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REVIEW ARTICLE

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Physical activity interventions in older adults with a cognitive impairment: A critical review of reviews

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Abstract

This critical review explores the review material on physical activity combined with cognitive stimulation interventions in older adults with cognitive impairment and/or dementia. A critical, systematic, review of the review method was used, considering four electronic databases: WEB OF SCIENCE, SCOPUS, MEDLINE, and the COCHRANE ELECTRONIC LIBRARY. The search terms "exercise," "physical activity," "cognitive impairment," "dementia," and "systematic review" were used. All available reviews were marked against predetermined inclusion and exclusion criteria. There were 32 reviews that met the inclusion criteria. A combination of various types of training and aerobic exercises were the most frequently reported interventions; meanwhile, dual task training programs (combining physical exercise with cognitive stimulation), functional training programs along with exercises combination, aerobic exercise as well as strength, stretching, or balance workouts were also reported. The evidence is compelling; exercise can improve physical health by ensuring cognitive, psychological, and behavioral benefits. Overall, exercise can improve the physical and mental health of people living with dementia: there is sufficient evidence to recommend multimodal exercise.

KEYWORDS
dementia, mild cognitive impairment, physical activity interventions, review of reviews

1 | INTRODUCTION

Aging is an irreversible process with biological, physiological, and cognitive changes that are diverse and distinct.[1,2] In fact, aging is related to a decrease in cognitive function and an increase in the prevalence of chronic pathologies, such as dementia.[3] According to the World Report on Aging and the World Health Organization (WHO), it is currently estimated that 35.6 million people worldwide live with dementia[4] and this number is expected to reach 65 million cases in 2050.[5] The incidence and prevalence of dementia increases with age, almost doubling every 5 years after the sixth decade of life.[5,6]

The WHO (2020) defines Dementia as a syndrome – usually of a chronic or progressive nature – in which there is deterioration in cognitive function (ie, the ability to process thought) beyond what might be expected from normal aging.

In fact, dementia cannot be considered as a single disease: it has to be understood as a set of different pathologies that have a progressive neurological deterioration of brain cells in common and,

therefore, a deficit in cognitive function[5,7] which affects memory, thinking, orientation, comprehension, calculation, learning capacity, language, and judgment, leading to the impairment of cognitive function beyond that expected with aging.[7,8]

Wang et al (2021) presented two types of dementia: (1) degenerative dementia, among which the most common are Alzheimer's disease, frontotemporal lobe degeneration, and dementia with Lewy bodies; and (2) vascular dementia, originated from a stroke or chronic cerebrovascular lesions, resulting in poor blood circulation in the brain.

The weakening of cognitive function is commonly accompanied by deterioration in emotional control, social behavior, disruptive behavior, personality changes, delusions, or motivation.[5] These impairments cause dependency and can be overwhelming, not only for the people who have it, but also for their caregivers and family.[5]

Cognitive ability can be impaired by a variety of neuropathological conditions, such as neurodegenerative diseases, in which the abnormal accumulation of certain proteins can cause silent chronic inflammatory processes. In this context, physical activity, by changing brain metabolism[9] and increasing aerobic fitness and cerebral blood flow,[10] seems to contribute to the reduction of chronic inflammation in the central nervous system while increasing neuroplasticity, promoting the re-organization of neural circuits[11,12] and improving cognitive function.[13,14]

In fact, exercise in the elderly improves overall health status and prevents several negative aging outcomes, including coronary heart disease, stroke, type 2 diabetes, obesity, hypertension, certain cancers, and osteoporosis.[15-17] Exercise also contributes to the reduction of the risk of falls[16] and mortality.[16]

Bauman et al (2016) emphasized the importance of exercise in aging, recommending a shift in focus that gives priority to interventions that aim for the retention of muscle mass and balance, promoting motor function and autonomy.

Nuzum et al (2020) referred to the fact that besides the benefits of exercise to overall health, better physical fitness also contributes to better cognitive functioning: individuals who are more physically active show better neurocognitive functioning compared to more sedentary individuals.

The study of the effect of exercise intervention on several physical and cognitive parameters has produced thousands of scientific papers. Considering the enormous amount of literature on this subject, numerous literature reviews were carried out.

Due to the number of reviews within this topic, an overall review of previously published reviews was justified as it provides a synopsis of the evidence in terms of the effects of exercise interventions in older adults with cognitive impairment on cognitive function and in physical fitness.

Consequently, the research question for this critical review is "what are the findings of the reviews on exercise interventions for older adults with a cognitive impairment, concerning the type and characteristics of the exercise and effects on physical fitness and cognitive function?"

Therefore, this paper aims to provide a theoretical framework to support a future exercise intervention for people with dementia/cognitive impairment.

2 | METHODS

This critical literature review was based on the methodology presented by Booth et al (2015) and Cammisuli et al (2018). However, these authors specifically consider fall prevention interventions in older adults with cognitive impairment, whereas we aimed to evaluate the effect of exercise interventions in physical fitness and cognitive function among the same population.

The primary purpose of this critical literature review was to gather and analyze previous literature reviews to investigate exercise interventions in adults with cognitive impairment, providing a clear summary of the evidence in this area to date and a set of data concerning the kind of exercise that should be recommended to improve both physical fitness and cognition among older adults.

A review of the review method[17,18] was used to summarize the existent literature considering the number of reviews already published in this field. The types of reviews used in this paper were: Systematic review, Review of studies (State of the Art Reviews), Meta-analysis, Narrative review, Umbrella review, and Overview (Table 1).

The electronic databases WEB OF SCIENCE, SCOPUS, PUBMED, and the COCHRANE ELECTRONIC LIBRARY were systematically examined, using the following conjugation of terms: (1) ["exercise" OR "physical activity"], AND (2) ["cognitive impairment" OR "dementia"] AND (3) "systematic review" (4) combinations. The search was performed from March to May 2021.

