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REVIEW ARTICLE

Effectiveness of physical exercise on cognitive and functional capacity in elderly patients with Alzheimer's disease: A systematic review of randomized controlled trials

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Abstract

Alzheimer's disease (AD) is a neurodegenerative condition characterized by progressive cognitive decline and a loss of functional independence. Physical exercise has emerged as a potential non-pharmacological intervention capable of improving or maintaining both cognitive and functional capacities in individuals with AD. This study synthesizes evidence from randomized controlled trials (RCTs) published between 2011 and 2024 evaluating the effects of physical exercise on cognitive and functional outcomes in elderly patients diagnosed with AD. A systematic search was conducted across PubMed, Web of Science, Cochrane Library, PsycINFO, and Physiotherapy Evidence Database databases, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses recommendations. The inclusion criteria were RCTs with participants (i) aged 65 years or older, (ii) clinically diagnosed with mild-to-moderate AD, (iii) who received structured physical exercise interventions compared with usual care or non-exercise controls, and (iv) assessed for cognitive and/or functional outcomes. The risk of bias was evaluated using the Cochrane Collaboration's risk-of-bias tool, and the quality of evidence was appraised using the Grading of Recommendations Assessment, Development, and Evaluation approach. Seven RCTs met the inclusion criteria ($n = 550$ participants, mean age = 75 years). Exercise interventions included aerobic, resistance, or multicomponent training lasting 12–52 weeks. Five studies demonstrated stabilization or modest improvement in cognitive scores, and six reported significant functional benefits in gait, balance, or activities of daily living. No serious adverse events were reported. Overall, moderate-intensity aerobic or multicomponent exercise performed at least 3 times weekly for 16 weeks or longer appears to maintain or modestly enhance cognitive performance, while consistently improving functional capacity in elderly individuals with mild-to-moderate AD. These findings support exercise as a safe, evidence-based adjunct to pharmacological treatment in AD management.

Keywords: Alzheimer's disease; Physical exercise; Cognitive function; Functional capacity; Elderly; Rehabilitation

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1. Introduction

Alzheimer's disease (AD) represents the leading cause of dementia worldwide, responsible for roughly two-thirds of all dementia cases in older adults.[1] Clinically, it is characterized by progressive deterioration in memory, executive functions, and behavior, leading to significant disability and dependency.[2] The neuropathological hallmarks include extracellular deposition of amyloid-β plaques, intracellular neurofibrillary tangles composed of hyperphosphorylated tau, synaptic loss, and neuroinflammation.[3,4]

Pharmacological treatments, such as cholinesterase inhibitors and N-methyl-D-aspartate receptor antagonists, provide symptomatic benefit but have a limited impact on disease progression.[5] Consequently, there is a growing interest in non-pharmacological strategies that may slow cognitive decline or preserve independence. Among these, physical exercise has shown promising neuroprotective and restorative potential.[6]

Exercise exerts multisystem effects relevant to AD. Aerobic training increases cerebral blood flow, improves mitochondrial efficiency, and enhances glucose metabolism. Both aerobic and resistance exercise elevate brain-derived neurotrophic factor (BDNF) and insulin-like growth factor-1 (IGF-1), which promote neurogenesis and synaptic plasticity within the hippocampus, key processes compromised in AD.[7] Moreover, exercise reduces systemic inflammation and oxidative stress, thereby potentially mitigating neurodegeneration.[8,9]

The pathophysiological hallmarks of AD, including extracellular accumulation of amyloid-β plaques, tau hyperphosphorylation, oxidative stress, and chronic neuroinflammation, collectively drive synaptic dysfunction and neuronal loss.[3,4] Emerging evidence indicates that physical exercise can counteract these mechanisms through several complementary biological pathways. Regular aerobic and resistance training can enhance amyloid-β clearance, modulate tau phosphorylation, and improve mitochondrial and vascular function.[6,9] Exercise further upregulates neurotrophic mediators, such as BDNF and IGF-1, promoting neurogenesis, synaptic maintenance, and neuronal resilience.[7] Across these combined effects, exercise may mitigate the neuropathological burden of AD, offering a biologically plausible and non-pharmacological approach to slowing disease progression.

