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EFFECTIVENESS OF HIGH-INTENSITY EXERCISE VERSUS MIND-BODY INTERVENTIONS IN IMPROVING COGNITION IN OLDER ADULTS WITH MILD COGNITIVE IMPAIRMENT: A SYSTEMATIC REVIEW AND META-ANALYSIS

EFECTIVIDAD DEL EJERCICIO DE ALTA INTENSIDAD FRENTE A INTERVENCIONES MENTE-CUERPO EN LA MEJORA DE LA COGNICIÓN EN ADULTOS MAYORES CON DETERIORO COGNITIVO LEVE: REVISIÓN SISTEMÁTICA Y METAANÁLISIS

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Abstract

According to the World Health Organization (WHO), by 2050, the proportion of people aged 60 years and above will double, posing a public health challenge due to the rising prevalence of mild cognitive impairment (MCI). Considering this evidence, high-intensity exercise and mind-body interventions have been recognized as approaches to preserve the physical and cognitive well-being of older adults. This review aimed to determine the optimal dose-response of high-intensity exercise compared to mind-body interventions for enhancing cognition in older adults with MCI in Colombia. A systematic review with meta-analysis was conducted, involving a bibliographic search between January and April 2024 in the PubMed, Scopus, CINAHL and Web of Science databases. Randomized clinical trials (RCTs) that implemented these interventions as part of MCI or dementia treatment in older adults were selected. From 1,607 studies identified, 28 met the inclusion criteria, all measuring cognition as the primary outcome. The meta-analysis yielded an average effect size of g = 0.644 (95% CI: 0.185 – 1.104, p = 0.006) for high-intensity exercise and g = 0.404 (95% CI: 0.288 – 0.521, p < 0.001) for mind-body interventions. None of the studies successfully blinded participants or therapists, which is known to lead to an overestimation of results by 7% to 13%. High-intensity exercise appears to be more effective than mind-body interventions for improving cognition, likely due to its role in increasing brain-derived neurotrophic factor (BDNF) and its impact on higher mental functions.

Keywords: Cognitive impairment, cognition, high-intensity exercise, mind-body interventions, older adults.

Resumen

Según la Organización Mundial de la Salud (OMS), para el año 2050 la proporción de personas mayores de 60 años se duplicará, representando un problema de salud pública frente al incremento del deterioro cognitivo leve (DCL). Ante esto, las intervenciones específicas de ejercicio representan una herramienta para preservar el bienestar físico y cognitivo de los adultos mayores. El objetivo principal de esta revisión fue determinar la dosis-respuesta óptima del ejercicio de alta intensidad en comparación con las intervenciones mente-cuerpo para mejorar la cognición en adultos mayores con DCL en Colombia. Se llevó a cabo una revisión sistemática con metaanálisis, realizando una búsqueda bibliográfica entre enero y abril del 2024 en las bases de datos Pubmed, Scopus, CINAHL y Web of Science. Se seleccionaron ensayos clínicos aleatorizados que incluyeron estas intervenciones como apoyo al tratamiento de adultos mayores con DCL o demencia. De los 1607 estudios identificados, se incluyeron 28 artículos que midieron la cognición como variable principal. Posterior al metaanálisis, se determinó el tamaño de efecto medio del ejercicio de alta intensidad (*g* = 0,644, *IC* 95%: 0,185 — 1,104, *p* = 0,006) y las intervenciones mente-cuerpo (*g* = 0,404, *IC* 95%: 0,288 — 0,521, *p* < 0,001). Ningún estudio logró cegar a los participantes o terapeutas, lo que tiende a generar sobreestimación de los resultados entre un 7% y 13%. El ejercicio de altaintensidad parece ser más efectivo que las intervenciones mente-cuerpo para mejorar la cognición debido al aumento del factor neurotrófico derivado del cerebro y sus efectos sobre las funciones mentales superiores.

Palabras clave: Adultos mayores, cognición, deterioro cognitivo, ejercicio de alta intensidad, intervenciones mente-cuerpo.

Introduction

The changes associated with aging tend to affect a wide variety of tissues, organs, systems, and their functions due to physiological variations, genetic predispositions, prior illnesses, and lifestyle-related factors, among others. These changes interfere with an individual's ability to perform activities of daily living (Minaker, 2012). Part of this normal aging process may manifest as cognitive impairment, which can appear in a mild form or progress toward dementia (Jongsiriyanyong & Limpawattana, 2018). This impairment affects memory and other cognitive skills, impacting the individual's independence and quality of life (WHO, 2023).

Recently, the Alzheimer's Association (2024b) reported that approximately 12%–18% of people aged 60 years or older live with Mild Cognitive Impairment (MCI), of whom 10%–15% will develop dementia each year, and one-third of this population will develop Alzheimer's disease within five years. These figures raise public health concerns, as according to the WHO (2022), the number of people over 60 years old has surpassed that of children under five, and this population is projected to double between 2015 and 2050, increasing from 12% to 22%. Although pharmacological treatments currently exist to address symptoms associated with MCI or dementia, non-pharmacological interventions such as Physical Activity (PA) or Exercise (EX) are also recommended, since physically inactive individuals are at greater risk of experiencing cognitive and motor decline (Alzheimer's Association, 2024a; Lövdén et al., 2013; Nyberg et al., 2014).

These types of interventions not only help maintain or improve cognitive function but also significantly contribute to health, quality of life, and the ability to perform daily activities (Alzheimer's Association, 2024a). In particular, Mind-Body Exercises (MBE), which are low-intensity practices such as tai chi, mindfulness, and qigong, promote mental relaxation, concentration, and breathing control, and may improve cognitive performance in older adults with MCI (Cai et al., 2023). On the other hand, High-Intensity Functional Training (HIFT), which combines aerobic and strength exercises through functional, multi-joint movements performed at high intensities (Feito et al., 2018), has also been shown to reduce the risk of cognitive decline (Rivas-Campo et al., 2022).

In this systematic review, a comparison was made between two types of exercises—Mind-Body Exercises (MBE) and High-Intensity Training—regarding their effects on cognitive performance. In this sense, it is essential to determine which type of exercise yields better results in preventing conditions caused by MCI or dementia, in order to make appropriate recommendations according to individual needs.

Materials and Methods

The present systematic review and meta-analysis aimed to compare the effects of high-intensity exercise and Mind-Body Exercises (MBE) on cognitive performance in older adults with Mild Cognitive Impairment (MCI) or dementia. The review was conducted in accordance with the guidelines outlined in the PRISMA 2020 Statement and the Cochrane Handbook for Systematic Reviews of Interventions.

Inclusion Criteria

The articles included in this review met the following inclusion criteria: i) studies that used high-intensity exercise and MBE as part of the treatment for older adults with MCI or dementia in the experimental group; ii) randomized controlled trials (RCTs); and iii) objective measures of cognition before and after the exercise intervention. These criteria ensured that the selected studies focused on interventions involving high-intensity exercise and MBE, employed rigorous experimental designs, and used objective measures to evaluate changes in cognition before and after the interventions.

Exclusion Criteria

The following exclusion criteria were applied: studies that did not measure the relevant variables of interest; studies focusing on ethnic minorities, populations with limited mobility, acute infections, neurological diseases, or hormonal disorders; and studies involving participants with a history of psychiatric disorders. Publications such as books, meta-analyses, reviews,

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systematic reviews, protocols, clinical trial registrations, and non-peer-reviewed articles were also excluded. These criteria ensured that only methodologically rigorous and relevant studies were included.

