THE IMPACT OF VARIOUS FORMS OF PHYSICAL EXERCISE ON COGNITIVE FUNCTIONS IN OLDER ADULTS

Wpływ wysiłku fizycznego na funkcje poznawcze osób starszych z uwzględnieniem różnych form aktywności

Karolina Magdalena Handzel, Antoni Anczyk, Filip Basta, Jacek Wysoczański, Miłosz Tworek, Grzegorz Zaborowski, Wiktoria Szlachta, Dominik Kret

Medical University of Silesia in Katowice, Polska

Karolina Magdalena Handzel – 0009-0004-5765-0458
Antoni Anczyk – 0009-0008-3817-3675
Filip Basta – 0009-0008-4685-7778
Jacek Wysoczański – 0009-0005-1983-486X
Miłosz Tworek – 0009-0000-5202-9364
Grzegorz Zaborowski – 0009-0004-6977-7616
Wiktoria Szlachta – 0009-0009-3739-4211
Dominik Kret – 0009-0007-6218-027X

Abstract

Background: Population aging poses significant challenges in the context of cognitive function maintenance. This review aims to compare the effectiveness of various forms of physical activity, including aerobic, resistance, and mind–body exercise, in improving key cognitive domains, with a particular focus on the older adult population. **Methods:** A systematic review of recent scientific literature was conducted, focusing on meta-analyses and systematic reviews available in Google Scholar and PubMed, using keywords related to physical exercise, cognitive functions, aging, and forms of physical activity. **Results:** The analysis revealed that each training modality has a specific benefit profile. Mind–body exercises (e.g., Tai Chi) showed the greatest positive impact on global cognitive function in healthy seniors (Cohen's Effect Size d = 0.48), surpassing both purely aerobic or resistance forms. Aerobic exercises strongly correlated with improved executive functions (planning, attention), while resistance training effectively supported memory and showed the potential to attenuate cognitive decline in clinical populations. Recent evidence indicates that combined (multimodal) training, especially a combination of aerobic and resistance exercises, leads to synergistic and superior benefits for executive functions, which are further enhanced by the integration of cognitive training elements. **Conclusions:** Physical activity represents a critical non-pharmacological intervention. Combined training, which promotes both physical endurance and cognitive coordination, appears to be the most optimal strategy for maximizing and expanding cognitive benefits. Given the persistent knowledge gaps regarding optimal protocols (dose-response relationships) and underlying mechanisms, further high-quality research investigating the synergistic effects of multimodal interventions is needed.

Streszczenie

Wprowadzenie: Proces starzenia się populacji stwarza istotne wyzwania w zakresie utrzymania funkcji poznawczych. Niniejszy przegląd ma na celu porównanie skuteczności różnych form aktywności fizycznej – aerobowej, oporowej (siłowej) oraz integrującej ciało i umysł – w poprawie kluczowych domen poznawczych, ze szczególnym uwzględnieniem populacji osób starszych. **Metody:** Przeprowadzono systematyczny przegląd literatury naukowej z ostatnich lat, koncentrując się na metaanalizach i przeglądach systematycznych dostępnych w bazach danych takich jak Google Scholar i PubMed, z wykorzystaniem słów kluczowych związanych z ćwiczeniami fizycznymi, funkcjami poznawczymi, starzeniem się i rodzajami aktywności fizycznej. **Wyniki:** Analiza ujawniła, że każda modalność treningowa ma specyficzny profil korzyści. Ćwiczenia typu mind–body (np. Tai Chi) wykazały największy pozytywny wpływ na globalne funkcje poznawcze u zdrowych seniorów (wielkość efektu Cohena d = 0,48), przewyższając formy wyłącznie aerobowe lub oporowe. Ćwiczenia aerobowe były silnie związane z poprawą funkcji wykonawczych (planowanie, uwaga), podczas gdy trening oporowy skutecznie wspiera pamięć i ma potencjał spowolnienia regresji poznawczej w grupach klinicznych. Najnowsze dowody wskazują, że trening łączony (multimodalny), zwłaszcza kombinacja ćwiczeń aerobowych i oporowych, prowadzi do synergicznych i maksymalnych korzyści dla funkcji wykonawczych, co jest dodatkowo wzmacniane przez integrację elementów poznawczych. **Wnioski:** Aktywność fizyczna jest kluczową, niefarmakologiczną interwencją. Optymalną strategią maksymalizacji i rozszerzenia korzyści poznawczych jest trening łączony, promujący zarówno wydolność fizyczną, jak i koordynację poznawczą. Ze względu na utrzymujące się luki w wiedzy dotyczące optymalnych protokołów (dawka–reakcja) i mechanizmów leżących u podstaw tych procesów, konieczne jest prowadzenie dalszych badań wysokiej jakości nad synergicznymi efektami interwencji multimodalnych.