Functionally, AD patients often experience gait instability, decreased muscle strength, and reduced ability to perform activities of daily living (ADL). These deficits not only compromise quality of life but also increase fall risk and institutionalization rates.[10,11] Exercise interventions targeting strength, balance, and endurance may therefore yield dual benefits: Improving physical independence while supporting cognitive integrity.[12,13]

Evidence from randomized controlled trials (RCTs) over the past decade has demonstrated encouraging, though sometimes heterogeneous, results. Some trials have reported significant improvements in global cognition and functional performance after structured exercise, whereas others observed stabilization rather than improvement.[14,15] Differences in intervention type, duration, intensity, and participant characteristics may explain this variability.

The aim of this systematic review is to consolidate evidence from RCTs published between 2011 and 2024 that examined the effects of physical exercise on cognitive and functional outcomes in elderly individuals with AD. By synthesizing results from these trials, this review aims to clarify the extent to which physical exercise contributes to the preservation or enhancement of cognitive and functional capacity in AD and to assess the overall quality of supporting evidence.

2. Literature review methodology

2.1. Study design

This review was designed and conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[16,17] The focus was restricted to RCTs investigating the effects of physical exercise interventions on cognitive and/or functional outcomes in elderly participants with AD.

2.2. Data sources and search strategy

Electronic searches were conducted in PubMed/MEDLINE, Web of Science, Cochrane Library (CENTRAL), PsycINFO, and the Physiotherapy Evidence Database. The search covered publications from January 2011 to December 2024. Search terms combined Medical Subject Headings and free-text keywords: "Alzheimer's disease," "physical exercise," "aerobic training," "resistance training," "physical activity," "cognitive function," "functional capacity," "activities of daily living," and "randomized controlled trial." Boolean operators (AND/OR) and truncations were applied to capture variations in terminology. Reference lists of retrieved articles and relevant reviews were also manually screened to identify any additional eligible studies.

2.3. Eligibility criteria

Studies were included if they met the following criteria: (i) Employed an RCT design; (ii) included participants aged ≥65 years with a clinical diagnosis of mild-to-moderate AD according to standardized criteria (Diagnostic and

Statistical Manual of Mental Disorders, Fourth Edition, and the National Institute of Neurological and Communicative Disorders and Stroke/AD and Related Disorders Association); (iii) implemented interventions comprising structured physical exercise (aerobic, resistance, balance, or multicomponent training), either supervised or home-based; (iv) included comparator groups receiving usual care, health education, or non-exercise interventions; and (v) measured outcomes assessing global cognition (mini-mental state examination [MMSE], AD assessment scale–cognitive subscale [ADAS-Cog]) and/or functional performance (balance tests, gait, ADL).

Exclusion criteria included observational studies, quasi-experimental designs, and trials that combined exercise with cognitive training as a primary component, as well as studies lacking quantitative outcome data. This exclusion criterion was adopted to isolate the independent effect of physical exercise and avoid confounding influences from cognitive-training protocols, which target different neural mechanisms.

2.4. Study selection and data extraction

Two independent reviewers screened titles and abstracts to determine eligibility. Full-text versions of potentially relevant articles were retrieved and assessed against the inclusion criteria. Disagreements were resolved through discussion until a consensus was reached. For each included study, data were extracted using a standardized form capturing (i) author(s), year, and country; (ii) sample size and participant demographics (age, sex, baseline MMSE); (iii) intervention characteristics (type, intensity, frequency, session duration, total duration); (iv) control condition; (v) outcome measures and results (cognitive and functional); and (vi) adherence and adverse events.