Information Sources

A bibliographic search was conducted between January and April 2024 in the following databases: PubMed, Scopus, Web of Science, and CINAHL.

Search Strategy

The following search strategy was used with relevant keywords:

("high-intensity training" OR "high-intensity exercise" OR "HIIT" OR "High-Intensity exercise training" OR "high intensity training" OR "high intensity exercise" OR "HIT" OR "High Intensity exercise training" OR "resistance training" OR "Physical exercise" OR "intensive training program" OR "circuit training" OR "dance" OR "high-intensity" OR "Pilates" OR "Yoga" OR "Tai Chi" OR "Core-Based" OR "Mind-Body") AND ("older adults with cognitive impairment" OR "cognitive impairment" OR "Cognitive decline" OR "Dementia") AND ("global cognition" OR "Cognition" OR "cognitive function" OR "Fall risk" OR "functionality").

Study Selection Process

The search results were processed using the Rayyan QCRI application (Ouzzani et al., 2016) (https://rayyan.qcri.org/welcome), where duplicates were automatically removed. Two authors (J.A.G.S. and S.Z.G.) independently and blindly screened titles and abstracts to verify compliance with inclusion criteria and conducted full-text reviews. Any discrepancies were resolved by consensus with a third author (L.M.V.B.).

Data Extraction

The primary variables of this review focused on outcomes related to cognition. Each included article was classified based on its year of publication, country, authors, participant characteristics (age, sample size, and group distribution), interventions applied to the experimental and control groups (intervention duration, session length and frequency, and intensity level), type of variable, test used, and follow-up period.

Assessment of Methodological Quality

The methodological quality of the selected articles was evaluated using the PEDro scale, one of the most widely used tools for assessing methodological quality. Scores were obtained from the official PEDro website when available. When not available, two authors (J.A.G.S. and S.Z.G.) independently evaluated the studies, and discrepancies were resolved by a third author (L.M.V.B.). The first item, which assesses external validity, was excluded from the final score. The remaining items were scored as 1 (present) or 0 (absent). Items 2 through 11 were considered for the total score, resulting in a possible range of 0 to 10 points. Scores between 0–3 were rated as Poor, 4–5 as Fair, 6–8 as Good, and >9 as Excellent.

Analytical Decisions for the Meta-Analysis

Heterogeneity among studies was assessed using Cochran's Q test and quantified using the I^2 statistic with a 95% confidence interval. Heterogeneity was categorized as low (<25%), moderate (25%–75%), or high (>75%) (Higgins et al., 2003). Fixed-effect or random-effects models were applied depending on the observed heterogeneity and variability. To evaluate potential publication bias, funnel plots were used, and asymmetry was tested using Egger's method, considering a *p-value* < 0.05 as statistically significant. The meta-analysis was conducted using the Comprehensive Meta-Analysis V4 software.

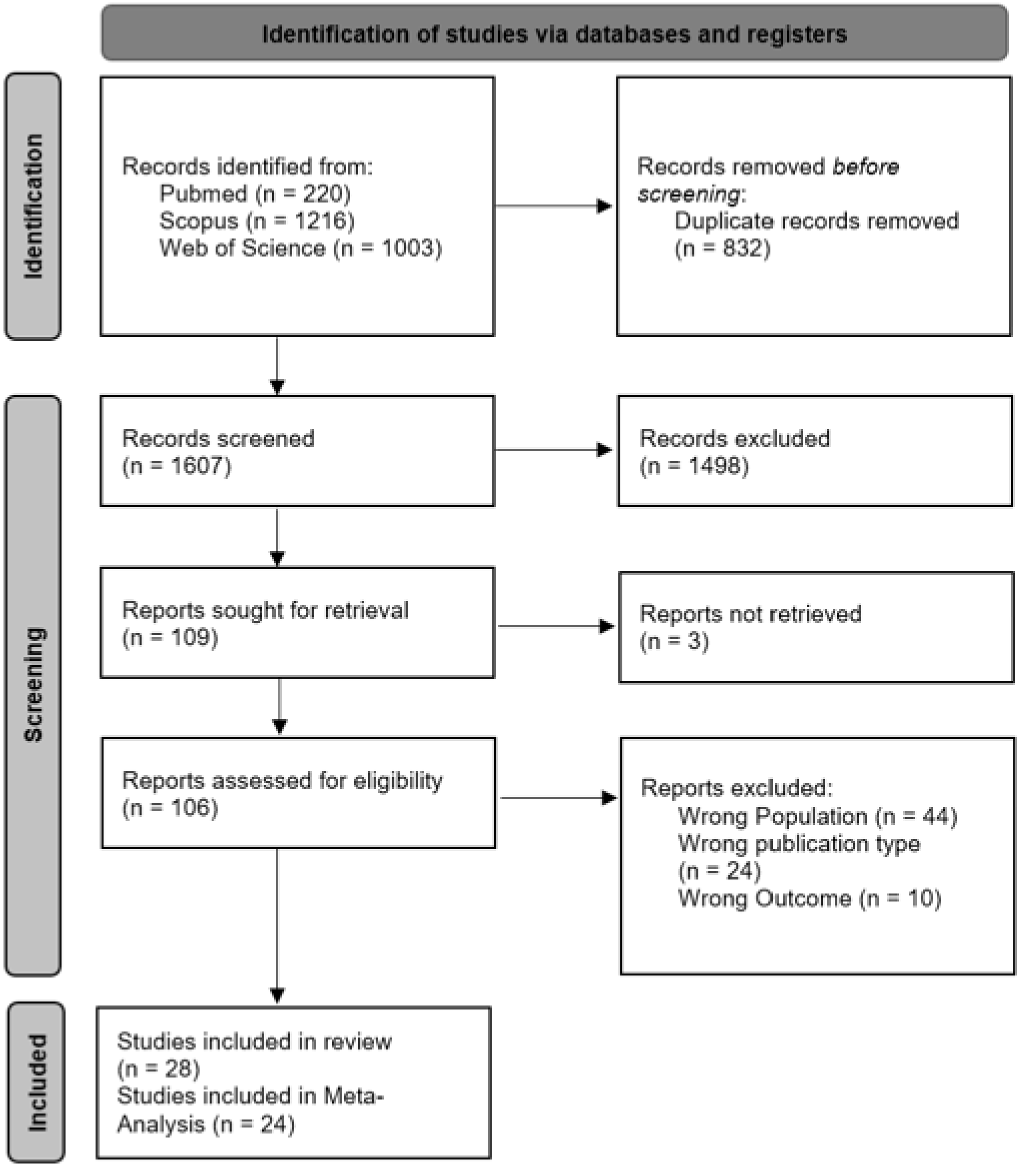
Results

Study Selection Process

The initial search across the selected databases yielded a total of 2,439 articles. After the removal of duplicates, 1,607 unique records remained. These records underwent title and abstract screening, resulting in 106 articles selected for full-text review. Following this stage, 28 studies met the inclusion criteria and were ultimately included in this systematic review and meta-analysis (Abbas et al., 2022; Ayari et al., 2023; Bossers et al., 2015; Chen et al., 2023; Cheng et al., 2014; de Oliveira Silva et al., 2019; Fiatarone Singh et al., 2014; Hoffmann et al., 2016; Huang et al., 2019; Jiayuan et al., 2022; Jin et al., 2020; Lam et al., 2012; Lamb et al., 2018; Liu-Ambrose et al., 2016; Maffei et al., 2017; Moon et al., 2020; Nascimento et al., 2014; Rivas-Campo et al., 2023; Sanders et al., 2020; Telenius et al., 2015a, 2015b; Toots et al., 2017; Xu et al., 2023; Yoon et al., 2017; Young, 2020; Yu et al., 2022; Zhu et al., 2018, 2022). Figure 1 illustrates the PRISMA flow diagram representing the systematic review process, detailing the number of records identified, screened, assessed for eligibility, and included in the final quantitative synthesis.

