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Effects of home-based physical exercise programs on cognition in older adults: an integrative review

Efeitos de programas de exercícios físicos domiciliares na cognição de idosos: uma revisão integrativa

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Abstract

This study sought to review randomized clinical trials of home-based physical exercises and their effects on cognition in older adults. An integrative review was carried out after searching the PubMed, Google Scholar, MEDLINE, LILACS, SciELO, and PEDro databases. The risk of bias of the included randomized controlled trials was assessed using the PEDro Scale. Fourteen studies were included, with an average PEDro score of 6.1 ± 1.7 (range, 3 to 9) points. Overall, the studies found that interventions consisting of home-based physical exercise programs, whether strength training alone or combined with aerobic and balance exercises, performed three times a week in 60-minute sessions for a minimum duration of 8 weeks, contribute to cognitive performance in older adults, with particular impact on executive function. We conclude that home-based physical exercises constitute a strategy to minimize the negative implications associated with cognitive impairment in older adults.

KEYWORDS: cognition; aging; exercise.

Resumo

Este estudo buscou revisar ensaios clínicos randomizados com exercícios físicos domiciliares e seus efeitos na cognição de idosos. Foi feita uma revisão integrativa com seleção nas bases de dados PubMed, Google Scholar, MEDLINE, LILACS, SciELO e PEDro. A avaliação do risco de viés dos ensaios clínicos randomizados incluídos foi feita usando a Escala PEDro. Catorze estudos foram incluídos, cuja pontuação dos artigos na escala PEDro foi em média de $6,1 \pm 1,7$ pontos, com a pontuação total variando de 3 a 9. De forma geral, os estudos apontaram que a intervenção com programas de exercícios domiciliares de treino de força isolado ou combinado com exercícios aeróbico e de equilíbrio, realizado três vezes na semana com 60 minutos por sessão e duração mínima de oito semanas, contribui para o desempenho cognitivo de idosos, especialmente sobre a função executiva. Concluiu-se que exercícios domiciliares se apresentam como uma estratégia para minimizar as consequências negativas associadas ao déficit cognitivo em idosos.

Palavras-chave: cognição; envelhecimento; exercício.



INTRODUCTION

Home-based physical exercise programs, also known in the literature as home training, aim to promote health and rehabilitation through engagement in physical exercise.¹ Home training is a simple, effective, feasible, and safe option for certain populations, such as patients undergoing cardiovascular rehabilitation, and can promote maintenance of the benefits usually obtained under professional supervision.¹

In home-based physical exercise programs, follow-up can take on several forms, but is most commonly achieved via telephone calls or periodic visits by a health care provider or other competent professional.² Due to its sustainable, effective nature, use of home-based physical exercise models is particularly common among older adults, especially those with progressive health conditions.³ It should be noted that the aging process involves several physiological and anatomical changes that can impair health and functionality, such as loss of tissue function, loss of body size and height, decreased bone density and muscle mass, reduced subcutaneous fat and increased visceral body fat, decreased hormone secretion, and a blunted neural response.⁴

Lacroix et al.⁵ suggest that supervised programs facilitate gains in balance and muscle strength in older adults and improve outcomes by making participants execute the exercises with better quality, higher training intensity, higher adherence, and thereby a higher training volume, in addition to beneficially influencing executive function – one of the cognitive determinants of physical capacity.⁵ Nevertheless, the authors highlight the excellent cost-benefit ratio of unsupervised home training, as participants do not need to leave their homes (eliminating transportation costs) and supervision costs are reduced.