2.5. Risk of bias assessment

Risk of bias was independently evaluated by both reviewers using the Cochrane Collaboration's tool. Each study was rated for random sequence generation, allocation concealment, blinding of participants and outcome assessors, completeness of data, and reporting of selective outcomes. Each domain was classified as low, high, or unclear risk.[18]

2.6. Quality of evidence

The overall strength of evidence for each primary outcome (global cognition, functional capacity) was determined using the grading of recommendations, assessment, development, and evaluation (GRADE) approach. Evidence quality was rated as high, moderate, low, or very low based on the risk of bias, consistency of results, directness, precision, and likelihood of publication bias.[19]

2.7. Data synthesis

Given the expected methodological and clinical heterogeneity among the included trials, a narrative synthesis approach was adopted. Study characteristics and main findings are summarized in structured tables (Tables 1 and 2), and the overall certainty of evidence for cognitive and functional outcomes was evaluated using the GRADE framework (Table 3). A quantitative meta-analysis was not feasible due to the considerable variability across studies in exercise modalities (aerobic, resistance, or multicomponent training), intervention duration and intensity, participant demographics, and outcome assessment tools. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, a descriptive synthesis was therefore conducted to ensure an accurate and transparent representation of the available evidence.

3. Results

3.1. Study selection

Of 1,474 records identified, 788 remained after removal of duplicates and title/abstract screening, and eight full-text reports were ultimately reviewed. Seven studies met the inclusion criteria and were included in the final systematic review (Figure 1), while one study was excluded because it was not an RCT. All studies were published between 2011 and 2017 and conducted in developed or upper-middle-income countries: The United States (n = 3), Australia (n = 1), Brazil (n = 1), China (n = 1), and Denmark (n = 1).[20-26]

3.2. Study characteristics

The seven trials collectively included 550 participants (aged 69–85 years) with mild-to-moderate AD. Sample sizes ranged from 20 to 200 participants. Mean MMSE scores at baseline ranged from 13 to 23 points, reflecting predominantly moderate impairment.

All interventions consisted of structured exercise programs, administered over 12–52 weeks, typically involving 2–7 sessions/week, each lasting 30–60 min. Exercise modalities included aerobic walking, treadmill or cycling training, resistance and balance exercises, or multicomponent regimens combining aerobic and strengthening elements. Control groups generally received usual care or non-exercise activities (health education, stretching).

Cognitive outcomes were primarily assessed using the MMSE or ADAS-Cog, while functional outcomes included gait speed, balance tests (Berg Balance Scale & Timed Up and Go Test), and independence in ADLs (Table 1).

3.3. Exercise interventions and outcomes

Across the seven studies, five demonstrated improvements or maintenance in cognitive performance compared

Table 1. Characteristics of the included studies

Author	Country	Design	Sample (*n*)	Mean age (years)	Baseline MMSE (mean±standard deviation)	Primary outcome
Venturelli *et al.*[20]	USA	RCT	24	84	13±2	Cognitive function (MMSE)
Vreugdenhil *et al.*[21]	Australia	RCT	40	74	21±3	Functional capacity
Arcoverde *et al.*[22]	Brazil	RCT	20	79	18±2	Gait and balance
Yang *et al.*[23]	China	RCT	50	71	20±3	Cognitive performance (MMSE)
Hoffman *et al.*[24]	Denmark	RCT	200	70	23±3	Cognitive and functional outcomes (MMSE, ADL)
Öhman *et al.*[25]	USA	RCT	140	78	18±6	Functional performance (ADL, balance)
Morris *et al.*[26]	USA	RCT	76	74	22±4	Aerobic versus non-aerobic training

Abbreviations: ADL: Activities of daily living; MMSE: Mini-mental state examination; RCT: Randomized controlled trial; USA: United States of America.

Table 2. Characteristics of the exercise interventions

Author	Exercise type	Intensity	Frequency	Session duration	Total duration	Control group	Main results
Venturelli *et al.*[20]	Walking (aerobic)	Moderate	4×/week	30 min	24 weeks	Usual care	Improved MMSE (+2 points); preserved cognitive function compared to control decline
Vreugdenhil *et al.*[21]	Strength and balance training	Moderate	7×/week	30 min	16 weeks	Pharmacological treatment only	Improved functional capacity and mobility; no cognitive changes
Arcoverde *et al.*[22]	Treadmill aerobic	40–60% $VO_{2\ max}$	2×/week	30–60 min	16 weeks	Usual care	Significant improvement in gait speed and balance tests
Yang *et al.*[23]	Stationary cycling	70% HR_{max}	3×/week	25–40 min	12 weeks	Usual care	Improved MMSE (7.03% increase in score); cognitive gains maintained at follow-up
Hoffman *et al.*[24]	Combined aerobic+resistance	70–80% HR_{max}	3×/week	60 min	16 weeks	Usual care	Improved MMSE (+0.1); enhanced ADL performance and quality of life
Öhman *et al.*[25]	Supervised+home multicomponent (aerobic, balance, strength)	Moderate	2×/week	60 min	12 months	Usual care	Improved ADL, mobility, and balance; cognitive stabilization
Morris *et al.*[26]	Progressive aerobic (cycling, treadmill)	40–75% HR_{max}	3–5×/week	60 min	26 weeks	Non-aerobic (stretching, yoga)	Greater improvements in the aerobic group for cognition, mood, and gait