Figure 1

PRISMA Flow Diagram of the Systematic Review Process



Methodological Quality

The methodological quality of the included studies was assessed using the PEDro scale, as this tool is one of the most appropriate for evaluating clinical trials involving exercise interventions. A total of 25 studies were evaluated using the official PEDro database, while only two studies (Ayari et al., 2023; Nascimento et al., 2014) were assessed manually. Overall, the 28 studies included in this review demonstrated good methodological quality. However, it is important to note that none of the studies blinded participants or therapists (items 5 and 6 of the PEDro scale). Furthermore, twelve studies (Ayari et al., 2023; Bossers et al., 2015; Cheng et al., 2014; de Oliveira Silva et al., 2019; Hoffmann et al., 2016; Lam et al., 2012; Maffei et al., 2017; Nascimento et al., 2014; Rivas-Campo et al., 2023; Sanders et al., 2020; Yoon et al., 2017; Young, 2020) did not implement concealed allocation of participants into groups (item 3). Table 1 summarizes the methodological quality scores of the included studies according to the PEDro scale.

Table 1

Methodological Quality of the Included Articles

Author/Year	1	2	3	4	5	6	7	8	9	10	11	Total
Abbas et al., 2022	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	7
Ayari et al., 2023	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	7
Bossers et al., 2015	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	6
Chen et al., 2023	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Cheng et al., 2014	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6
De Oliveira Silva et al., 2019	Y	Y	N	Y	N	N	N	N	N	Y	Y	4
Fiatarone Singh et al., 2014	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	7
Hoffmann et al., 2016	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	7
Huang et al., 2019	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	6
Jiayuan et al., 2022	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Jin et al., 2020	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	6
Lam et al., 2012	Y	Y	N	Y	N	N	Y	N	Y	Y	Y	6
Lamb et al., 2018	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Liu-Ambrose et al., 2016	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	7
Maffei et al., 2017	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	7
Moon et al., 2020	Y	Y	Y	Y	N	N	Y	N	N	Y	Y	6
Nascimento et al., 2014	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	6
Rivas-Campo et al., 2023	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	6
Sanders et al., 2020	Y	Y	N	Y	N	N	Y	N	Y	Y	Y	6
Telenius et al., 2015a	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Telenius et al., 2015b	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Toots et al., 2017	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Xu et al., 2023	Y	Y	Y	Y	N	N	Y	N	Y	Y	Y	7
Yoon et al., 2017	Y	Y	N	Y	N	N	N	N	N	Y	Y	4
Young, 2020	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	7
Yu et al., 2022	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8
Zhu et al., 2022	Y	Y	Y	N	N	N	Y	Y	N	Y	Y	6
Zhu et al., 2018	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	7

Items: 1 = eligibility criteria; 2 = random allocation; 3 = concealed allocation; 4 = baseline comparability; 5 = blinding of participants; 6 = blinding of therapists; 7 = blinding of assessors; 8 = adequate follow-up; 9 = intention-to-treat analysis; 10 = between-group comparison; 11 = point estimates and variability; Y = Yes; N = No

Studies Characteristics

All the articles included in this systematic review were randomized controlled clinical trials. The studies were published in various countries, including Switzerland (Ayari et al., 2023; Jiayuan et al., 2022; Jin et al., 2020; Rivas-Campo et al., 2023; Xu et al., 2023; Zhu et al., 2022), the Netherlands (Cheng et al., 2014; Hoffmann et al., 2016; Huang et al., 2019; Toots et al., 2017), England (Bossers et al., 2015; Lamb et al., 2018; Maffei et al., 2017; Moon et al., 2020; Sanders et al., 2020; Telenius et al., 2015b; Young, 2020; Yu et al., 2022), Japan (Yoon et al., 2017), New Zealand (Zhu et al., 2018), the United States (Abbas et al., 2022; Chen et al., 2023; Fiatarone Singh et al., 2014; Lam et al., 2012; Liu-Ambrose et al., 2016; Telenius et al., 2015a), Ireland (de Oliveira Silva et al., 2019), and the United Arab Emirates (Nascimento et al., 2014).

However, it is important to note that while the articles were published in these countries, the actual research was conducted in different locations, such as China (Chen et al., 2023; Cheng et al., 2014; Huang et al., 2019; Jin et al., 2020; Lam et al., 2012; Young, 2020; Yu et al., 2022; Zhu et al., 2018, 2022), Denmark (Hoffmann et al., 2016), the Netherlands (Bossers et al., 2015; Sanders et al., 2020), France (Ayari et al., 2023), Sweden (Toots et al., 2017), Korea (Yoon et al., 2017), the United States (Moon et al., 2020; Xu et al., 2023), Brazil (de Oliveira Silva et al., 2019; Nascimento et al., 2014), Colombia (Rivas-

Campo et al., 2023), Lebanon (Abbas et al., 2022), Australia (Fiatarone Singh et al., 2014), Canada (Liu-Ambrose et al., 2016), Italy (Maffei et al., 2017), Norway (Telenius et al., 2015a, 2015b), and the United Kingdom (Lamb et al., 2018).

The studies were conducted between 2012 and 2024, with 2022 and 2023 being the years with the highest number of publications (Abbas et al., 2022; Ayari et al., 2023; Chen et al., 2023; Jiayuan et al., 2022; Rivas-Campo et al., 2023; Xu et al., 2023; Yu et al., 2022; Zhu et al., 2022).

From the 1,607 studies initially identified, 28 were included in this review. These studies employed a variety of high-intensity exercise and mind-body intervention protocols, all focusing on the measurement of cognition as the primary variable. A total of 2,923 older adults participated across the included studies, with 1,396 assigned to the control groups and 1,537 receiving exercise interventions.