Home-based physical exercise programs may help overcome some of the barriers to physical exercise faced by older adults, such as fear of falling, the effort and costs of traveling to exercise facilities, and lack of motivation, by respecting the preferences of those who prefer the privacy of their own home environment.⁶

The effectiveness of home-based physical exercise on functional capacity is quite evident in the older population, especially regarding increased performance in test batteries involving mobility and aerobic resistance⁷ and increased muscle strength.⁸ Many studies have also reported improvements in quality of life,⁹ mood, and well-being,¹⁰ as well as a decrease in the risk of falls and fear of falling,⁶ anxiety,¹⁰ body fat percentage, and loss of body mass.¹¹ The pathological aging process can also promote harmful effects on the brain, with reductions in mass, oxygen supply, and

number of neural connections,⁴ increasing the prevalence of chronic degenerative diseases such as dementia and leading to a gradual decline in attention and information processing speed.¹²

However, the social isolation measures put in place as a result of the COVID-19 pandemic have led to a decline in physical activity levels among the older population, contributing to sarcopenia, frailty, and cardiometabolic disorders.¹³ With the increase in sedentary behavior in this population, home-based physical exercise programs have been indicated to prevent this decrease in physical activity levels and avoid sedentariness in older adults within the context of social distancing, which, in addition to reducing cardiovascular risk, might also be effective in improving cognition and reducing the risk of dementia.¹⁴

Publications summarizing studies with exclusively home-based training, regardless of the level of supervision, of older adults which employed cognitive parameters as variables are scarce, even in the specific context of the COVID-19 pandemic. Knowing that older adults are a high-risk group for COVID-19¹⁵ and were instructed to avoid fitness clubs and even open spaces and remain in isolation to reduce their risk of exposure, home-based physical activity became an alternative to comply with these safety recommendations and prevent the spread of the novel coronavirus.¹⁶

It is important to understand how home-based physical exercise programs affect cognition, since the reduction in socialization and social participation during the COVID-19 pandemic was a crucial factor increasing the prevalence of mood disorders and cognitive decline in older adults.¹⁷ Given the increased popularity of this training model in the post-pandemic setting, the benefits of this modality need to be further elucidated. The present review aims to summarize the best available evidence from randomized clinical trials which evaluated the effects of home-based physical exercise programs on cognitive function in older adults.

METHODS

An integrative review design was selected for this study. The methods were divided into six stages:

1. Formulation of the guiding question;
2. Literature search or sampling;
3. Data collection;
4. Critical review of the included studies;
5. Discussion of results; and
6. Presentation of the integrative review.¹⁸

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations as far as possible, within the constraints of an integrative review design. The review protocol was not entered into any registry.

For the first stage (formulating the research question), we considered a need to investigate the effects of home-based exercise programs on cognition in older adults. The following inclusion criteria were established: randomized clinical trials; having home-based physical exercise as the sole intervention; and studying cognitive outcomes, specifically in older adults. There were no limitations on language or date of publication. Subsequently, the following steps were performed by 5 authors, and any conflicts between opinions were resolved by consensus:

1. Analysis of article titles,
2. Analysis of abstracts, and
3. Analysis of full-text articles.

Sample selection

A bibliographic search was carried out from October 2020 to March 2021 for randomized clinical trials on PubMed, Google Scholar, Virtual Health Library with analysis of the International Literature in Health Sciences (MEDLINE via BIREME), Latin American and Caribbean Health Sciences Literature (LILACS) and Scientific Electronic Library Online (SciELO), and the Physiotherapy Evidence Database (PEDro). Google Scholar was also used in a complementary way. The subject headings used were “*home-based*” (primary subject heading for exercise intervention), “*elderly*” (secondary subject heading for the population group), and “*cognition*” (tertiary subject heading for the outcome). Synonyms and supplementary concept record terms extracted from the Descriptors in Health Sciences (DeCS)/Medical Subject Headings (MeSH) thesaurus were used to compile the following advanced search query: “*Home-based*” (or) “*Minimally supervised*” (and) “*Elderly*” (or) “*Old people*” (or) “*Aged*” (and) “*Cognition*” (or) “*Cognitive function*” (or) “*Memory*” (or) “*Memory and Learning Tests*” (or) “*Memory Disorders*” (or) “*Neuropsychological Tests*” (or) “*Memory, Episodic*” (or) “*Memory, Long-Term*” (or) “*Memory, Short-Term*” (or) “*Learning*” (or) “*Mental Status*” (and) “*Dementia Tests*” (or) “*Memory Loss, Anterograde*” (or) “*Dementia*” (or) “*Neurocognitive Disorders*” (or) “*Neurocognition*” (or) “*Amnesia*”.