The results from the literature search were selected from an initial search if they met the following criteria: (1) literature reviews (systematic, narrative, and umbrella); (2), included an adult population with a cognitive impairment recognized through cognitive testing (eg, Mini Mental State Examination) or diagnosis (eg, dementia and Alzheimer's disease); (3) exercise-based intervention; (4) results concerning physical fitness (fall prevention interventions were potentially eligible for inclusion as long as they included evaluation of physical parameters like strength, gait, or equilibrium) or cognition (including better memory and mental abilities) if the revision considered any valid standardized neuropsychological test of cognition reported at baseline and follow-up; and (5) papers written in English.

Exclusion criteria encompassed: (1) exercise interventions aimed at improvements in other factors, including physical fitness or cognition, such as improvement of sleep patterns, general health, quality of life, pain management, mental health, and improving psychological parameters, such as mood or depression; (2) lifestyle interventions; (3) revision of exercise guidelines or recommendations; (4) the use of specific exercise programs, such as Tai chi, yoga, or dance; (5) patients that present psychiatric diseases and other comorbid medical conditions; and (6) papers written in languages other than English.

Due to the number of reviews identified, 1815, a further exclusion criterion, namely reviews published before 2015, was introduced to ensure identification of recent evidence and the exclusion of material published prior to that year (as made by Booth et al [2015]). This screening finally yielded 29 studies to

TABLE 1 Revision types.

Review type	Overarching goal	Search strategy	Appraisal of included studies	Analysis and synthesis	Key references
Systematic review	Aims to aggregate, critically appraise, and synthesize in a single source all empirical evidence that meet a set of prespecified eligibility criteria in order to answer in depth a clearly formulated research question to support evidence-based decision making	Exhaustive literature search of multiple sources and databases using highly sensitive and structured strategies to identify all available studies (published and unpublished) within resource limits that are eligible for inclusion. Uses a priori inclusion and exclusion criteria.	Two different quality assessments must be addressed in systematic reviews: (a) risk of bias in included studies, and (b) quality of evidence by outcome of interest. Both assessments require the use of validated instruments (eg, Cochrane criteria and GRADE system).	Two different types of analyses and syntheses methods can be used 1. Meta-analysis (statistical pooling of study results), and 2. qualitative/narrative: use of vote counting, content analysis, frameworks, classification schemes, and/or tabulations	Borenstein et al (2009); Higgins and Green, (2008); Liberati et al (2009)[22]
Narrative review	Aims to summarize or synthesize what has been written on a particular topic but does not seek generalization or cumulative knowledge from what is reviewed	Selective in nature. Authors usually select studies that support their own view	No formal quality or risk of bias assessment of included primary studies is required	Narrative using thematic analysis, chronological order, conceptual frameworks, content analysis or other classification criteria	Cronin et al (2008); Green et al (2006); Levy and Ellis, (2006); Webster and Watson, (2002)
Umbrella review	Tertiary type of evidence synthesis. Aims to compare and contrast findings from multiple systematic reviews in priority areas, at a variety of different levels, including different types of interventions for the same condition or alternatively, same interventions for different conditions, outcomes, problems, or populations, and adverse effects.	Exhaustive literature search to identify all available systematic reviews (published and unpublished) within resource limits that are eligible for inclusion. No search for primary studies. Uses a priori inclusion and exclusion criteria.	Two different quality assessments must be addressed: (a) methodological quality assessment of the included systematic reviews, and (b) quality of evidence in included reviews. Both assessments require use of validated instruments (eg, AMSTAR and GRADE systems).	Many umbrella reviews will simply extract data from the underlying systematic reviews and summarize them in tables or figures. However, in some cases, they may include indirect comparisons based on formal statistical analyses, especially if there is no evidence on direct comparisons	Becker and Oxman, (2008); Shea et al (2009); Smith et al (2011)
Meta-analyze	Meta-analysis is specifically designed to integrate the results of multiple studies on the same research question into a systematic review of the literature	Note that meta-analysis should not be confused with systematic review of the literature itself, which is the systematic method used to find and critically evaluate all available scientific evidence on a research question	The most commonly used method for assigning weight to each study is the inverse of the variance (ie, the greater the variability, the smaller the study's share of the final conclusion)	The synthesis produced by the meta-analysis is weighted, with each study assigned a different weight, so that each contributes differently to the final conclusion. Because of increased sample sizes by combining studies, the synthesis produced by meta-analysis on a set of studies with good validity reduces our degree of uncertainty about the beneficial or undesirable effects of health interventions, for example. Systematic reviews with meta-analysis are the main guideline guiding evidence-based health care practices.	Higgins et al (2009)[23]

TABLE 1 (Continued)

Review type	Overarching goal	Search strategy	Appraisal of included studies	Analysis and synthesis	Key references
Overview (Reviews of reviews)	Aim to provide "user-friendly" summaries of the breadth of research relevant to a decision without decision makers needing to assimilate the results of multiple systematic reviews themselves. Often broader in scope than an individual systematic reviews, so that they can examine broad… options in ways that can be aligned with the choices that decision makers often make. In comparison to a synthesis of primary studies, overviews can be conducted more quickly				Pollock et al (2016; 2019)
State of the art reviews	Tends to address current matters in contrast to combined retrospective/current approaches. May offer new perspectives on issue or point out area for further research.				Grant and Booth (2009)[22]

*"Synthesizing information systems knowledge: A typology of literature reviews," by G. Paré, M. C. Trudel, M. Jaana, and S. Kitsiou, 2015, *Information & Management*, *52*(2), p. 187.

be evaluated (Figure 1), screened according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol.[19,20]

The search was performed by Catarina Alexandra de Melo Rondão (the first author). Two independent reviewers (authors D.E. and P.M.) assessed the included studies for their methodological quality (Table 2). Any discrepancies were discussed until a consensus was definitively reached.