Table 2

Characteristics of the Included Studies

Author	HI / MBE	Control Group Activities	Population	Age	Measurements	Cognition	Intervention	Changes in Variables Over Time
Abbas et al., 2022	HI	Usual treatment	Total: 60 IG–Mo: 20 IG–Ex: 20 IG–MoEx: 20	GI - Mo: 79 ± 6.67 GI - EX: 81.55 ± 7.42 GI - MoEx: 78.4 ± 6.21	T0 = Baseline T1 = 12 weeks	MMSE Mo: T0 = 9.6 ± 2.9 T1 = 10.1 ± 3.47 Ex: T0 = 9.85 ±2.96 T1 = 10.15 ± 3.13 MoEx: T0 = 10.95 ± 3.03 T1 = 11 ± 4.21	Motorized Cycle Ergometer (Mo): 3×/ week for 12 weeks, 50 min High-Intensity Functional Exercise (Ex): 3×/week for 12 weeks, 50 min Combined (MoEx): 3×/ week for 12 weeks, 50 min	No significant differences (p > 0.05) in MMSE among the three groups. Post-test mean comparisons showed no statistically significant differences (p > 0.05) in any dependent variables across groups.
Ayari et al., 2023	HI	Usual treatment	Total 23 IG Dance 11 IG Aerobic 12	Total 78 ± 7 IG Dance 79.8 ± 7.7 IG Aerobic 77.2 ± 5.3	T0 Baseline T1 16 weeks	MMSE Dance T0 20.1 ± 3.5 T1 23.3 ± 3.8 Aerobic T0 21.2 ± 3.5 T1 21.1 ± 4.6	Dance and Aerobic Exercises Intensity 60–70 HRR Frequency once per week for 4 months Duration 60 minutes	MMSE score increased significantly in the dance group 3.3 or 14 percent p 0.03 especially in memory performance 1 or 220 percent p 0.03 but not in the aerobic group

Table 2 (cont.)

Characteristics of the Included Studies

Author	HI / MBE	Control Group Activities	Population	Age	Measurements	Cognition	Intervention	Changes in Variables Over Time
Bossers et al., 2015	HI	30 minute individual social visits	Total 109 CG 36 IG Combined 37 IG Aerobic 36	Total 85.5 ± 5.1 CG 85.4 ± 5.0 IG Combined 85.7 ± 5.1 IG Aerobic 85.4 ± 5.4	T0 Baseline T1 9 weeks	MMSE Combined T0 15.81 ± 4.30 T1 17.16 ± 4.33 Aerobic T0 15.22 ± 4.79 T1 15.50 ± 5.51	Combined Strength and Aerobic Training Intensity 12–15 RPE Frequency twice per week for 9 weeks Duration 30 minutes Aerobic Training Intensity 50–85 HRmax Frequency four times per week for 3 months Duration 30 minutes walking	The combined group scored higher than the social group in global cognition visual and verbal memory executive function walking endurance leg strength and balance
Chen et al., 2023	MBE	30 minute educational session on diabetes self management once every 4 weeks for 24 weeks	Total 328 IG Tai Chi 107 IG Walking 110 CG 111	Total 67.55 ± 5.02 IG Tai Chi 67.56 ± 4.99 IG Walking 67.46 ± 4.73 CG 67.62 ± 5.35	T0 Baseline T1 24 weeks T2 36 weeks	MoCA Tai Chi T0 21.38 ± 2.79 T1 24.13 ± 3.13 T2 24.87 ± 2.64 Walking T0 21.54 ± 2.44 T1 23.53 ± 3.53 T2 23.93 ± 3.36	Tai Chi Chuan and Brisk Walking Frequency three times per week for 24 weeks Duration 60 minutes	At 36 weeks the Tai Chi group showed better MoCA scores than the walking group mean 24.67 SD 2.72 versus 23.84 SD 3.17 mean difference 0.84 95 percent CI 0.02 to 1.66 p 0.046 in the intention to treat analysis Per protocol and subgroup analyses yielded similar results
Cheng et al., 2014	MBE	Simple crafts	Total 110 CG 35 IG Mahjong 36 IG Tai Chi 39	CG 80.9 ± 7.2 IG Mahjong 81.9 ± 6.2 IG Tai Chi 81.8 ± 7.4	T0 Baseline T1 3 months T2 6 months T3 9 months	MMSE Mahjong T0 19.0 ± 3.2 Regression 2.240 0.361 to 4.118 Tai Chi T0 18.7 ± 3.9 Regression 1.617 −0.175 to 3.410	Mahjong and Tai Chi Frequency three times per week for 12 weeks Duration 1 hour	Over the 9 month period the control group decreased by 2.9 points 95 percent CI −4.2 to −1.7 in MMSE while the Mahjong and Tai Chi groups gained 1.5 95 percent CI −0.0 to 3.0 and 1.3 95 percent CI −0.0 to 2.5 points respectively

Table 2 (cont.)

Characteristics of the Included Studies

Author	HI / MBE	Control Group Activities	Population	Age	Measurements	Cognition	Intervention	Changes in Variables Over Time
De Oliveira Silva et al., 2019	HI	Clinical follow up	Total 56 CG 28 IG 28	CG 78.20 ± 5.26 IG 71.85 ± 5.69	T0 Baseline T1 3 months	MMSE T0 29.00 28.00–30.00 T1 28.00 27.00–30.00	Multimodal training balance aerobic strength and flexibility Intensity 70 percent VO2max or 80 percent HRmax Frequency twice per week for 12 weeks Duration 60 minutes	Cognitive tests showed a significant difference p 0.05 between the deltas of CG and IG only in the verbal fluency test Participants with MCI showed significant improvements in mobility and executive function while these improvements were not observed in patients with AD
Fiatarone et al., 2014	HI	SCOG and SPEX	CG 27 IG 27	55–89 years	T0 Baseline T1 6 months T2 18 months	ADAS Cog T0 8.02 6.87–9.17 T1 6.26 5.11–7.41 T2 5.76 4.59–6.92	Progressive resistance training Intensity 5–18 Borg Scale and 80 percent RM Frequency three times per week Duration 60–100 minutes	A 6 month high intensity functional exercise program improved global cognition compared with sham exercise and the benefit tended to persist for 18 months
Hoffmann et al., 2016	HI	Usual treatment with access to clinic staff as needed	Total 200 CG 93 IG 107	Total 70.5 ± 7.4 CG 71.3 ± 7.3 IG 69.8 ± 7.4	T0 Baseline T1 16 weeks	MMSE T0 23.8 ± 3.4 T1 23.9 ± 3.4	Moderate to high intensity aerobic exercise Intensity 70–80 percent HRmax Frequency three times per week for 16 weeks Duration 60 minutes	Neuropsychiatric symptoms were significantly less severe A possible cognitive effect was found among participants who adhered to the program suggesting that physical exercise may influence cognition if attendance and intensity are maintained

Table 2 (cont.)