Data collection

The following information was selected for data extraction: year of publication, sample characteristics (sex, mean age, sample size, clinical or physical status), description of the

home-based physical training intervention (type of training, session duration, weekly frequency, duration of intervention), and performance on cognitive assessments.

Statistical analysis

For analysis and synthesis of the included articles, a summary table of the extracted data was constructed to highlight the main results. Risk-of-bias assessment of the included randomized clinical trials was based on the PEDro Scale, with scores ranging from 0 (low quality) to 10 (high quality). The objectives of the PEDro Scale are to assist users of the database in evaluating the methodological quality of randomized controlled studies, as well as to assess whether the study contains the minimal necessary statistical information so that the results can be interpreted; the PEDro database is a specific database for studies investigating the effectiveness of physical therapy interventions.¹⁹

RESULTS

A total of 1347 articles were identified in PubMed, 63 in MEDLINE via BIREME, 6 in PEDro, and none in LILACS or SciELO. A total of 142 articles were identified in Google Scholar. After refinement, eligible articles were identified only among those retrieved from PubMed and Google Scholar; 14 articles were ultimately included (Figure 1).

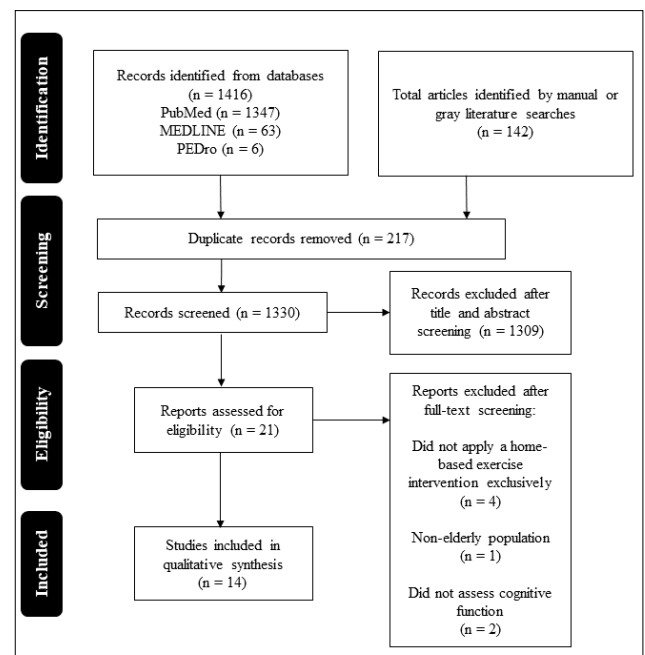


FIGURE 1. Flow diagram of study selection.

Table 1 summarizes the 14 articles selected from the PubMed (n=10) and Google Scholar (n=4) databases, reporting sample characteristics, components of the home-based exercise interventions, and cognitive outcomes measured in the participants.²⁰⁻³³

The PEDro score of the articles averaged 6.1±1.7 (range, 3 to 9) (Table 2).²⁰⁻³³

DISCUSSION

The 14 selected studies included a mean sample of 96.6±68.8 participants, with sample sizes ranging from 25 to 210 older adults, most of whom were female. The mean age of participants was 70.3±7.1 years, ranging from 57.6 to 78 years.

Regarding clinical and physical status, only the Nemček & Simon²⁸ study specified physical status; the authors

TABLE 1. Description of the studies that evaluated the effects of home-based exercise programs on the cognitive function of older adults.