The first author completed the search, and all included papers were reviewed for inclusion and the quality was independently evaluated by two reviewers (authors P.M. and D.E.; any discrepancies were discussed with the third reviewer). The included reviews were independently critiqued for their quality by two reviewers (authors V.B. and V.H.), using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Research Synthesis.[21] This quality measure was used as recommended within the JBI: Methodology for Umbrella Reviews (2014) and rated the inclusion of topics, such as review questions, inclusion criteria, search strategies, critical appraisals, and data extraction methods. Due to a variety of review methods (ie, narrative and meta-analysis), a quality measure was indicated to provide clarity on how the reviews synthesized material and therefore achieved their results and recommendations. Data involving the details of participants, the number of studies included, the intervention types, the results and conclusions, and the effect sizes were extracted.

3 | RESULTS

The search process identified 29 reviews to be included. Figure 1 describes the reviews identified at each search stage. On occasion, the same study was identified from the different electronic databases and is identified as "repeats." Reasons for exclusion of reviews at the full-text stage are provided.

The populations studied, the outcomes, and the summaries from the included reviews are presented in Table 2. All selected papers studied adult populations with mild cognitive impairment (MCI) or some type of dementia diagnosis.

According to the revision type, six different types were found, most of them being systematic revisions (n = 23), as well as two meta-analyses (one with a systematic review), one narrative revision, one umbrella revision, one review, and one over-review revision.

Review studies were divided according to the type of training (aerobic training, strength training, multicomponent training, and Dual Task training; Figure 2; Tables 3–6).

Regarding the type of exercise program, six reviews focus on aerobic training benefits for individuals with MCI. These six reviews summarize the results of 137 intervention studies (Table 3).

All studies referenced in this research show improvements[22–27] in cognitive function. Regarding de exercise characteristics, all the studies recommend at least three times per week of aerobic exercise with a duration equal or superior to 30 minutes per session. Only

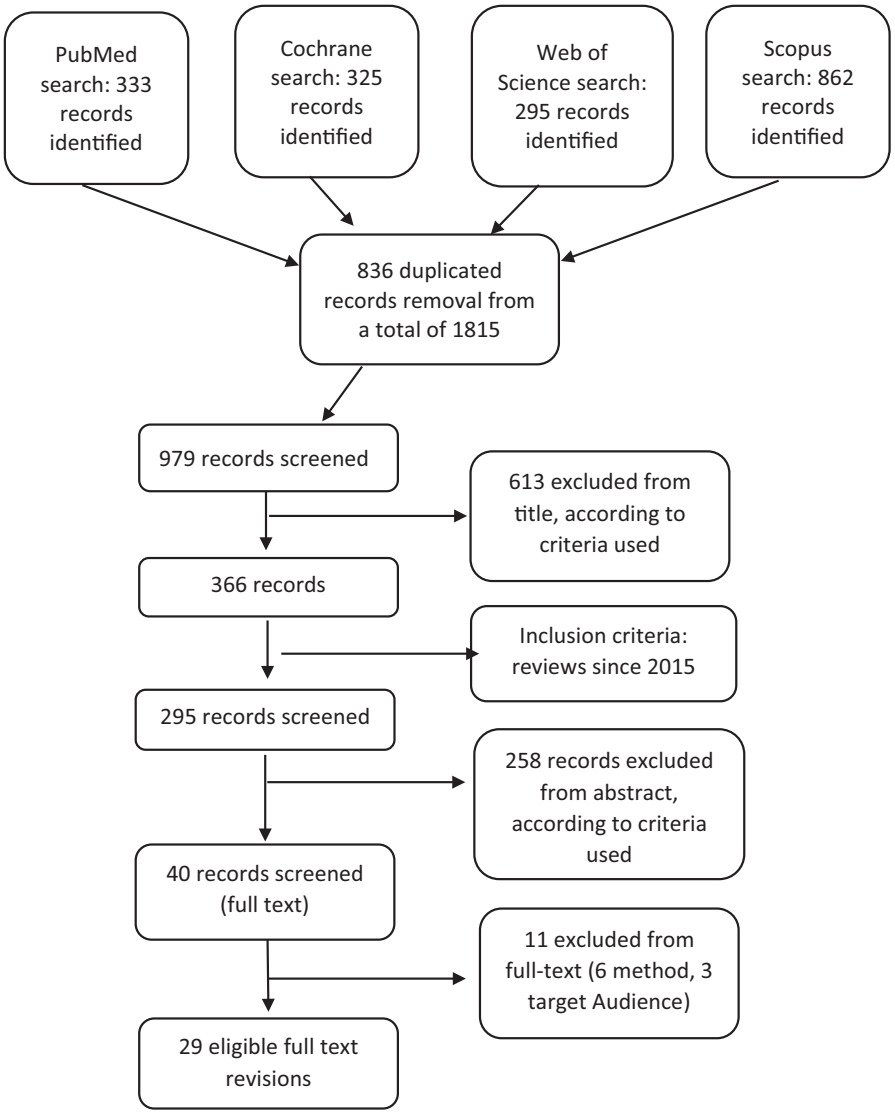

FIGURE 1 Flowchart illustrating reviews identified.

one study[25] referred the recommended intensity of this type of exercise that should be performed at 60% of maximal oxygen uptake. Only two revisions distinguished between living in a community[28] or nursing home.[23]

Only one review study was found regarding the effects of strength training in individuals with MCI, which included 15 intervention studies (Table 4).

The only review study found reported benefits of strength training in cognitive function of older people with MCI, which activity should consist of 150 minutes of strength exercises with moderate intensity per week.

Considering the multicomponent exercise program, 17 reviews were found, summarizing 459 intervention studies (Table 5).