Characteristics of the Included Studies

Author	HI / MBE	Control Group Activities	Population	Age	Measurements	Cognition	Intervention	Changes in Variables Over Time
Huang et al., 2019	MBE	Usual treatment	Total 80 IG 40 CG 40	Total 81.9 IG 81.9 ± 6.0 CG 81.9 ± 6.1	T0 Baseline T1 5 months T2 10 months	MoCA T0 13.06 ± 5.34 T1 13.94 ± 5.88 T2 14.83 ± 5.71	Tai Chi Frequency three times per week for 10 months Duration 20 minutes	A significant group by time interaction was found F 5.71 p 0.01 indicating an upward trend in MoCA scores in the intervention group
Jiayuan et al., 2022	MBE	Usual treatment	Total 91 IG Mindfulness 30 IG Tai Chi Chuan 31 IG MTCC 30	Total 71.4 ± 4.6 IG Mindfulness 70.8 ± 4.2 IG Tai Chi Chuan 71.7 ± 3.9 IG MTCC 71.3 ± 5.0	T0 Baseline T1 6 months T2 1 year	MMSE Mindfulness T0 23.9 ± 2.6 T1 25.1 ± 2.4 T2 25.4 ± 2.3 Tai Chi Chuan T0 24.2 ± 1.7 T1 24.9 ± 1.4 T2 24.7 ± 1.6 MTCC T0 24.5 ± 1.6 T1 25.7 ± 1.5 T2 26.1 ± 1.5	Mindfulness Tai Chi Chuan and MTCC Frequency twice per week for 6 months Duration 60 minutes	Improvements in cognitive function MMSE and physical performance SPPB TUG chair test were significantly different in the time group interaction p less than 0.05 Group 3 showed lower frailty and better cognition and physical performance compared with the other groups at follow up p less than 0.05
Jin et al., 2020	MBE	Breathing stretching and relaxation activities mostly performed in a seated position	Total 51 CG 26 IG 25	Total 66.1 ± 4.4 CG 66.4 ± 4.3 IG 66.7 ± 4.5	T0 Baseline T1 1 year	MoCA T0 23.7 ± 2.8	Qigong Intensity 60–80 percent HRmax Frequency twice per week Duration 60 minutes	MoCA scores increased significantly from baseline to 1 year in the Qigong group p less than 0.001 but not in the control group
Lam et al., 2012	MBE	Stretching and muscle toning exercises developed by physiotherapist	Total 389 CG 218 IG 171	CG 78.3 ± 6.6 IG 77.2 ± 6.3	T0 Baseline T1 12 months	MMSE T0 25.1 ± 3.0 T1 25.4 ± 3.3	Tai Chi Frequency three times per week for 12 months Duration 30 minutes	The intervention group showed a trend toward a lower risk of developing dementia at 1 year OR 0.21 95 percent CI 0.05 to 0.92 p 0.04

Table 2 (cont.)

Characteristics of the Included Studies

Author	HI / MBE	Control Group Activities	Population	Age	Measurements	Cognition	Intervention	Changes in Variables Over Time
Lamb et al., 2018	HI	Usual care	CG 165 IG 329	CG 78.4 ± 7.6 IG 76.9 ± 7.9	T0 Baseline T1 6 months T2 12 months	ADAS Cog T0 21.2 ± 9.5 T1 22.9 ± 11.6 T2 25.2 ± 12.3	Moderate to high intensity physical training Intensity six minute walk test for aerobic training and 20 RM for strength training Frequency twice per week Duration 60–90 minutes Sessions 30	A four month period of aerobic and strength training with continued exercise support did not slow cognitive decline
Liu Ambrose et al., 2016	HI	Usual care plus education	CG 35 IG 35	CG 73.7 ± 8.3 IG 74.8 ± 8.4	T0 Baseline T1 6 months T2 12 months	ADAS Cog T0 11.7 ± 5.5 T1 −1.71 −3.15 to −0.26 T2 −1.14 ± 0.57	Progressive aerobic training Intensity 40 to 70 percent HRR Frequency three times per week Duration 60 minutes Sessions 78	The study provides preliminary evidence of the effectiveness of a 6 month progressive aerobic training program three times per week in community dwelling adults with MCI compared to usual care plus education
Maffei et al., 2017	HI	Usual care	CG 58 IG 55	CG 74.9 ± 4.4 IG 74.0 ± 4.8	T0 Baseline T1 7 months	ADAS Cog T0 9.92 ± 4.81 T1 −1.40 ± 0.32	Cognitive training Frequency three times per week Duration 120 minutes Aerobic exercise Intensity high according to ACSM Frequency three times per week Duration 60 minutes	Combined physical and cognitive training in a social environment improves the cognitive status of subjects with MCI and enhances brain health indicators

Table 2 (cont.)

Characteristics of the Included Studies

Author	HI / MBE	Control Group Activities	Population	Age	Measurements	Cognition	Intervention	Changes in Variables Over Time
Moon et al., 2020	MBE	Simulated Qigong	Total 17 IG 8 CG 9	IG 66.4 ± 8.1 CG 65.9 ± 5.4	T0 Baseline T1 12 weeks	MMSE T0 28.9 ± 1.4 T1 29.3 ± 0.7	Qigong Frequency twice daily at home and once weekly in group sessions for 12 weeks Duration 15 to 20 minutes at home and 45 to 60 minutes in group	Both groups showed significant improvement in sleep quality p less than 0.05 and non motor symptoms p less than 0.05 No significant differences were found between groups Qigong exercise shows potential as a rehabilitation method for individuals with Parkinsons disease particularly in alleviating non motor symptoms
Nascimento et al., 2014	HI	Usual care	CG 17 IG 20	CG 68.5 ± 5.9 IG 67.3 ± 5.3	T0 Baseline T1 16 weeks	MoCA T0 19 ± 4 T1 23 ± 3	Intensity 60 to 80 percent heart rate reserve Frequency three times per week Duration 60 minutes Sessions 48	A significant improvement in attention was observed in the MCI group that participated in the exercise program
Rivas Campo et al., 2023	HI	Manual activities directed by occupational therapists	Total 132 IG 64 CG 68	Total 77.2 ± 7.6 IG 77.11 ± 7.3 CG 77.19 ± 7.7	T0 Baseline T1 12 weeks	MoCA T0 21.63 ± 1.53 T1 22.58 ± 1.41	High Intensity Functional Training Intensity 80 to 85 percent HR Frequency three times per week Duration 45 minutes	The intervention group showed improvement with significant differences compared to the control group in cognitive impairment level MoCA p less than 0.001
Sanders et al., 2020	HI	Flexibility exercises and recreational activities	CG 30 IG 39	CG 82.1 ± 7.51 IG 81.7 ± 7.16	T0 Baseline T1 12 weeks T2 24 weeks	MMSE T0 21.4 ± 3.94 T1 21.0 ± 4.38 T2 20.4 ± 4.77	Moderate to high intensity physical training Intensity LI phase RPE 9 to 11 HI phase RPE 13 to 16 Frequency three times per week Duration 30 minutes Sessions 72	No significant effects of exercise compared to the control intervention were found in any cognitive measures

Table 2 (cont.)

Characteristics of the Included Studies

Author	HI / MBE	Control Group Activities	Population	Age	Measurements	Cognition	Intervention	Changes in Variables Over Time
Telenius et al., 2015a	HI	Light physical activity in a seated position	CG 79 IG 81	CG 86.4 ± 7.8 IG 86.9 ± 7.0	T0 Baseline T1 12 weeks	MMSE T0 15.6 ± 5.0 T1 15.5 ± 5.5	High Intensity Functional Exercise Intensity 12 RM Frequency twice per week Duration 50–60 minutes Sessions 24	The high intensity functional exercise program improved balance and muscle strength and reduced apathy in nursing home residents with dementia
Telenius et al., 2015b	HI	Light physical activity in a seated position	CG 83 IG 87	CG 86.5 ± 7.7 IG 87.3 ± 7.0	T0 Baseline T1 3 months T2 6 months	MMSE T0 15.5 ± 0.6 T1 15.4 14.5–16.3 T2 14.4 13.5–15.2	High Intensity Functional Exercise Intensity 12 RM Frequency twice per week Duration 50–60 minutes Sessions 24	Results demonstrate long term positive effects of high intensity functional exercise on balance and indicate a beneficial effect on agitation
Toots et al., 2017	HI	While seated in groups participants conversed sang listened to music or readings and or viewed images and objects	Total 186 CG 93 IG 93	Total 85.1 ± 7.1 CG 85.9 ± 7.8 IG 84.4 ± 6.2	T0 Baseline T1 4 months T2 7 months	MMSE T0 15.4 3.4 T1 −1.15 0.41 T2 −2.25 0.42	High Intensity Functional Exercise HIFE Intensity 8–12 RM Frequency five sessions every two weeks Duration 45 minutes	No significant differences in mean change from baseline between exercise and activity groups at 4 months MMSE −0.27 95 percent CI −1.4 to 0.87 p 0.644 or at 7 months MMSE −1.15 95 percent CI −2.32 to 0.03 p 0.056
Xu et al., 2023	MBE	Usual treatment	Total 180 IG TCT 44 IG TCS 49 IG WAT 44 IG WAS 43	IG TCT 59 ± 8.75 IG TCS 61 ± 8.5 IG WAT 63 ± 12.75 IG WAS 58 ± 8	T0 Baseline T1 12 weeks	MoCA Tai Chi T0 23.5 ± 3 T1 25 ± 2.83 Walking T0 22.5 ± 3 T1 24.24 ± 1.61	Tai Chi TCT Frequency three times per week for 12 weeks Duration 60 minutes Walking WAT Intensity 50–70 percent HRmax Frequency three times per week for 12 weeks Duration 60 minutes	After 12 weeks there were significant differences in MoCA scores between groups p less than 0.001 F 3174 7.415 Post hoc analysis showed TCT was more effective than WAT p 0.032