Author, year of publication, country	Sample	Home-based exercise program	Results
Lachman et al. ²⁰ 2006. United States	Sex: 77.6% female. Mean age: 75 years. n: 210. Status: at least one comorbidity. Educational attainment not reported.	Intervention: Strength training, 35 minutes/session, 3 sessions/week, for 26 weeks. Control: Instructed to continue with normal everyday routines and enroll in a waiting list for the exercise program.	↑ Backward digit span (improved attention).
Liu-Ambrose et al. ²¹ 2008. Canada.	Sex: 66.5% female. Mean age: 70 years. n: 59. Status: frail. Educational attainment not reported.	Intervention: Strength and balance training, 30 minutes/session, 3 sessions/week, for 6 months. Control: No physical activity.	↓ Trail Making Test B ↑ Digit span test, ↓ Stroop Test (improvement in visuospatial function, attention, and inhibitory control).
Lautenschlager et al. ²² 2008. Australia.	Sex: 50.5% female. Mean age: 68.6 years. n: 170. Status: Memory-impaired, but not diagnosed with dementia. Mean educational attainment: 12 years of schooling.	Intervention: Walking, strength training, or gym circuit exercise, 50 minutes/session, 3 sessions/week, for 24 weeks. Control: Participants in this group received educational material about memory loss, stress control, healthy diet, alcohol intake, and smoking, but not about physical activity.	↑ ADAS-Cog ↓ Word List Total Immediate Recall ↑ Delayed Word List Recall ↑ Digit Symbol Coding ↑ Total Verbal Fluency Score ↓ Clinical Dementia Rating Scale. (improvement in cognitive screening, memory, attention, verbal fluency).
Taylor-Piliae et al. ²³ 2010. United States	Sex: 70% female. Mean age: 69 years. n: 132. Status: healthy. Educational attainment not reported.	Intervention: Tai Chi versus Western exercise (strength, resistance, and flexibility training); 60 minutes/session, 3 sessions/week, for 12 months. Control: Only “healthy aging” classes.	↑ Animal-Naming Test ↑ Forward Digit Span ↑ Backward Digit Span (improvement in verbal fluency and attention).
Suzuki et al. ²⁴ 2012. Japan.	Sex: 54% male. Mean age: 76 years. n: 50. Status: amnesic. Mean educational attainment: 11 years of schooling.	Intervention: Aerobic training, postural balance retraining, and dual-task exercises, 90 minutes/session, 2 sessions/week, for 12 months. Control: Only classes on health promotion.	↑ Mini-Mental State Examination ↓ Logical Memory subtest of the Wechsler Memory Scale-Revised ↓ Digit-Symbol Coding ↓ Verbal Fluency Test ↑ Stroop Test (improved cognitive screening, attention, and verbal fluency).
Sosnoff et al. ²⁵ 2014. United States	Sex: 77.8% female. Mean age: 60 years. n: 27. Status: with multiple sclerosis. Educational attainment not reported.	Intervention: Walking, balance training, and lower-limb strength training, 45 to 60 minutes/session, 3 sessions/week, for 12 weeks. Control: Instructed to continue normal everyday routine, without any physical activity intervention.	↑ Reaction time (improved attention).

Continue...

TABLE 1. Continuation.