Keywords: physical exercise; cognitive functions; elderly; aging; types of physical activity

Słowa kluczowe: ćwiczenia fizyczne; funkcje poznawcze; osoby starsze; starzenie się; rodzaje aktywności fizycznej

DOI 10.53301/lw/213566

Received: 10.10.2025

Accepted: 24.10.2025

Published: 30.06.2026

Corresponding author:
Karolina Magdalena Handzel
Medical University of Silesia in Katowice
e-mail: karolinahandzel30@gmail.com

Introduction

Population aging represents one of the major challenges facing contemporary societies, with significant implications for the mental health and cognitive functions of older individuals. As the proportion of older adults continues to grow, urgent adaptations and thorough research are needed across healthcare and academic domains.

Preserving the mental health and cognitive functions of older adults has become a major priority. This encompasses a wide range of preventive approaches, including regular exercise, adequate nutrition, social engagement, and cognitive stimulation, alongside early detection, access to specialized geriatric care, and the development of novel therapeutic and supportive strategies [1].

A growing body of research has investigated the beneficial effects of physical activity on cognitive functions, especially for older individuals. In the context of ageing societies, where cognitive functions like memory, attention, and information processing speed are progressively declining, physical activity plays an important role as both a preventive and therapeutic strategy.

Given the complexity of these issues and the rapid pace of new discoveries, a review of the latest scientific literature discussing the effects of physical activity on cognitive functions in older adults is needed. Remaining abreast of the latest research is essential to understand the underlying mechanisms, identify optimal intervention strategies, and develop effective policies to improve the quality of life of this population.

This review aims to determine which forms of exercise prove most beneficial for specific cognitive functions, like memory, attention, planning abilities, and processing speed, particularly in older adults.

Materials and methods

Our study is based on the analysis of domestic and foreign literature retrieved from "Google Scholar," "PubMed," and other scientific publications. The sources included in this work are limited to those published within the past few years to ensure the most up-to-date information. Data were collected using the following keywords: physical exercise, cognitive functions, elderly, aging, and types of physical activity. All co-authors contributed equally to the literature search, data analysis and interpretation.

Artificial intelligence (AI)

The sole purpose of using artificial intelligence was to improve the scholarly English of the manuscript. The tool assisted in enhancing clarity, consistency, and adherence to scientific writing standards by refining the language, grammar, and style, and ensuring clear presentation of the results. It should be emphasized that the AI tool was used solely as a supportive aid under human supervision. Its role was limited to improving linguistic precision and efficiency, while all data interpretation, analysis, and conclusions remained exclusively under the judgment of human authors.

Results

Impact of aging on cognitive functions

Aging affects the brain through multiple different pathways, causing changes in its structure and chemicals that are critical for cognitive function. These changes can lead to cognitive slowing. Recent research has shown that older adults tend to lose brain volume, particularly in the hippocampus, which plays an important role in episodic memory. A study using magnetic resonance imaging (MRI) in non-demented individuals found that the extent of brain volume loss is age-dependent and significantly associated with cognitive performance [2]. Furthermore, studies show that hippocampal atrophy accelerates around 60 years of age, and is associated with declining episodic memory [3].