Regarding the 17 reviews on multicomponent exercise considering elderly adults with MCI, 12 reported benefits in cognitive function, and five did not describe changes. Nine revision studies summarized the effects of multicomponent exercise training, including strength or resistance exercises, aerobic exercise, balance, and flexibility[29-37] with all of them reporting benefits in cognitive function. Groot et al. (2016)[14] included 18 studies comparing aerobic exercise with, non-aerobic or combined exercise, and reported benefits for cognitive function only when intervention included aerobic exercise alone or combined with non-aerobic exercise. The remaining multicomponent exercise programs include revisions of functional training,[32,38-40] and others which combine different types of exercise such as Tai chi, virtual reality, or exergames, yoga, and mind body exercise.[38,41,42] Only two reviews[40,43] failed to report benefits in cognitive function. Assorted differences in the exercise protocols make it difficult to identify general guidelines for multicomponent exercise intervention.

Considering dual task training, five reviews were found, summarizing 125 intervention studies (Table 6).

Five reviews were found regarding Dual Task training for individuals with MCI.[26,44-47] Four studies reported benefits for cognitive function[26,44,45,47] and the remaining one only referred to physical outcomes.[46] The prescription varied in frequency and duration.

4 | DISCUSSION

This study aimed to provide a theoretical framework to support future exercise interventions for people with dementia/cognitive

TABLE 2 Evaluation of the quality criteria fulfillment in RCTs examining the effects of exercise intervention on cognition.

Study	1	2	3	4
Brett et al (2016)	+	+	−	+
Bruderer-Hofstetter (2018)	+	+	+	+
Cai et al (2016)	+	+	−	+
Cammisuli et al (2017)	+	+	−	+
Cammisuli et al (2018)	+	+	−	+
Chong et al (2020)	+	±	+	+
Gallou-Guyot et al (2020)	+	+	−	+
Gheysen et al (2018)	+	+	+	+
Gomes-Osman et al (2018)	+	+	+	+
Groot et al (2016)	+	±	−	+
Hernández et al (2014)	±	+	+	+
Demurtas (2020)	+	+	−	+
Lam et al (2018)	+	+	+	+
Chun-Kit et al (2020)	+	+	+	+
Learner et al (2016)	+	+	−	+
Lewis et al (2020)	+	+	−	+
Xudong Li et al (2019)	+	±	−	+
Loprinzi et al (2018)	+	±	−	+
Loprinzi et al (2019)	+	−	−	+
Park and Cohen (2019)	+	+	−	+
Sandler et al (2019)	+	+	+	+
Biazus et al (2020)	+	±	+	+
Yeh et al (2020)	+	+	−	+
Song et al (2018)	+	+	−	+
Venegas-Sanabria (2020)	+	+	−	+
Vseteckova et al (2020)	+	+	−	+
Russ et al (2021)	+	±	−	+
Xiong et al (2021)	+	+	+	+
Zhang et al (2019)	−	+	+	+

Note: (1) The diagnosis of Alzheimer's Disease is based on validated criteria (NINCDS-ADRDA, 1984; APA, 2000; 2013); (2) Inclusion and exclusion criteria of the study are specifically described; (3) The study has sufficient statistical power (n ≥ 25 per group); (4) Intervention, measurements, and outcome measurements are correctly described by + applicable; ± superficially; − not applicable.

Abbreviation: RCT, randomized clinical trial.

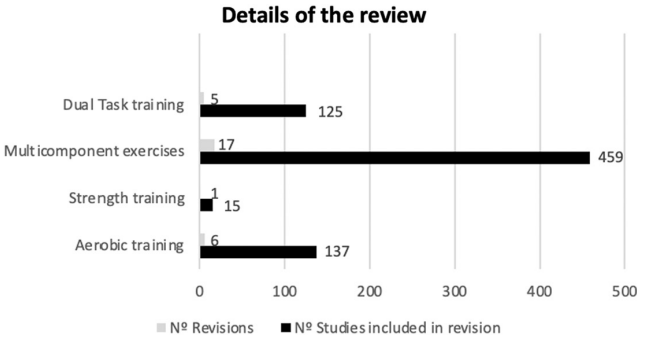

FIGURE 2 Distribution of the review studies according to the type of training, and total studies.

impairment. Twenty-nine review studies were analyzed, and although they were divided according to the type of physical training used as well as variables measured, all of them consistently reported benefits for the elderly with MCI.

From an initial search of 1815 reviews, only 41 met the defined criteria; however, only 29 presented sufficient methodological quality to be considered in this critical review. Many of the reviews were excluded due to a lack of either systematic research or analysis method, the heterogeneity of sample populations, as well as unclear interventions in the applied physical exercise programs. Moreover, only eight of the 29 studies had higher values in terms of quality assessment.[22,26,31,34,44,45,48,49] Although the 29 review studies included in this critical review concerned 721 interventions or review studies, it is likely that several studies had been repeatedly analyzed in several revision studies with the same aim. Consequently, the risk of analyzing the same intervention study several times exists, which may bias the results. It seems important to suggest that future revision studies take into consideration the period in which each revision performed its search process, avoiding the overlap of the same intervention studies.

Another concern is related to the revision types taken into account. In fact, six different revision types were included in this critical review (narrative, revision, over-review, systematic review, meta-analysis, and umbrella-review), which according to criteria, such as the overarching goal, search strategy, appraisal of included studies, analysis, and synthesis,[50] make it difficult to achieve a concrete proposal of guidelines for the physical training of the elderly with MCI. Indeed, most of the review studies are too vague in what concerns exercise prescription, and those that were not vague were systematic reviews,[7,22,23,25,27–30,33–35,37,39,40,42–45,51,52] and meta-analysis.[14,26] One narrative review has also been included[36]; however, this could be could be seen as an actualization of a previous systematic review published a year before.[25,52]

The main focus of this critical review was to evaluate the effects of physical exercise on the cognitive and physical fitness of elderly patients with MCI. Based on the present findings, patients with dementia may benefit from various exercise programs, namely the improvement of global cognition, especially in the initial-to-moderate phase of the disease.