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Table 2 (cont.)

Characteristics of the Included Studies

Author	HI / MBE	Control Group Activities	Population	Age	Measurements	Cognition	Intervention	Changes in Variables Over Time
Yoon et al., 2017	HI	Balance and toning exercises	Total 30 CG 7 IG HSPT 14 IG LSST 9	CG 78.0 ± 1 IG HSPT 75.0 ± 0.9 IG LSST 76.0 ± 1.3	T0 Baseline T1 12 weeks	MoCA LSST T0 16.44 ± 4.22 T1 18.33 ± 5.29 MMSE LSST T0 21.56 ± 0.73 T1 24.56 ± 3.21	Low Speed Strength Training LSST Intensity blue elastic band high tension perceived exertion 15–16 hard Sets 2 or 3 Reps 8–10 Frequency twice per week for 12 weeks Duration 1 hour	Significant improvements were observed in MMSE and MoCA in the LSST group compared with the control group indicating effectiveness for improving cognitive function physical function and muscle strength
Young, 2018	MBE	Interest classes and recreational activities	Total 80 IG 41 CG 39	Total 80.44 ± 6.55 IG 80.05 ± 6.17 CG 80.25 ± 6.33	T0 Baseline T1 7 weeks	MMSE T0 20.69 ± 1.98 T1 22.29 ± 2.15	Baduanjin and Tai Chi Frequency twice per week for 7 weeks Duration 60 minutes	A 2 × 2 repeated measures ANCOVA showed the treatment group was more effective than the control for improving MMSE score F 9.96 p less than 0.01 with a moderate to large effect size partial eta squared 0.12 after controlling for age sex education marital status and number of physical illnesses

Table 2 (cont.)

Characteristics of the Included Studies

Author	HI / MBE	Control Group Activities	Population	Age	Measurements	Cognition	Intervention	Changes in Variables Over Time
Yu et al., 2022	MBE	No intervention participants maintained their usual daily activities during the study period	Total 37 IG Tai Chi 12 IG Conventional 13 CG 12	IG Tai Chi 67.3 ± 4.2 IG Conventional 67.2 ± 6.8 CG 67.6 ± 8.1	T0 Baseline T1 12 weeks T2 24 weeks	MoCA Tai Chi T0 19.7 ± 1.5 T1 24.6 ± 2.1 T2 26.6 ± 1.9 Conventional T0 19.3 ± 2.0 T1 22.1 ± 2.3 T2 25.0 ± 2.5	Tai Chi TC Frequency once per week for 24 weeks Duration 60 minutes Conventional Exercise EX Frequency three times per week for 24 weeks Duration 60 minutes	Both TC and EX groups showed significant improvements in MoCA HK scores compared with CON at mid and post assessments both p less than 0.001 At mid assessment TC showed greater improvements than EX p less than 0.001 At post assessment TC tended to show greater improvement than EX but did not reach statistical significance p 0.061
Zhu et al., 2022	HI	The control group received only health education	Total 68 IG 35 CG 33	IG 71.51 ± 6.62 CG 69.82 ± 7.74	T0 Baseline T1 12 weeks T2 24 weeks	MMSE Group −0.021 −0.923 0.768 Age −0.366 −0.151 −0.034 Gender −0.199 −1.596 0.127	Aerobic dance Intensity 60–80 percent HRmax Frequency three times per week for 3 months Duration 35 minutes	Linear regression analysis showed age was associated with decreased MMSE score β 95 percent CI −0.366 −0.151 −0.034 p 0.002
Zhu et al., 2018	HI	Received physician counseling at baseline 3 months and 6 months to promote a healthy lifestyle for preventing cognitive decline	Total 60 IG 29 CG 31	Total 69.6 ± 7.0 IG 70.3 ± 6.7 CG 69.0 ± 7.3	T0 Baseline T1 3 months T2 6 months	MoCA T0 23.2 ± 1.9 T1 24.7 ± 2.2 T2 25.0 ± 2.4	Dance exercise Intensity 60–80 percent HRmax Frequency three times per week for 3 months Duration 35 minutes	Participants in the intervention group significantly improved cognitive function at 3 months mean MoCA increase 1.6 95 percent CI 0.8 2.3 p less than 0.001 Improvements were still observed at 6 months

HI: High Intensity; MBE: Mind-Body Exercise; IG: Intervention Group; CG: Control Group; T0: Baseline Measurement; I: Intensity; F: Frequency; D: Duration; MoCA: Montreal Cognitive Assessment; MMSE: Mini-Mental State Examination.

Intervention

The studies included in this systematic review with meta-analysis evaluated the effectiveness of mind-body interventions and high-intensity exercises on global cognition in older adults with cognitive impairment. The studies implementing mind-body interventions were based on practices such as Qigong, Mahjong, Tai Chi, Baduanjin, and Mindfulness. These interventions were generally performed twice per week (Jiayuan et al., 2022; Jin et al., 2020; Moon et al., 2020; Young, 2020) or three times per week, with only one study conducting a single session per week (Yu et al., 2022); additionally, one study combined two individual home sessions with one group session each week (Moon et al., 2020).

In general, each session lasted 60 minutes (Chen et al., 2023; Cheng et al., 2014; Jiayuan et al., 2022; Jin et al., 2020; Xu et al., 2023; Young, 2020; Yu et al., 2022), although interventions lasting 20 minutes (Huang et al., 2019; Moon et al., 2020) and 30 minutes (Lam et al., 2012) were also reported. Most studies indicated that the intervention period lasted 3 months (Cheng et al., 2014; Moon et al., 2020; Xu et al., 2023) or 6 months (Chen et al., 2023; Jiayuan et al., 2022; Yu et al., 2022), while three studies reported durations of 7 weeks (Young, 2020), 10 months (Huang et al., 2019), and 12 months (Lam et al., 2012).

