer's disease: a longitudinal study. Aging. 2020;12:2005–2017. doi: 10.18632/aging.102865. PMID: 32025594.