Abbreviations: ADL: Activities of daily living; HR_{max}: Maximum heart rate; MMSE: Mini-mental state examination; $VO_{2\ max}$: Maximum volume of oxygen.

Table 3. Grading of recommendations, assessment, development, and evaluation evidence

Outcome	Number of RCTs	Risk of bias	Consistency	Directness	Precision	Publication bias	Overall quality
Global cognition (MMSE/ADAS-Cog)	5	Moderate (some unclear allocation concealment)	Moderate	High	Moderate	Possible	Moderate
Functional capacity (balance, gait, ADL)	6	Low–moderate	High	High	Moderate	Unlikely	Moderate–high
Quality of life	2	Moderate	Low	High	Low	Possible	Low–moderate
Safety (adverse events)	7	Low	High	High	High	None detected	High

Abbreviations: ADAS-Cog: Alzheimer's disease assessment scale–cognitive subscale; ADL: Activities of daily living; MMSE: Mini-mental state examination; RCT: Randomized controlled trial.

with control conditions. Aerobic and multicomponent exercise appeared to be the most effective. Notably, Venturelli *et al.*[20] and Yang *et al.*[23] observed measurable MMSE improvements, while Hoffman *et al.*[24] and Öhman

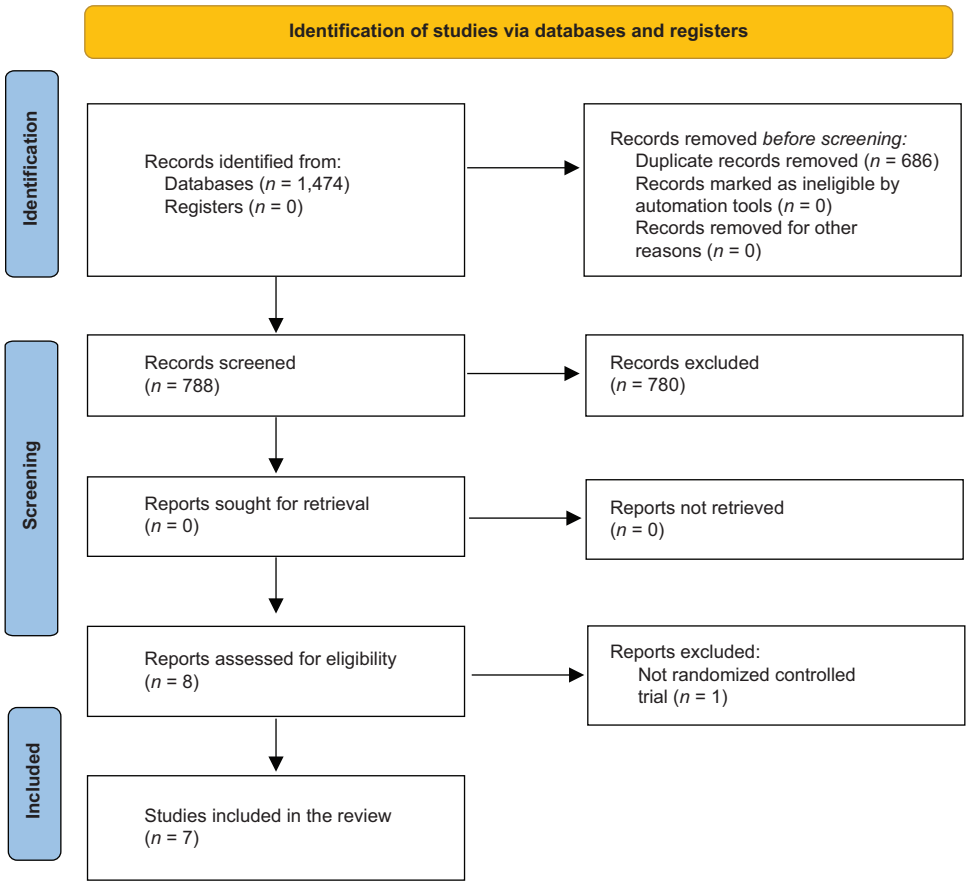

Figure 1. Preferred reporting items for systematic reviews and meta-analyses flow diagram of the study selection process

et al.[25] found maintenance of cognitive function alongside functional benefits (Table 2).[20,23,24,25]

Regarding functional outcomes, six studies reported significant enhancements in balance, gait speed, or ADL independence. Improvements were particularly notable in interventions lasting 16 weeks or more and conducted at moderate intensity.[21,26]

No study reported serious adverse events. Adherence rates ranged from 75% to 92%, with the highest compliance in supervised or group-based programs. Table 2 details the type, intensity, frequency, and duration of the exercise programs.

3.4. Risk of bias

Overall, the methodological quality of the included studies was moderate. Most trials demonstrated a low risk of bias for random sequence generation and completeness of outcome data, and selective reporting was rarely observed. However, blinding of participants and personnel was generally rated as high or unclear risk, reflecting the inherent challenges of concealing group allocation in exercise-based interventions. Blinding of outcome assessors was more consistently reported, although details were insufficient in several studies. Allocation concealment was clearly described in only three trials, resulting in an overall classification of moderate methodological quality. These patterns are consistent with previous reviews of exercise interventions in dementia populations, where behavioral interventions are less amenable to full blinding.