Among the articles implementing high-intensity training, seven studies based their interventions on moderate-to-high-intensity aerobic exercise (Ayari et al., 2023; Bossers et al., 2015; Hoffmann et al., 2016; Liu-Ambrose et al., 2016; Maffei et al., 2017; Zhu et al., 2018, 2022), five studies performed High-Intensity Functional Exercise (HIFE) (Abbas et al., 2022; Rivas-Campo et al., 2023; Telenius et al., 2015a, 2015b; Toots et al., 2017), and three studies implemented combined interventions (Abbas et al., 2022; Karssemeijer et al., 2019; Lamb et al., 2018). Additionally, interventions involving multimodal training (de Oliveira Silva et al., 2019), progressive resistance training (Fiatarone Singh et al., 2014), and Low-Speed Strength Training (LSST) (Yoon et al., 2017) were reported.

The frequency of high-intensity interventions was three sessions per week (Abbas et al., 2022; Fiatarone Singh et al., 2014; Hoffmann et al., 2016; Liu-Ambrose et al., 2016; Maffei et al., 2017; Nascimento et al., 2014; Rivas-Campo et al., 2023; Sanders et al., 2020; Zhu et al., 2018, 2022) or two sessions per week (Bossers et al., 2015; de Oliveira Silva et al., 2019; Lamb et al., 2018; Telenius et al., 2015b, 2015a; Yoon et al., 2017), with only two studies reporting one session per week (Ayari et al., 2023) and one study reporting five sessions every two weeks (Toots et al., 2017). The average session duration was 60 minutes (Ayari et al., 2023; de Oliveira Silva et al., 2019; Fiatarone Singh et al., 2014; Hoffmann et al., 2016; Lamb et al., 2018; Liu-Ambrose et al., 2016; Maffei et al., 2017; Nascimento et al., 2014; Telenius et al., 2015b, 2015a; Yoon et al., 2017), although some studies reported 30–35-minute sessions (Bossers et al., 2015; Sanders et al., 2020; Zhu et al., 2018, 2022) and 45-minute sessions (Rivas-Campo et al., 2023; Toots et al., 2017).

Most studies reported an intervention period of 3 months (Abbas et al., 2022; de Oliveira Silva et al., 2019; Rivas-Campo et al., 2023; Sanders et al., 2020; Telenius et al., 2015a; Yoon et al., 2017; Zhu et al., 2018, 2022), while other durations included 4 months (Ayari et al., 2023), 6 months (Fiatarone Singh et al., 2014; Liu-Ambrose et al., 2016; Telenius et al., 2015b), and 7 months (Maffei et al., 2017; Toots et al., 2017).

Global Cognition

The main variable in this review was global cognition, for which the studies implemented the following assessment tools: the Montreal Cognitive Assessment (MoCA) (Abbas et al., 2022; Chen et al., 2023; Jin et al., 2020; Nascimento et al., 2014; Xu et al., 2023; Yoon et al., 2017; Yu et al., 2022; Zhu et al., 2018), the Mini-Mental State Examination (MMSE) (Abbas et al., 2022; Ayari et al., 2023; Bossers et al., 2015; Cheng et al., 2014; de Oliveira Silva et al., 2019; Hoffmann et al., 2016; Huang et al., 2019; Jiayuan et al., 2022; Lam et al., 2012; Rivas-Campo et al., 2023; Sanders et al., 2020; Telenius et al., 2015a, 2015b; Toots et al., 2017; Yoon et al., 2017; Young, 2020; Zhu et al., 2022), and the Alzheimer's Disease Assessment Scale–Cognitive Subscale (ADAS-Cog) (Fiatarone Singh et al., 2014; Lamb et al., 2018; Liu-Ambrose et al., 2016; Maffei et al., 2017).

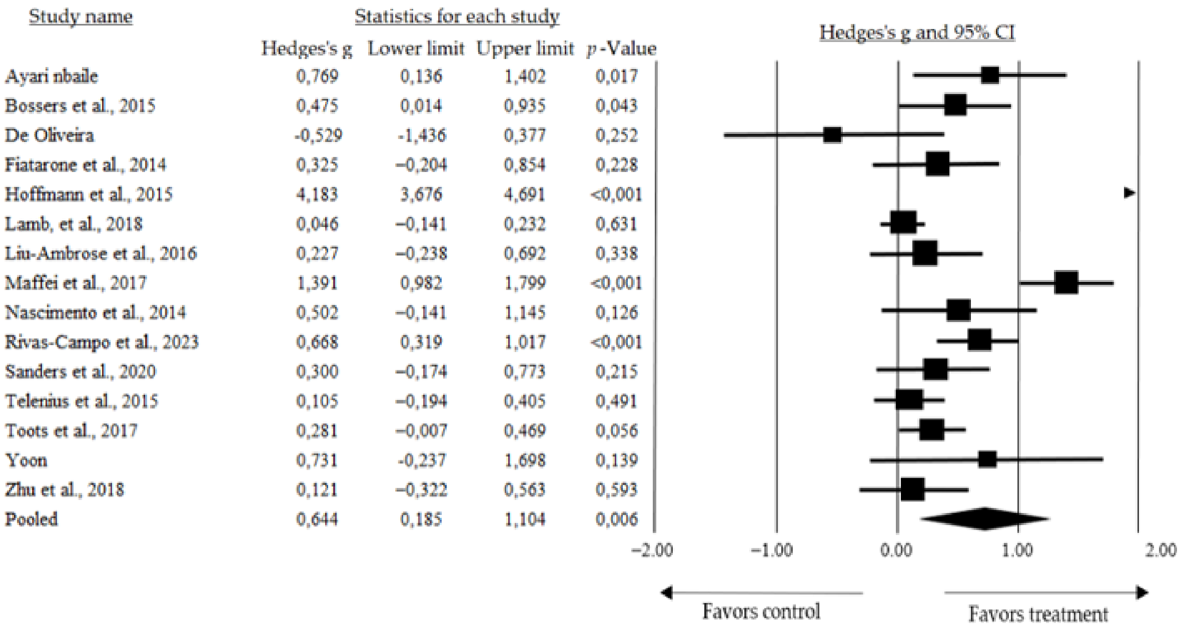
Among the included studies, ten reported statistically significant improvements in global cognition among participants who received mind-body exercise interventions such as Qigong, Mahjong, Tai Chi, Baduanjin, and Mindfulness (Chen et al., 2023; Cheng et al., 2014; Jiayuan et al., 2022; Jin et al., 2020; Lam et al., 2012; Moon et al., 2020; Xu et al., 2023; Young, 2020; Yu et al., 2022). Additionally, of the studies implementing high-intensity exercise interventions, fourteen (Ayari et al., 2023; Bossers et al., 2015; de Oliveira Silva et al., 2019; Fiatarone Singh et al., 2014; Hoffmann et al., 2016; Liu-Ambrose et al., 2016; Maffei et al., 2017; Nascimento et al., 2014; Rivas-Campo et al., 2023; Telenius et al., 2015a, 2015b; Yoon et al., 2017; Zhu et al., 2018, 2022) reported statistically significant improvements in cognition, identifying positive effects on global cognition, executive function, and memory. Only four studies (Abbas et al., 2022; Lamb et al., 2018; Sanders et al., 2020; Toots et al., 2017) found that this type of intervention did not result in cognitive improvements.