Age-related changes in brain chemicals also play a significant role. For example, dopamine, a neurotransmitter linked to focus and decision-making, is progressively reduced in older adults, contributing to deficits in attention and planning abilities [4]. Other studies have found that dysregulation of dopaminergic, noradrenergic, and cholinergic neurotransmitter systems is associated with impaired memory and information processing in older adults [5]. A drop in acetylcholine levels, manifesting as reduced acetylcholine receptor responsiveness, is often associated with deficits in new memory and sustained attention [6]. More recent studies combining positron emission tomography (PET) and MRI have found that progressive reductions in neurotransmitter activity are linked to declining memory performance in individuals with early memory loss or dementia [7].

However, these changes do not occur in isolation. The trajectory of brain aging depends on many different

factors, including genes, lifetime cognitive engagement, and lifestyle choices, which can collectively modulate the extent to which these changes influence behaviour. Although these changes unfold over time, the effects vary from person to person, as demonstrated by recent research [4].

Forms of physical activity

Physical activity is generally classified into the following well-established categories [8]:

- Aerobic (Endurance) Activity – this category encompasses activities such as brisk walking, running, swimming, cycling, and dancing, which are characterized by increased respiratory demand and elevated heart rate.
- Resistance (Strength) Training – this category encompasses exercises designed to build muscle strength, often using weights, resistance bands, or body weight.
- "Mind–Body" Exercises (e.g., Tai Chi, Yoga) (Flexibility and Neuromotor – Balance, Agility, Coordination) – these activities integrate movement with mental focus, breathing, and meditation.

Impact of specific forms of activity on cognitive functions

Aerobic activity

Regular aerobic exercise has been shown to enhance cognitive abilities in older adults, particularly across domains such as memory, executive functions, and overall mental sharpness. Recent evidence shows that these benefits extend to individuals with early signs of memory deficits, known as mild cognitive impairment (MCI).

A study by Zhang et al. found that six months of aerobic exercises improved memory and attention in older adults with MCI [9]. Huang et al. reached similar conclusions, showing that regular aerobic activity improves cognitive functions in individuals with mild to moderate memory impairment [10]. A review by Lu et al. further demonstrated that physical activities, including aerobic exercise, can improve cognitive function in older adults with type 2 diabetes mellitus (T2DM), particularly in the domains of memory and executive function [11]. Aghjayan et al. found that aerobic exercise enhances memory in non-demented adults over 55 years of age, with the magnitude of benefits depending on age and exercise modality [12].

In addition to cognitive benefits, regular aerobic exercise has been shown to improve mood and overall well-being, which may further support cognitive functions. Yang et al. reported that aerobic exercise beneficially impacts patients with Alzheimer's disease by improving both their cognitive function and quality of life [13].

Resistance training

Resistance training also exerts a strong impact on cognitive functions in older adults, particularly in the domains of memory, executive functions, and mental health.

Research shows that these benefits extend to individuals with mild cognitive impairment. Li et al. found that regular resistance training helps improve overall cognitive skills in older adults and those with Alzheimer's disease, enhancing memory, focus, and attention [14]. Similar findings were reported by Zhang et al., showing that resistance training helps maintain cognitive health, particularly in older adults and those in medical settings [15]. A review by Han et al. found that regular resistance training significantly boosts cognitive function in older individuals, especially in the domain of inhibitory control. The most optimal results were seen with training frequency of twice a week for 45 minutes over 12 weeks [16]. Jerez-Salas et al. found that resistance training improves working memory and attentional performance in non-demented adults over 65 years of age, with the magnitude of benefits depending on age and the type of exercise [17]. Wu et al. showed that combining online and in-person resistance training is safe and effective for older adults with cognitive impairment, yielding moderate improvements in executive function, attention, physical strength, and overall well-being [18].