3.5. GRADE assessment

The GRADE assessment indicated that the overall quality of evidence supporting the effects of physical exercise on both cognitive and functional outcomes in AD was moderate, reflecting reasonable confidence in the observed benefits (Table 3). Evidence for global cognition (MMSE, ADAS-Cog) was downgraded primarily due to methodological limitations, including small sample sizes and unclear allocation concealment in several trials. Nevertheless, the direction and consistency of results across five studies supported a genuine positive effect of exercise on cognitive performance. Evidence for functional outcomes

(balance, gait, ADL) was rated moderate to high, driven by the larger number of studies showing reproducible and clinically relevant gains with minimal heterogeneity. Quality of life outcomes were assigned a low-to-moderate certainty rating because they were secondary endpoints, often assessed using heterogeneous tools and with limited precision. Importantly, the high quality rating for safety outcomes reflects the consistent absence of adverse events across all studies, underscoring the feasibility and tolerability of structured exercise programs in elderly populations with mild-to-moderate AD. Collectively, the GRADE synthesis supports physical exercise as a reliable, evidence-based adjunct to conventional care in AD, while also highlighting the need for larger, methodologically robust trials to further strengthen the confidence of these findings (Table 3).

4. Discussion

This systematic review, based on a search conducted for studies published between 2011 and 2024, ultimately synthesized seven RCTs that were published between 2011 and 2024. These trials collectively demonstrate that structured physical exercise has a beneficial impact on both cognitive and functional outcomes in elderly individuals with mild-to-moderate AD. Collectively, the evidence indicates that exercise interventions, particularly aerobic and multicomponent programs, can maintain or enhance cognitive performance while improving physical independence, gait, and balance. Although methodological heterogeneity and moderate sample sizes preclude firm quantitative conclusions, the consistency in direction of results across the reviewed trials supports exercise as a biologically plausible and clinically relevant approach to AD management.