Author, year of publication, country	Sample	Home-based exercise program	Results
Öhman et al. ²⁶ 2016. Finland.	Sex: 61.4% male. Mean age: 77 years. n: 210. Status: with Alzheimer's disease. Average educational attainment: >8 years of schooling.	Intervention: Aerobic, strength, balance, and executive-function training, 60 minutes/session, 2 sessions/week, for 52 weeks. Control: Received standard community care.	↑Clock Drawing Test ↔verbal fluency ↔Mini-Mental State Examination (improvement in visuospatial function, verbal fluency, and cognitive screening).
Rasmussen et al. ²⁷ 2016. Denmark.	Sex: 57.7% female. Mean age: 78 years. n: 71. Status: no limitations. Educational attainment not reported.	Intervention: Physical activities and daily activities, duration not specified, 1 to 5 times a week, for 8 weeks. Control: No activity.	↑CT-50 Cognitive Test (improvement in cognitive screening).
Nemček & Simon ²⁸ 2016. Slovakia.	Sex: 80.6% female. Mean age: 78 years. n: 31. Status: sedentary. Educational attainment not reported.	Intervention: Aerobic activities and psychomotor exercises, duration not specified, 2 times a week, for 15 weeks. Control: No activity.	↓Stroop Test, Dot ↓Stroop Test, Word ↓Stroop Test, Interference (improved inhibitory control).
Vieira et al. ²⁹ 2018. Portugal.	Sex: Both. Mean age: 57.6 years. n: 33. Status: with coronary artery disease. Educational attainment not reported.	Intervention: Strength and resistance training, virtual-reality exercise, 86 minutes/session, 3 sessions/week, for 30 weeks. Control: No activity.	↓Trail Making Test ↑Digit Span ↓Stroop Test (improvement in visuospatial function, attention, and inhibitory control).
Prike et al. ³⁰ 2017. Australia.	Sex: 63.1% male. Mean age: 77 years. n: 111. Status: with dementia. Educational attainment not reported.	Intervention: Flexibility, strength, balance, and resistance training, eight 60-minute sessions, for 3 months. Control: Usual care with minimal intervention.	↔8 Words Test ↔Face and Picture Recognition of the Rivermead Behavioural Memory Test ↔Backward Digit Span Test ↔Key Search Test ↔Category Fluency subtest of the Groninger Intelligence Test ↑Digit Span Test Forward (improved attention, memory, and verbal fluency).
Song et al. ³¹ 2018. Australia.	Sex: 60.5% female. Mean age: 66.5 years. n: 60. Status: with Parkinson's disease. Educational attainment not reported.	Intervention: Exergame training (a modified version of the Stepmania video game), minimum 15 minutes/session, 3 sessions/week, for 12 weeks. Control: No activity.	↓Reaction time ↑MoCa ↓Trail Making Test A ↑Trail Making Test B (improvement in attention memory, cognitive screening, and visuospatial function).
Sebastião et al. ³² 2018. United States	Sex: 88.5% female. Mean age: 60 years. n: 25. Status: with multiple sclerosis. Educational attainment not reported.	Intervention: Strength, balance, flexibility, and agility training (Square-Stepping Exercise), 25 minutes/session, 5 sessions/week, for 12 weeks. Control: Light stretching and minimal strengthening program, 2 sessions/week.	↑Visual Short-Term Memory Test ↑California Verbal Learning Test ↑Symbol Digits Modality Test (improvement in memory and attention).
Brinke et al. ³³ 2020. Canada.	Sex: 60.6% female. Mean age: 72.2 years. n: 124. Status: preserved cognitive function. Educational attainment not reported.	Intervention: Walking exercises combined with computerized cognitive training, 60 minutes/session, 3 sessions/week, for 8 weeks. Control: Cognitive training, stretching, balance and core strengthening exercises, and brain health education classes, 60 minutes/session, 3 sessions/week.	↑Stroop Test ↓Trail Making Test Parts B-A ↓Flanker Test. ↓Dimensional Chance Card Sort Test (improvement in inhibitory control, visuospatial function, and attention).

The symbols ↑, ↓, and ↔ respectively denote increased, decreased, or unchanged score/time on each test.

TABLE 2. PEDro score for each included study.

Study	1	2	3	4	5	6	7	8	9	10	11	Score
Lachman et al. ²⁰	●	●	○	○	○	○	●	○	○	●	●	4/10
Liu-Ambrose et al. ²¹	●	●	●	●	○	○	●	○	●	●	●	7/10
Lautenschlager et al. ²²	●	●	●	●	○	○	●	●	●	●	●	8/10
Taylor-Piliae et al. ²³	●	●	○	●	○	○	●	●	●	●	●	7/10
Suzuki et al. ²⁴	●	●	○	●	○	○	○	●	●	●	●	6/10
Sosnoff et al. ²⁵	●	●	●	●	○	○	●	○	○	●	●	6/10
Öhman et al. ²⁶	●	●	○	●	○	○	○	○	○	●	●	4/10
Rasmussen et al. ²⁷	●	●	●	●	○	○	○	●	●	●	●	7/10
Nemček & Simon ²⁸	●	○	○	●	○	○	○	○	○	●	●	3/10
Vieira et al. ²⁹	●	●	●	●	○	○	○	○	○	●	●	5/10
Prike et al. ³⁰	●	●	●	●	○	●	●	●	●	●	●	9/10
Song et al. ³¹	●	●	●	●	○	○	●	●	●	●	●	8/10
Sebastião et al. ³²	●	●	●	●	○	○	○	●	○	●	●	6/10
Brinke et al. ³³	●	●	○	●	○	○	●	●	○	●	●	6/10