Regarding aerobic exercise intervention improving global cognition, especially in the moderate stage of the disease,[53] all studies referenced in this research show improvements.[22–27] Only two revisions distinguished between living in a community[28] or nursing home.[23] In nursing homes, programs tend to be more controlled and follow a predefined organization of the institution, which may contribute to the success of intervention programs. In contrast, programs for community-dwelling older adults with subjective cognitive decline (SCD) depend on the involvement of family members and caregivers and their willingness to participate in the programs. Regardless of these constraints, the review of Vseteckova et al (2020), which included 10 studies, found improvements in cognitive function in community-dwelling older adults with aerobic training.

TABLE 3 Population, results, and summaries of the reviews included for the aerobic training.

Authors, year and review methodology	Number of included studies in review	Population, prevalence of dementia, and setting	Intervention: FITT	Outcomes measured	Summary of findings	Exercise recommendations
Learner et al 2016[28] Systematic review	6	Diagnosis of dementia and resident in a nursing home	Different types of programs: walking, balance, and endurance for 1 h, 3 times a wk, for 15 wk	Improvement of cognition after exercise	Longer duration aerobic exercise may be more effective in maintaining cognitive levels	Aerobic exercise
Cammisuli et al 2017[29] Systematic review	9	Patients with MCI	Aerobic training 50/60 min, 3 days a wk	Cognition	MCI patients benefit from aerobic exercise, but it is not possible to conclude that aerobic exercise promotes a selective effect on cognition	Aerobic training 50/60 min, 3 days a wk
Cammisuli et al 2018[29] Narrative revision	8	Patients with probable AD	Aerobic exercise	Cognition	AD patients can benefit from aerobic exercise intervention to improve global cognition	Aerobic exercise, 60% of VO_2max, 30 min, 3 d/wk
Gomes-Osman et al 2018[18]Systematic review	98	Adults (age ≥ 60 years) with or without cognitive impairment	Aerobic exercise	Cognition	There are cognitive improvements with exercise	3 times a wk for 60 h spread over 25 wk
Vseteckova et al 2020[31] Systematic review	10	Elderly people living with dementia in the community	Walking exercise	Physical, social, and mental improvement	The benefits of walking as an activity that improves health and participants' well-being	Outdoor walking
Loprinzi et al 2018[32] Systematic review	6	Patients with MCI	Aerobic, resistance or combined exercise or exercise duration (less than or greater than a 6-mo exercise program)	Cognition	Exercises can have beneficial effects on memory function among people with MCI	Aerobic exercise

AD, Alzheimer's disease; FITT, frequency, intensity, type, and time; MCI, mild cognitive impairment.

TABLE 4 Population, results and summaries of the reviews included for the strength training.

Authors, year and review methodology	Number of included studies in review	Population, Prevalence of dementia and setting	Intervention: FITT	Outcomes measured	Summary of findings	Exercise recommendations
Lewis et al 2020[7] Systematic review	15	Patients with MCI	Strength, power and muscle flexibility	Cognition physical condition	General benefits for physical health, cognitive, psychological, and behavioral aspects	Muscle strength, balance, and flexibility—an activity goal of 150 min per wk of moderate-intensity aerobic exercise

FITT, frequency, intensity, type, and time; MCI, mild cognitive impairment.

Aerobic exercise is a low cost, low risk, and widely available strategy for counteracting the consequences of dementia on the brain. Among the main methods used to perform aerobic exercise, walking[23,28] has stood out as the foremost method to improve brain physiology (improving mitochondrial function, increasing antioxidant capacity, and reducing oxidative stress,[54] as well as reducing chronic inflammation in the central nervous system, increasing neuroplasticity, and promoting the re-organization of neural circuits[55]). If performed outdoors, it may also stimulate attention, memory, executive function, orientation, and, if accompanied, language. As exercise with the elderly who have MCI should also be supervised and accompanied, walking outdoors may also be advantageous to the caregiver. This could be an appropriate exercise proposal for those individuals who live in a community setting.

Only three revisions[22,24,25] propose guidelines for aerobic exercise, whereas the remaining[22,25,52] are too unspecific, as they propose aerobic exercise three times per week. Only Cammisuli et al (2018) suggest an intensity of 60% of maximal oxygen uptake (VO_2maximum). Although this is a very precise method to utilize when prescribing exercise intensity, it may be difficult for exercise professionals to do so based on maximal oxygen uptake, as most of them cannot afford it. We therefore suggest that future recommendations should use other physiological parameters, such as heart rate, which are more feasible and easier to use.

Considering the effect of strength training in the cognition of older adults with MCI, only one systematic review was included.[7] This revision summarizes 15 intervention studies and reports general benefits in cognitive function, psychological health, and behavioral aspects. As strength training sessions imply, the existence of a clearly defined routine with sequential exercises and a set number of repetitions, it demands that the subject be alert when performing said tasks in order to stimulate cognitive function. Besides the effect of strength training on muscle strength,[7] which in turn reduces the risk of falls, it also promotes changes in self-image and self-esteem[6] with consequences in general psychological well-being. Although several benefits have been identified, the training load recommendations proposed by this revision study are 150 minutes of exercise (strength, balance, and flexibility) per week with moderate to vigorous intensity.