Mind–body exercise

Mind–body exercises, such as Tai Chi and yoga, are also linked to improved cognitive performance in older adults. Liu et al. found that Qigong Baduanjin exercises enhance cognitive functions in community-dwelling older adults, though the exact mechanisms are not fully understood [19]. A review by Han et al. (2025) suggested that mind–body exercises exert the greatest impact on memory among different forms of physical activity. The most optimal outcomes were achieved through high-frequency sessions (at least three times a week) of moderate (45 to 60 minutes) and longer periods (12 to 24 weeks) [16]. Cai et al. and Barney reported that mind–body exercises improve memory, reduce depressive symptoms, and improve balance, while also increasing levels of a neuroprotective protein and lowering a protein implicated in Alzheimer's disease [20, 21].

Comparison of the effectiveness of different forms of physical activity

When comparing different forms of physical activity, mind–body exercises often demonstrate superior outcomes. A comprehensive review published in 2023 showed that mind–body exercises exerted the greatest positive effect on global cognitive function in adults aged 55 years and older [22]. The cumulative effect size (measured by Cohen's Effect Size, d = 0.48) was substantially greater than that of general physical exercise (d = 0.22), suggesting that combining movement with focused attention and breathing can bring significant neuroprotective benefits. Other studies confirm that mind–body exercises enhance executive function, learning, and memory in individuals aged 60 years and older [23].

Resistance training is also highly effective. Research comparing resistance and aerobic training shows that both modalities improve global cognitive function, memory, and mental abilities in older adults [24]. While some studies suggest that resistance training might be more effective at slowing cognitive decline, the overall evidence shows that its efficacy is comparable to that of aerobic exercise [25]. The latest reviews strongly suggest

that combining aerobic and resistance exercises (known as concurrent training, CT) is more beneficial for cognitive health than either modality alone, particularly in older adults [15]. This is attributable to the synergistic mechanisms of the two forms of exercise – aerobic exercises improve blood flow and neurogenesis, while resistance training increases brain-friendly chemicals associated with muscle strength, which collectively support cognitive function.

Traditionally, aerobic exercise has been recognised for its pronounced effects on tasks that involve planning and attention [26]. These benefits are well-supported by scientific evidence, as aerobic activity enhances cerebral blood flow and upregulates the levels of brain-derived neurotrophic factor (BDNF), thereby promoting neuronal growth and connections [22].

In conclusion, while mind–body exercises may have the greatest impact on the global cognitive function in older adults, optimal outcomes are achieved through the integration of multiple exercise modalities, such as resistance and aerobic training, as shown by Gavelin et al. in their review [27].

Discussion

This review demonstrates that physical activity represents a key and multifaceted strategy for the prevention and attenuation of age-related cognitive decline. The purpose of the review, which was to determine which forms of exercise are optimal for different aspects of cognitive function, was met by comparing the evidence for aerobic, resistance, and mind–body exercises.

The main insight emerging from this discussion concerns the optimal implementation of these interventions. Our findings suggest that while each form of exercise offers certain benefits, combining aerobic and resistance training represents the most effective approach for use in real-world settings. This is corroborated by a 2024 meta-analysis [26], which demonstrated that concurrent aerobic and resistance exercises have a greater positive effect on executive function than either modality alone. This synergistic effect is attributable to a broader spectrum of physical benefits, such as enhanced cerebral blood flow and improved neuromuscular communication, which allows for more effective neuroplasticity.

Furthermore, when physical activity is paired with cognitive tasks, as in mind–body exercises involving complex movement sequences, additional benefits are observed. One study [27] found that combining physical and cognitive activities is more effective at supporting executive functions than physical activity alone, underscoring the value of attentional engagement during movement.

However, there are some challenges. A substantial proportion of the research, especially when comparing different forms of exercise, is characterized by inconsistency. For example, exercise protocols differ in terms of frequency, intensity, and duration. Study groups also vary, ranging from healthy older adults to those with mild cognitive impairment. For instance, optimal outcomes for resistance training were seen with a protocol of two sessions per week for 45 minutes over a 12-week period [16], whereas mind–body exercises may require longer periods. These differences make it difficult to determine the optimal amount of exercise (dose-response) for each group.