● Criterion met; ○ Criterion not met; 1: Eligibility criteria specified (not included in score); 2: Random allocation; 3: Allocation concealed; 4: Groups similar at baseline; 5: Blinding of subjects; 6: Blinding of therapists; 7: Blinding of assessors; 8: Adequate follow-up; 9: Data treatment; 10: Between-group comparisons; 11: Point measures and measures of variability.

investigated only sedentary older adults. As for clinical status, three trials enrolled older adults with dementia,^{26,30,31} and three others, healthy older adults with no limitations.^{23,27,33} Two studies assessed older adults with multiple sclerosis,^{25,32} and one trial each investigated participants with amnesia;²⁴ with memory impairment, but no dementia;²² with coronary artery disease;²⁹ with at least one comorbidity;²⁰ and with the frailty syndrome.²¹

Regarding the type of exercise, studies generally involved home-based strength training, aerobic training, and balance training programs, with some adaptations such as work on executive functions^{26,31-33} and use of technology aids.^{29,31,33} The average duration of interventions was 24.8 weeks, ranging from 8 to 52 weeks. The overall average training frequency and session duration across the 14 studies was three weekly sessions and 52.5 minutes, respectively.

Only Sebastian et al.,³² Suzuki et al.,²⁴ Brinke et al.,³³ and Öhman et al.²⁶ combined traditional physical training protocols with activities that also include a cognitive component.

Regarding control groups, in most studies, participants did not perform any physical activity or were instructed to go about their normal routines.^{20,21,25,27-29,31} In the remaining studies, participants received educational materials or classes,²²⁻²⁴ standard care in the community or minimal intervention.^{26,30,32} Only one study combined cognitive training, a physical-activity intervention, and educational classes.³³

Home-based physical exercise programs and cognitive skills

Regarding the investigation of cognitive skills in participants undergoing home-based training, the included trials used different assessment instruments to evaluate different components of executive functions. Liu-Ambrose et al.²¹ assessed three central executive functions in older adults with a history of falls: visuospatial function, using the Trail Making Test Part B; working memory, using the verbal digit span test; and response inhibition, using the Stroop Test. Implementation of a home-based resistance training and balance training

program significantly improved the executive process of response inhibition by 12.80% and reduced the incidence of falls by 47.00% after one year, although it did not significantly reduce the risk of physiological falls. The study suggests that further research on exercise interventions for falls should measure elements of executive function.

Lachman et al.²⁰ studied the effect of a home-based strength training program on memory in older adults. Within the treatment group, change in resistance level during the intervention was a significant predictor of memory change ($\gamma_{20} = 0.17$, $t = 2.34$, $p = 0.02$). Memory was assessed by the digit span test, administered by telephone. Although the specific mechanisms for improving neurotrophic factors involved in memory were not explored by the authors, their results suggest that home-based strength training can benefit memory among older adults, especially when using higher resistance levels.

Nemček & Simon²⁸ sought to determine the effect of regular participation in a home-based physical exercise program on cognitive functioning, as assessed by the Stroop Test, among older adults living in long-term care facilities. The authors used a version of the Stroop Test that involves two conditions in addition to the standard word-based test: in one, “Dot”, dots are substituted for words; in the other, “Interference”, more colors and words are used than in the standard test. Pre- and post-intervention comparisons showed 69% of time improvement in all three test conditions, but only the score on the “Word” condition of the Stroop Test showed a statistically significant increase ($p < 0.01$), in which 88% of older adults improved their time score.

Rasmussen et al.²⁷ investigated home-based physical training as a replacement for usual rehabilitation treatment for older adults who suffered a stroke, with a secondary objective of evaluating the effect of home training on cognitive function. To do so, they used the CT-50 Cognitive Test, which is similar to other questionnaires such as the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA). According to the authors, the CT-50 is a neuropsychological test battery that assesses several elements including memory, perception, and problem-solving skills, with a maximum score of 50 points. Lower scores are associated with greater cognitive dysfunction. Although the study showed a correlation between total amount of time in home-based rehabilitation and CT-50 scores, statistical significance was not reached regarding the effect on cognition.