Multimodal exercise interventions are the most frequently reported in adults with and without cognitive impairment, both in community and residential settings. Seventeen revision studies were found considering the elderly adults with MCI, which, due to the heterogeneity of the programs reviewed, makes it difficult to propose a model of intervention. In fact, nine revision studies summarize the effects of multicomponent exercise training in more traditional and academic programs,[29–35,37,47] including strength or resistance exercises, aerobic exercise, balance, and flexibility, reflecting the guidelines proposed by the American College Sport Medicine (ACSM). All of these revision studies reported benefits in cognitive function, which may be explained as aforementioned by a combination of benefits due to aerobic, or strength training. An interesting meta-analytical study[15] compared interventions mainly focused in different metabolic demanding exercises (aerobic, non-aerobic, or

TABLE 5 Population, results, and summaries of included reviews for multicomponent exercises.

Authors, year and review methodology	Number of included studies in review	Population, prevalence of dementia and setting	Intervention: FITT	Outcomes measured	Summary of findings	Exercise recommendations
Hernández et al 2015[35] Systematic review	14	People with mild cognitive impairment or dementia	Physical activity and exertion (ie, multimodal, resistance training). Moderate intensity by in at least 30 min.	Strength exercises, stretching, and aerobic capacity	The practice of physical exercise helps to improve the performance of activities of daily living, improvement in neuropsychiatric disorders, improvement in depressive symptoms, improvement in cardiovascular and cardiorespiratory fitness, improvement in functional capacity components (flexibility, agility, balance, strength) and improvement in some of frontal cognitive function in patients with mild to severe AD	Multimodal, resistance training
Brett et al 2016[36] Systematic review	12	Diagnosis of dementia and being reside in a nursing home	Exercise for 30–60 min per wk. Different types of physical exercises aimed at strength, balance, flexibility, aerobic capacity, cognition, functional capacity, and/or coordination	Physical exercise has a positive effect on the health	Exercise positively affects the health and well-being of people living with dementia in nursing homes	30 min twice a wk strength, balance, flexibility and endurance
Cai Y, et al 2016[37] Review of studies	13	Community-dwelling adults aged 60 ys or older; participants had MCI	Aerobic exercise, Tai chi exercise, functional task exercise, resistance training and multicomponent physical training	Improvement in the areas of global cognition, executive function, memory, attention, and processing speed	More research will be needed to better understand the effect of physical exercise on cognitive function	Durations of >6 mo aerobic exercise, Tai chi exercise, functional task exercise, resistance training
Groot et al 2016[15] Meta-analysis of RCTs	18	Patients with MCI	Aerobic only, non-aerobic and combined	Cognitive function, ADLs	Positive effect in cognitive function, ADLs	Benefits of aerobic activity even at low frequency (40–45 min wk)
Lam et al 2018[38] Systematic review	43	Patients with MCI	Aerobic, balance, flexibility and functional training. 60 min a d, 2–3 d a wk	Cognition physical condition	Physical training improves cognitive and physical function in healthy elderly adults, and it is viable and beneficial for people with cognitive problems	Regular multimodal exercise with a combination of resistance, aerobic, balance, flexibility, and functional training for fence. 60 min a d, 2–3 d a wk is effective for improving various aspects of physical functioning (strength of the lower limbs, mobility, balance, resistance to walking)

TABLE 5 (Continued)

Authors, year and review methodology	Number of included studies in review	Population, prevalence of dementia and setting	Intervention: FITT	Outcomes measured	Summary of findings	Exercise recommendations
Song et al 2018[39] Systematic review	11	Patients with MCI	Aerobic exercise was of moderate intensity multimodal exercise program. Exercise programs included three or four types of exercise (aerobic, resistance training, stretching and balance, Tai chi)	Physical condition	Positive effects of physical exercise on improving global cognition	Moderate-intensity aerobic exercise appears to have greater beneficial effects on executive function
Xudong Li et al 2019[40] Systematic review	20	Patients with MCI	Combination of resistance, strength and balance interventions	Cognition	Exercise programs can play an important role in cognition and ADL	Resistance, strength and balance interventions
Loprinz et al 2019[34] Systematic review	11	Patients with MCI	Exercise protocols ranged from light stretching, basic exercise, aerobic walking, functional activities, and exercise combined with cognitive training	Cognition	Exercise has many beneficial effects on brain function	High intensity functional exercise is generally safe and viable for patients
Park and Cohen et al 2019[41] Systematic review	64	Older adults with various types of dementia	Exercise (supportive exercise, aerobics, resistance exercise, stationary cycling, exercise, yoga, tai-chi, walking, dancing, multi-component exercise, mind–body exercise)	Functional ability, psychological/ behavioral or social factors	Exercise has beneficial effects on functional ability, behavioral or social factors (mixed results), cognition (mild dementia) Individualized leisure and exercise activities that are simple, with structured one-on-one social interaction	Not possible to retrieve
Sandler et al 2019[42] Systematic review	64	Patients with MCI	Exercise, aerobics, resistance exercise, stationary cycling, exercise, yoga, taichi, walking, multi-component exercise, and body–mind exercise	Cognition physical condition	Exercise has a positive effect on physical health and psychosocial well-being	Intensive exercise programs (aerobics, cycling, strength, flexibility, balance and endurance combined with walking) 2–3 times a wk

TABLE 5 (Continued)