Meta-Analysis

For this meta-analysis, a subgroup analysis was conducted using the type of intervention—either high-intensity exercise or mind-body exercise—as the grouping variable. The mean effect size was calculated using Hedges' g for each subgroup. For high-intensity exercise, fifteen studies were included, showing a moderate and statistically significant mean effect size on cognition (g = 0.644, 95% *CI*: 0.185–1.104, p = 0.006), favoring the groups of older adults with mild cognitive impairment who received the intervention (Figure 2).

Figure 2

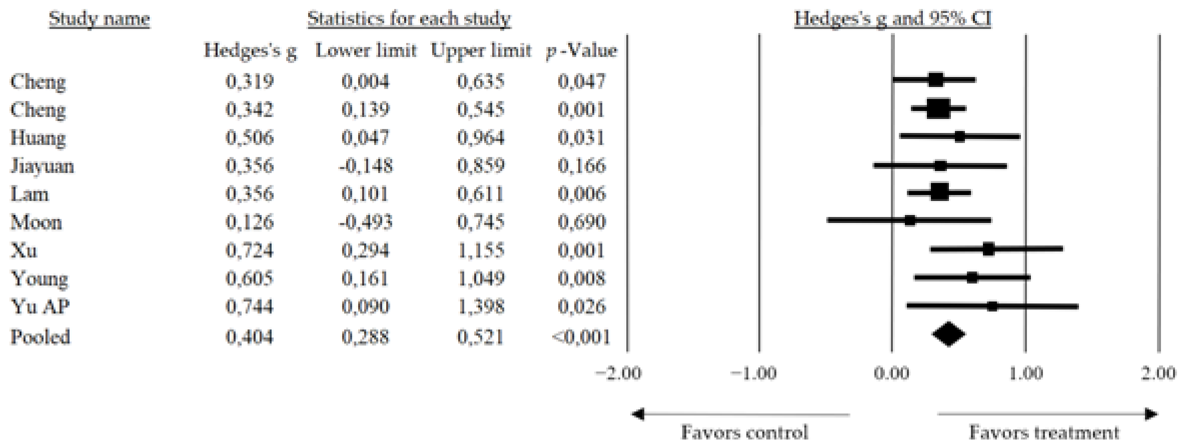
Mean Effect Size of High-Intensity Exercise



On the other hand, in the subgroup analysis for mind-body interventions, nine studies were included, showing a small but statistically significant mean effect size on cognition (g = 0.404, 95% *CI*: 0.288–0.521, p < 0.001), favoring the groups of older adults with mild cognitive impairment who received the intervention (Figure 3).

Figura 3

Mean Effect Size of the Mind-Body Intervention



Discussion

The objective of this systematic review and meta-analysis was to determine which type of intervention—high-intensity exercise or mind-body interventions—produces greater effects on global cognition in older adults with mild cognitive impairment (MCI). The most relevant findings indicated that, although both types of interventions are beneficial, high-intensity exercise shows a greater effect on cognition (g = 0.644, 95% *CI*: 0.185–1.104, p = 0.006) compared with mind-body interventions (g = 0.404, 95% *CI*: 0.288–0.521, p < 0.001), suggesting that more intense physical activities may have a stronger impact on preserving and improving cognitive functions in this population.

This review included 28 randomized controlled trials, most of which demonstrated good methodological quality, while only two studies showed poor methodological quality (de Oliveira Silva et al., 2019; Yoon et al., 2017). Although the overall methodological quality was good, it is important to note that none of the trials were able to blind participants or therapists, which could lead to an overestimation of the results by 7% to 13% (Savović et al., 2012). This is a common challenge in exercise-based intervention studies, where blinding participants is almost impossible due to the nature of the intervention itself.

Following the meta-analysis, it was determined that high-intensity exercise has a moderate and statistically significant effect size (g = 0.644, p = 0.006) on cognition in older adults with MCI. This may be due to the fact that this type of intervention increases levels of brain-derived neurotrophic factor (BDNF), a key protein involved in neurogenesis and synaptic plasticity, which strengthens neuronal connections and enhances higher mental functions (Erickson et al., 2013). This increase in BDNF, along with other physiological mechanisms such as improved cerebral vascularization and reduced oxidative stress, could explain why high-intensity exercise is effective in preserving and even improving cognition in older adults (Cotman & Berchtold, 2002).

On the other hand, mind-body interventions showed a small but statistically significant mean effect size (g = 0.404, p < 0.001). These interventions, which include practices such as yoga and tai chi, may reduce cortisol levels and improve the regulation of the hypothalamic–pituitary–adrenal axis, leading to a better stress response and contributing to less cognitive decline (Pascoe et al., 2017). Additionally, literature suggests that these interventions enhance hippocampal volume and stimulate the frontal lobes, leading to the activation of microglial cells, which facilitate waste clearance and promote overall brain health (Chen et al., 2023).

When comparing high-intensity exercise with mind-body interventions, the former appears to be more effective in improving cognition. This finding aligns with the results reported by Northey et al. (2018) in their systematic review, which identified greater cognitive benefits in older adults following high-intensity interventions. The physical and mental demands of high-intensity exercise seem to more efficiently activate the neural networks associated with cognition, positioning it as the preferred option for enhancing cognitive performance in this population (Northey et al., 2018). Similarly, this difference may be explained by the lower capacity of low-intensity interventions to induce robust neuroplastic changes. Reviews such as those by Sofi et al. (2011) and Smith et al. (2010) reflect a similar pattern, emphasizing once again that higher-intensity interventions tend to provide greater cognitive benefits when compared with lower-intensity or mind-control-based exercises.

This review has multiple strengths and limitations that are important to consider when interpreting the findings. On the one hand, it included a considerable number of studies for each type of intervention, and the risk of publication bias was low. Regarding the limitations, none of the studies blinded participants or therapists, which could lead to overestimated effects. Additionally, although studies were conducted in various regions worldwide, a geographical bias was evident, which may limit the generalizability of the findings—particularly to countries in Latin America and Africa. Finally, the high heterogeneity in the intervention protocols makes it difficult to establish a specific model, highlighting the need for further research focused on the dose–response relationship of these interventions.

Conclusions

This systematic review and meta-analysis demonstrate that both high-intensity exercise and mind-body exercises (MBE) can improve cognition in older adults with mild cognitive impairment (MCI). However, high-intensity training (HIT) appears to have a greater effect on the preservation and enhancement of cognitive functions in this population. These findings should be interpreted with caution due to potential biases resulting from the high heterogeneity of the included studies,

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the geographical locations where they were conducted, and the lack of blinding of participants or therapists. Nevertheless, the incorporation of high-intensity exercise into the comprehensive care plan for older adults may represent an effective strategy to improve cognition.

Ethics Committee Statement

Not applicable, as this study is a secondary review of existing information.

Conflict of Interest Statement

The authors declare that there is no conflict of interest.

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Authors' Contribution

Conceptualization: D.F.A.-R. & S.Z.-G.; Methodology: D.F.A.-R. & J.A.G.S.; Formal Analysis: D.F.A.-R. & S.Z.-G.; Writing – Original Draft: S.Z.-G., J.A.G.S. & L.M.V.B.; Writing – Review & Editing: D.F.A.-R. & C.M.B.-C.; Supervision: D.F.A.-R.; Project Administration: D.F.A.-R.; Funding Acquisition: D.F.A.-R. All authors have read and agreed to the published version of the manuscript.

Data Availability Statement

Data are available upon request from the corresponding author at dafanador4@areandina.edu.co

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