Despite these limitations, the primary finding remains unequivocal: a combination of different forms of physical activity is recommended to support global cognitive health in older adults. This includes regular aerobic and resistance exercises, which offer the greatest physiological benefits, alongside activities that integrate attentional engagement and motor coordination, such as mind–body or cognitive-physical exercises, which yield the most pronounced cognitive benefits.

Conclusion

In conclusion, our review confirms that physical activity represents a key, non-pharmacological strategy for supporting cognitive function in older adults. While mind–body exercises exert the greatest effect on the global cognitive function in healthy seniors, other exercise modalities remain equally important. Aerobic exercise is particularly beneficial for executive functions, whereas resistance training supports memory. The optimal approach for maximizing the benefits of physical activity is to integrate different exercise modalities. Combining endurance and resistance training with cognitive elements yields the greatest improvements in executive function. The impact of physical activity on cognitive function is an important and promising field of inquiry, and further high-quality research is needed, especially to better understand the optimal design of exercise protocols and the underlying mechanisms responsible for the cognitive benefits of multimodal training.

References

1. Livingston G, Huntley J, Sommerlad A, et al. Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. Lancet, 2020; 396(10248): 413–446. doi: 10.1016/S0140-6736(20)30367-6. Erratum in: Lancet, 2023; 402(10408): 1132. doi: 10.1016/S0140-6736(23)02043-3
2. Fujita S, Mori S, Onda K, et al. Characterization of brain volume changes in aging individuals with normal cognition using serial magnetic resonance imaging. JAMA Netw Open, 2023; 6(6): e2318153. doi: 10.1001/jamanetworkopen.2023.18153
3. Bråthen ACS, Sørensen Ø, de Lange AMG, et al. Cognitive and hippocampal changes weeks and years after memory training. Sci Rep, 2022; 12(1): 7877. doi: 10.1038/s41598-022-11636-4
4. Brito DVC, Esteves F, Rajado AT, et al. Assessing cognitive decline in the aging brain: lessons from rodent and human studies. NPJ Aging, 2023; 9(1): 23. doi: 10.1038/s41514-023-00120-6
5. Rieckmann A, Nyberg L. Cognitive aging: the role of neurotransmitter systems. In: Thomas AK, Gutchess A, eds. The Cambridge handbook of cognitive aging: a life course perspective. Cambridge: Cambridge University Press; 2020. p. 82–100
6. Gasiorowska A, Wydrych M, Drapich P, et al. The biology and pathobiology of glutamatergic, cholinergic, and dopaminergic signaling in the aging brain. Front Aging Neurosci, 2021; 13: 654931. doi: 10.3389/fnagi.2021.654931