Authors, year and review methodology	Number of included studies in review	Population, prevalence of dementia and setting	Intervention: FITT	Outcomes measured	Summary of findings	Exercise recommendations
Biazus et al 2020[41] Systematic review	27	Participants investigated (average age ≥ 60 y) with a diagnosis of MCI	Kind of exercise (aerobic, endurance, multicomponent; ie, a type of physical training that combines different exercise regimens in the same exercise session, incorporating aerobic and/or resistance training and other forms of physical training)	Cognition	Physical activity (PA) improves cognitive function in older people with MCI	Perform at least 150 min/wk of moderate-intense or 75 min/wk of vigorous aerobic physical activity or an equivalent combination of both
Chong et al 2020[43] Narrative review	41	Older adults with MCI or SCD	Aerobic physical activity, multimodal PA, balance. The intensity was moderate-vigorous in most studies and this was defined most often by target heart rate or maximal oxygen uptake (VO2 max). 60 min a wk 6 mo	Cognition physical condition	PA can bring benefits to cognition and other health activities parameters in elderly people with MCI or SCD	Aerobic exercise, progressive resistance training and balance exercises, all of which must be tailored to the individual
Law et al 2020[44] Systematic review	50	People with MCI or dementia	Aerobic exercise, walking exercise and resistance exercise and combination with cognitive function was classified into global cognition, memory, executive function, reasoning, attention and language	Cognition	Exercise has been estimated as effective for global cognition, it can improve working memory	Moderate to high intensity aerobic exercise 12 wk
Demurtas et al 2020[46] Umbrella Review of Intervention and observational studies	23	Patients with MCI	Aerobic exercises, resistance exercises, balance and coordination exercises, motor-cognitive interventions (Virtual reality, exergaming)	Cognition	Physical activity/exercise was able to improve cognitive and non-cognitive outcomes in RCTs	Physical activity/exercise
Venegas-Sanabria et al 2020[47] Systematic review	11	Adults with dementia (of any type, including)	All exercise	Cognition	Benefit of global physical activity cognition, executive functions, memory, and processing speed among people with mild cognitive impairment and dementia	Multicomponent exercises

TABLE 5 (Continued)

Authors, year and review methodology	Number of included studies in review	Population, prevalence of dementia and setting	Intervention: FITT	Outcomes measured	Summary of findings	Exercise recommendations
Yeh et al 2021[48] Systematic review	15	Patients with MCI	High intensity functional exercises	Cognition physical condition	High intensity functional training is beneficial for balance, walking speed	High intensity functional exercise is generally safe and viable for patients with mild or moderate dementia. High intensity functional exercise is beneficial to the balance function and daily functioning among patients with insanity. High intensity functional exercise may not improve cognition or depression based on current evidence
Russ et al 2021[49] Systematic review and metanalysis	7	Patients with MCI	HIT program, High Intensity Functional Exercise (HIFE) program Duration 45–60 min, 12 wk	Cognition physical condition	Present data support that HIT regimens have led to greater improvements in balance and ability to execute ADLs	Physical training is recommended for treating dementia symptoms additional, well-designed studies it would be helpful to identify more effective exercise factors for different types and stages of dementia

AD, Alzheimer's disease; ADL, activities of daily living; FITT, frequency, intensity, type, and time; MCI, mild cognitive impairment; RCT, randomized clinical trial; SCD, subjective cognitive decline.

TABLE 6 Population, results, and summaries of the reviews included for the dual task training.

Authors, year, and review methodology	Number of included studies in review	Population, prevalence of dementia and setting	Intervention: FITT	Outcomes Measured	Summary of findings	Exercise recommendations
Bruderer-Hofstetter et al 2018[50] Systematic review	17	Patients with MCI	Dual task cognitive training exergames, dance and Tai chi	Cognition physical condition	Improved specific aspects of physical ability and/or cognitive function	The results of this systematic review confirmed that dual task intervention is more effective compared to active comparison interventions
Gheysen et al 2018[51] Systematic review	40	General mean age ≥ 65 y with or without mild cognitive impairments in the beginning	Dual task, cognitive training and aerobic exercise or strength training	Cognition physical condition	Interventions combining physical and cognitive activity can improve cognitive level	Dual task cognitive training aerobic exercise or strength training
Zhang et al 2019[52] Systematic review	34	Average age 65 y or older, participants had cognitive impairment or dementia	Dual task, strength and balance training combined with, functional mobility and attention training and the training of executive functions	Cognition	There is evidence that anti-dementia drugs, exercise combined programs and exercises and cognitive interventions improve walking in people with MCI or dementia	Physical training combined with cognitive training
Gallou-Guyot et al 2020[53] Overview	9	Participants with neurological diseases other than dementia or MCI	Dual task strength, march, mobility, balance and falls cognitive covered attention, memory and executive functions frequency (1–6 times a wk), duration of sessions (30–180 min), and duration (4–52 wk duration). Group gym sessions mind–body exercises such as Tai chi, dancing, music, or martial arts	Cognition physical condition	Dual-task training appears to be effective both cognitively and physically in adults with MCI or dementias	Frequency: 1–6 times a wk; duration of 30–180 min per session; and lasting between 4–52 wk. Group gym sessions should include mind–body exercises such as Tai chi, dancing, music, or martial arts
Xiong et al 2021[33] Systematic review and metanalysis	25	Healthy elderlies with no known cognitive impairment	Aerobic, resistance or body–mind exercises. 3 weekly sessions ranged from 20 to 90 min in duration 1–12 mo (VO2max)	Cognition	Physical exercise results in significant improvement in working memory, inhibition, and cognitive flexibility in cognitively healthy older adults	Aerobic exercises Body mind exercises

FITT, frequency, intensity, type, and time; MCI, mild cognitive impairment.

combined exercise), and described benefits for cognitive function with aerobic and combined exercises programs. This study pointed out the importance of metabolic imbalance, induced by specific exercise types, in the stimulation of cell signaling pathways that result in oxidative capacity increase,[56] fundamental for cognitive performance.[57] Other multicomponent exercise programs include functional training,[32,38–40] and combinations of different exercises, such as Tai chi, virtual reality or exergames, yoga, and mind body exercise.[38,41,42] All of the studies reported health benefits for people with MCI, although benefits of four cognitive functions were only described by references 32,38,43,52,53. However, possibly due to a lack of criteria in the selected studies,[42] recommendations could not be made. As should be expected, innumerous differences in exercise protocols make it difficult to prescribe general guidelines for multicomponent exercise intervention. Nevertheless, these types of interventions represent programs which are more dynamic, creative, and motivational for older adults with MCI, thus it could be a way to improve program attendance and success.