4.1. Cognitive outcomes and mechanistic interpretation

Five of the seven trials reported improvement or stabilization of cognitive function following exercise compared with controls. Venturelli *et al.*[20] and Yang *et al.*[23] observed significant MMSE gains after 12–24 weeks of aerobic training, while Hoffman *et al.*[24] and Öhman *et al.*[25] reported cognitive stabilization relative to decline in controls.[20,23-25] These results are consistent with recent meta-analyses showing that moderate-intensity exercise produces small-to-moderate improvements in global cognition in AD.[27,28]

Neuroimaging and biomarker evidence support these effects. A 2024 Bayesian network meta-analysis identified an optimal dose–response of 650–700 metabolic equivalent of task minutes per week for maximal cognitive benefit,[29] while a 2023 meta-analysis reported significant increases in BDNF and IGF-1 after 12–24 weeks of training, reinforcing a plausible neurobiological basis.[30]

Overall, cognitive gains remained modest, with most studies showing stabilization rather than marked improvement, suggesting that exercise may slow rather than reverse decline. The reliance on global measures, such as MMSE or ADAS-Cog, which are insensitive to domain-specific changes, may further explain variability in observed effects.

4.2. Functional outcomes and physiological basis

Six of the seven trials reported significant functional improvements in gait, balance, and ADLs. Arcoverde *et al.*[22] and Vreugdenhil *et al.*[21] found that treadmill and balance–strength training enhanced mobility and functional capacity, while Öhman *et al.*[25] observed better ADL performance after a 12-month multicomponent program. These results align with a 2021 systematic review of 28 RCTs showing that exercise significantly improves physical function and independence in AD.[31]

Beyond muscular gains, exercise enhances neuromuscular coordination, proprioception, postural control, and cardiovascular efficiency, counteracting motor decline and reinforcing cognition through increased self-efficacy and engagement.[24] This functional–cognitive interdependence is further supported by a 2022 meta-analysis demonstrating that combined aerobic-resistance programs yield the greatest benefits in both gait and global cognition.[32] Trials by Hoffman *et al.*[24] and Morris *et al.*[26] confirmed this synergy, whereas shorter or lower-intensity protocols (e.g., Arcoverde *et al.*[22]) produced more limited effects.

4.3. Neurobiological plausibility and systemic effects

The beneficial effects of physical exercise in AD likely arise from the interaction of several complementary biological pathways. Regular aerobic or multicomponent training enhances cerebral blood flow, glucose metabolism, and mitochondrial efficiency, thereby counteracting the cerebral hypoperfusion and metabolic deficits typical of AD.[23,26] Exercise stimulates the expression of neurotrophic factors, such as BDNF, IGF-1, and vascular endothelial growth factor; together, these mediators promote neurogenesis, synaptic maintenance, and neuronal resilience in the hippocampus and prefrontal regions.[20,26,30] In parallel, improved endothelial function and angiogenesis enhance cerebral oxygenation, while systemic reductions in pro-inflammatory cytokines (interleukin 6, tumor necrosis factor alpha, C-reactive protein) and oxidative stress further support neural integrity.[9,33] Together,

these vascular, metabolic, and anti-inflammatory effects provide a biologically plausible explanation for the modest cognitive and functional benefits observed in the reviewed trials.

Moreover, improved vascular health may partly mediate the benefit. Cerebral small-vessel disease and impaired perfusion are common comorbidities in AD; exercise-induced angiogenesis and endothelial function improvements mitigate these risks.[23] A 2023 meta-analysis examining cardiovascular fitness interventions in dementia reported that aerobic capacity increases correlated strongly with both improvement in MMSE scores and reductions in ADL dependency.[33] These data reinforce the view that maintaining cardiovascular fitness directly supports cognitive function by enhancing brain oxygenation and nutrient supply.

The reviewed trials also demonstrated excellent safety profiles. None reported serious adverse events, and adherence rates were generally high, particularly in supervised programs. This supports the feasibility of implementing structured exercise interventions in elderly populations with cognitive impairment, provided that proper monitoring and individualized progression are ensured.

4.4. Integration with broader evidence

The results of this review are consistent with those from more recent large-scale meta-analyses that include trials published up to and beyond 2024. For instance, a 2024 systematic review of 27 RCTs found consistent cognitive improvements with aerobic exercise, particularly at moderate intensity and with program durations exceeding 16 weeks.[29] Similarly, a 2021 review comparing exercise and pharmacologic interventions observed that exercise produced cognitive effect sizes comparable to donepezil over equivalent intervention periods, suggesting comparable efficacy within a non-pharmacological framework.[34]

Together, these findings strengthen the hypothesis that the therapeutic benefits of exercise in AD are dose-dependent and mediated through complementary vascular, metabolic, and neuroplastic pathways. Importantly, the convergence of evidence across time and methodological diversity lends external validity to the conclusions drawn from the seven RCTs included in this review.