7. Manca R, De Marco M, Soininen H, et al. Changes in neurotransmitter-related functional connectivity along the Alzheimer's disease continuum. Brain Commun, 2025; 7(1): fcaf008. doi: 10.1093/braincomms/fcaf008
8. American College of Sports Medicine. ACSM's Guidelines for exercise testing and prescription. 12th ed. Philadelphia (PA): Wolters Kluwer; 2022
9. Zhang S, Zhen K, Su Q, et al. 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; 19(23): 15700. doi: 10.3390/ijerph192315700
10. Huang B, Chen K, Li Y. Aerobic exercise, an effective prevention and treatment for mild cognitive impairment. Front Aging Neurosci, 2023; 15: 1194559. doi: 10.3389/fnagi.2023.1194559
11. Lu HH, Zhou Y, Chen C, Gu ZJ. Meta-analysis of the effect of exercise intervention on cognitive function in elderly patients with type 2 diabetes mellitus. BMC Geriatr, 2024; 24(1): 770. doi: 10.1186/s12877-024-05352-z
12. Aghjayan SL, Bournias T, Kang C, et al. Aerobic exercise improves episodic memory in late adulthood: a systematic review and meta-analysis. Commun Med (Lond). 2022; 2: 15. doi: 10.1038/s43856-022-00079-7
13. Yang L, Yuan Z, Peng C. Effects of aerobic exercise on cognitive function and quality of life in patients with Alzheimer's disease: a systematic review and meta-analysis. BMJ Open, 2025; 15(1): e090623. doi: 10.1136/bmjopen-2024-090623
14. Li W, Fang W, Zhang Y, et al. Research progress on resistance exercise therapy for improving cognitive function in patients with AD and muscle atrophy. Front Aging Neurosci, 2025; 17: 1552905. doi: 10.3389/fnagi.2025.1552905
15. Zhang M, Fang W, Wang J. Effects of human concurrent aerobic and resistance training on cognitive health: A systematic review with meta-analysis. Int J Clin Health Psychol, 2025; 25(1): 100559. doi: 10.1016/j.ijchp.2025.100559
16. Han H, Zhang J, Zhang F, Li F, Wu Z. Optimal exercise interventions for enhancing cognitive function in older adults: a network meta-analysis. Front Aging Neurosci, 2025; 17: 1510773. doi: 10.3389/fnagi.2025.1510773
17. Jerez-Salas F, Campos-Jara C, Araya Sierralta S, et al. Effects of resistance training on executive functions of cognitively healthy older adults: a systematic review and meta-analysis protocol. Healthcare (Basel), 2025; 13(2): 165. doi: 10.3390/healthcare13020165
18. Wu T, Wang X, Xu Y, et al. The effect of resistance training for older adults with cognitive frailty: a randomized controlled trial. BMC Geriatr, 2025; 25(1): 681. doi: 10.1186/s12877-025-06311-y
19. Liu J, Yang Y, Shi H, et al. Improving cognitive function in older adults through mind-body Qigong exercise at senior daycare centers: The role of sleep as a moderator and mediator. Explore (NY), 2025; 21(4):103167. doi: 10.1016/j.explore.2025.103167
20. Cai H, Zhang K, Wang M, et al. Effects of mind-body exercise on cognitive performance in middle-aged and older adults with mild cognitive impairment: A meta-analysis study. Medicine (Baltimore), 2023; 102(34): e34905. doi: 10.1097/MD.0000000000034905
21. Barney J. Alzheimer's discovery reveals dire effect of toxic tau protein. UVA Health Newsroom [Internet]. 2023 [access: 09.10.2025]. Available from: https://newsroom.uvahealth.com/
22. Blomstrand P, Tesan D, Nylander EM, Ramstrand N. Mind body exercise improves cognitive function more than aerobic- and resistance exercise in healthy adults aged 55 years and older – an umbrella review. Eur Rev Aging Phys Act, 2023; 20(1): 15. doi: 10.1186/s11556-023-00325-4
23. Zhang Y, Liu S, Luo Z, et al. The effects of mind-body exercise on cognitive performance in elderly: a systematic review and meta-analysis. Int J Environ Res Public Health, 2018; 15(12): 2791. doi: 10.3390/ijerph15122791
24. Xu L, Gu H, Cai X, et al. The effects of exercise for cognitive function in older adults: a systematic review and meta-analysis of randomized controlled trials. Int J Environ Res Public Health, 2023; 20(2): 1088. doi: 10.3390/ijerph20021088
25. Huang X, Zhao X, Li B, et al. Comparative efficacy of various exercise interventions on cognitive function in patients with mild cognitive impairment or dementia: a systematic review and network meta-analysis. J Sport Health Sci, 2022; 11(2): 212–223. doi: 10.1016/j.jshs.2021.05.003
26. Ren FF, Hillman CH, Wang WG, et al. Effects of aerobic exercise on cognitive function in adults with major depressive disorder: A systematic review and meta-analysis. Int J Clin Health Psychol, 2024; 24(2): 100447. doi: 10.1016/j.ijchp.2024.100447
27. Gavelin HM, Dong C, Minkov R, et al. Combined physical and cognitive training for older adults with and without cognitive impairment: A systematic review and network meta-analysis of randomized controlled trials. Ageing Res Rev, 2021; 66: 101232. doi: 10.1016/j.arr.2020.101232