Regarding dual task training revision studies, five met the defined criteria (three systematic reviews, one meta-analysis, and one over-review). For the purpose of this critical review, a study was included in terms of dual task training if during a motor task exercise the subject had to perform a cognitive task (eg, calculation during walking, evocation, and orientation during a trail, among others).[45,54] Despite the diversity of intervention programs (aerobic + cognitive, strength + cognitive, coordination + cognitive, balance + cognitive, etc.), results consistently suggested benefits at both the physical and cognitive level in people with MCI.[26,44–47] In fact, the effect of transferring cognitive function to physical ability has been shown through the effectiveness of cognitive dual task training on balance and postural control in older adults.[44,58] Moreover, improvements in cognitive functioning tended to be greater for interventions consisting of physical activity + cognitive activity (PA + CA) combined simultaneously, in contrast to PA + CA interventions which were combined sequentially. Furthermore, results showed that improvements in cognition can be expected after combined PA + CA interventions for both cognitively healthy and moderately impaired older adults.[44–47]

Dual task training has some important benefits. Besides the fact that it performs two tasks simultaneously, motor and cognitive, it may be a form of cognitive distraction, allowing the exercises to be performed without focusing on the possible pain or discomfort caused by the exercise itself.

The results of these review studies improve the effectiveness of dual-task interventions.[43-46,51] Summarizing the recommendations, the effectiveness of the interventions depends on the frequency (if possible, every day), and the duration (30–180 minutes per session). In addition, it is suggested that each session should include mind–body exercises, such as walking, strength exercise, functional mobility, exergames, dance, music, or martial arts, simultaneously with cognitive tasks.[43-46,51]

Considering the effects of different methods of exercise on physical function, most of the results report improvements in variables specific to the type of exercise performed. Regarding this, those that performed aerobic exercise improved aerobic capacity,[21,24,25,28,49,59] and those that trained improved strength and overall functionality while reducing the risk of falling in daily living activities.[7] The remaining revisions presented different outcomes in functionality which vary according to the variables measured,[26,37,40] including the risk of falling.[26,43-46] Dual task interventions were mainly concerned with the improvement of cognitive function.

Despite the complexity in not only the selection process of the revision papers and the analyses of different methodological issues, but also the heterogeneity of the exercise interventions which were implemented, it is possible to recommend the practice of daily physical exercise combined with cognitive tasks, and other forms of stimulation (music, exergames, dance…) for individuals with MCI. In fact, the gains made in cognitive function seem to depend more on the frequency of the exercise sessions, whereas the gains made in terms of physical function depend on the duration of intensity of at least three times per week. Particularly in elderly individuals with MCI, we suggest that the frequency of the stimulation through exercise follow a daily routine to avoid the delay and onset of the impairment of cognitive function. Moreover, the planning of exercise sessions should include aerobic, strength, balance, flexibility, and agility exercises combined with cognitive tasks. Combining strength and balance exercises with mobility training, which targets basic functions needed during daily living activities (functional mobility training), such as sit-to-stand, walking, wandering in spaces, and turning, may be effective for improving gait.[60,61] Because it is difficult to achieve a high attendance rate in such programs, we propose that a minimum of two to three sessions occur in the presence of an exercise professional, and the remaining sessions occur at the individual's residence with remote monitoring and/or the use of exergames. Regarding the low fitness capacity of most of these individuals, it may be advisable that, at the beginning of the program, exercise sessions be performed at home throughout the day, divided into three to four sessions lasting 10 minutes.

4.1 | Limitations

Some of the main concerns of this critical revision is the low methodological quality of several of the included revision articles, which restricts the ability to objectively propose guidelines of physical exercise for people with MCI.

Another limitation is related to the process of the analyses of revision articles. In fact, although at first glance a critical revision seems to be an excellent opportunity to summarize the main findings of hundreds or thousands of intervention studies analyzed in each review article, a cautious reflection should be carried out because the same articles could have been cited in different revisions.

4.2 | Future contributions

An important aspect to incorporate in future revision studies is the interindividual variability in responses to exercise, and modifiable factors (eg, diet) as well as non-modifiable factors (eg, genetic), which could impact the effect of exercise.[32]

Another recommendation that is still required is the elaboration of a manual with a program, including the advocacy of dual task training in interventions for individuals with MCI.

5 | CONCLUSION

Based on the present findings, patients with dementia may benefit from various exercise programs to improve global cognition, especially in the initial-to-moderate phase of the disease. In addition, exercise can improve the balance ability of patients with MCI and reduce the risk of falls. Consequently, this allows preliminary counseling of patients with mild dementia, particularly those who are sedentary, to begin with daily multicomponent exercise in conjugation with cognitive tasks, and other creative forms of brain stimulation.

AUTHOR CONTRIBUTIONS

Study concept and design: de Melo Rondão and Esteves. Methodology: de Melo Rondão. Software: de Melo Rondão. Validation: de Melo Rondão, Esteves, and Mota. Formal analysis: de Melo Rondão. Investigation: de Melo Rondão. Resources: Esteves. Data curation: de Melo Rondão. Writing of the manuscript and original draft preparation: de Melo Rondão. Writing of the manuscript with review and editing: Esteves. Visualization: Esteves. Supervision: Mota. Project administration: Esteves. Funding acquisition: Esteves and Mota. All authors have read and agreed to the published version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

INSTITUTIONAL REVIEW BOARD STATEMENT

All the experimental procedures were approved according to the Declaration of Helsinki (UNESCO. Universal Declaration on Bioethics and Human Rights 2006) and were carried out with the approval of the Ethics Committee of the University of Beira Interior (reference code No. CE-UBI-PJ-2019-021).

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