Nevertheless, it remains evident that the magnitude of observed cognitive improvements is generally smaller than that seen for functional outcomes. This discrepancy may reflect both the neurobiological complexity of cognitive impairment and the relative sensitivity of functional measures to rehabilitation. While exercise clearly contributes to maintaining cognitive stability and slowing decline, full reversal of neurodegenerative changes remains biologically unlikely.

In summary, the reviewed body of evidence, supported by contemporary meta-analyses, provides a coherent and biologically plausible framework for the role of exercise in AD. Regular moderate-intensity physical exercise is effective in maintaining functional independence and may attenuate cognitive decline or produce modest cognitive improvements through mechanisms that involve enhanced neuroplasticity, improved vascular health, and reduced systemic inflammation. While more recent meta-analyses reported broader cognitive benefits, these findings serve primarily as external supportive evidence rather than altering the conclusions drawn from the seven RCTs analyzed in this review.

4.5. Clinical implications

From a clinical perspective, exercise should be viewed as an essential complementary strategy within multidisciplinary AD management. Programs that combine aerobic, resistance, and balance components, performed at moderate intensity for at least 16 weeks, appear most effective for maintaining independence and mobility.[25,26,29] Adherence across the reviewed trials was high (75–92%), and no serious adverse events were reported, confirming feasibility and safety in elderly individuals with mild-to-moderate AD.

While some external meta-analyses have noted that cognitive improvements from exercise may reach magnitudes comparable to those of pharmacologic treatments, such as donepezil,[35] these comparisons are indirect and should be interpreted with caution. Exercise is not a substitute for medication but a biologically grounded, cost-effective adjunct that enhances overall well-being and functional capacity.

4.6. Limitations

Despite encouraging results, the strength of evidence remains limited by the small sample sizes, variable intervention protocols, and short follow-up durations. Blinding and allocation concealment were often incomplete, introducing potential bias. Future research should employ standardized reporting of frequency, intensity, time, and type of exercise, include mechanistic biomarkers (e.g., BDNF, tau, amyloid load), and extend follow-up to evaluate long-term sustainability. Large multicenter RCTs integrating clinical, cognitive, and neurobiological outcomes are needed to consolidate the role of exercise in AD management.

4.7. Future research

Future RCTs should recruit larger, multicenter samples with follow-up durations of at least 12 months to assess the persistence of benefits. Standardized reporting of exercise parameters, following the frequency, intensity, time, type framework, and harmonized cognitive and functional outcomes, are needed to enhance comparability.

The integration of neuroimaging (magnetic resonance imaging, functional magnetic resonance imaging) and biomarker analyses (BDNF, cytokines, tau, & amyloid) will help elucidate mechanisms and identify responders. Further exploration of dose–response relationships may clarify optimal training thresholds and prevent overtraining effects.

Combined interventions—linking exercise with cognitive training or nutritional strategies—should be tested for synergistic effects. Implementation studies are also necessary to evaluate feasibility and cost-effectiveness in community and home-based settings. Ensuring diverse participant representation across sociocultural and disease severity spectra will strengthen the external validity of future findings.

5. Conclusion

Evidence from seven RCTs indicates that regular, structured physical exercise, particularly aerobic and multicomponent programs of moderate intensity, produces consistent functional improvements and stabilization or modest enhancement of cognitive outcomes in older adults with mild-to-moderate AD. These findings suggest that exercise may help slow cognitive decline rather than produce substantial improvements, reinforcing its value as a safe, evidence-based adjunct to pharmacologic management.

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Conflict of interest

The authors declare that they have no competing interests.

Author contributions

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Visualization: All authors
Writing – original draft: All authors
Writing – review & editing: All authors

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data

The data will be available from the corresponding author upon reasonable request.

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