Finally, Taylor-Piliae et al.²³ assessed the effects of Tai Chi versus Western exercise as applied to a home-based physical exercise intervention with older adults. A statistically significant improvement in cognitive function was demonstrated

by the backward digit span test ($F = 7.75$, $p < 0.001$). This may be related to the way in which this modality is practiced – participants are taught to be careful when executing movements, performing them at a slow, proper pace, using their legs and arms.²³

Home-based physical exercise programs and neurodegenerative diseases

The literature has shown that physical exercises performed at home can improve balance and gait speed in people with neurodegenerative diseases.³ Among the trials included in this review, Öhman et al.²⁶ examined whether a personalized program of regular, long-term exercise, performed at home or in a group setting in an adult daycare center in the community, would have beneficial effects on the cognition of 210 older adults with Alzheimer’s disease. Exercises were designed by physiotherapists specializing in dementia, according to each participant’s individual requirements, and included elements of executive function training, dual-task exercises, strength, balance, endurance, and aerobic training. Cognitive function was measured using the Clock Drawing Test, the Verbal Fluency Test, the Clinical Dementia Rating Scale, and the MMSE, at 3, 6, and 12 months of follow-up. Home training was found to improve the executive function of older adults with memory disorders, as assessed by the Clock Drawing Test, but the effects were mild and not observed in the other domains of cognition, especially verbal fluency.

Lautenschlager et al.²² studied whether physical activity decreases the rate of cognitive decline in older adults at risk for Alzheimer’s disease during 18 months of follow-up. Volunteers with memory problems but who were not classified as having dementia were recruited. The Alzheimer Disease Assessment Scale–Cognitive Subscale (ADAS-Cog), which has a range of 0 to 70 points and is widely used in the assessment of Alzheimer’s disease, was employed. An interim analysis showed that, over a 6-month period, the home-based physical exercise program was associated with a modest improvement in cognition of 0.26 points. At the end of the study, the intervention group had improved 0.73 points. The authors concluded that modest improvement was identified in the Clinical Dementia Rating and word list delayed recall tests.

Considering the lack of exercise rehabilitation approaches for older adults with multiple sclerosis (MS), Sebastião et al.³² investigated the application of a home-based physical exercise program in patients with this condition, using the Square-Stepping Exercise (SSE), a novel, systematic form of physical activity that, in addition to demanding physical effort, also demands a high level of cognitive performance (focused

attention, memory, and executive functions). SSE uses one mat, divided into 40 squares, and one coach per mat monitors participant performance.

In the Sebastião et al. study,³² older adults with mild to moderate cognitive impairment were recruited and randomized to the intervention. They received an SSE mat, instruction manual, and logbook, as well as a pedometer, while the control group received minimal muscle strengthening and light stretching. After 12 weeks, effect sizes calculated for cognition and mobility outcomes ranged from small to moderate ($d = -0.34$ and $d = 0.30$), providing preliminary evidence that home-based physical training with SSE can improve cognition and mobility.

Sosnoff et al.²⁵ also worked with older adults with MS. One of the secondary outcomes of the study was cognitive function, assessed by simple reaction time, defined as the time interval between the onset of the stimulus and the onset of the voluntary response. The authors found no statistically significant differences between the intervention group and the control group, which continued to receive only motor therapy sessions. Older adults who underwent the home-based physical exercise intervention increased their reaction time by 1.2% after 12 weeks.

Suzuki et al.²⁴ sought to investigate the effect of a multi-component home-based physical exercise program on cognitive function in 50 older adults with amnesic mild cognitive impairment (MCI). The authors found that participants with amnesic MCI who performed aerobic exercises, postural balance retraining, and dual-task training showed good adherence to this multicomponent home-based program at the end of 12 weeks, as well as improvements in general cognitive function and in the logical memory of immediate recall and letter verbal fluency domains of cognitive tests.

Due to the lack of treatment approaches for dementia including home-based physical exercises, Prick et al.³⁰ sought to evaluate the effects of a multicomponent intervention on the cognitive functioning of 57 older adults with dementia living at home. Eight sessions were carried out, which included physical exercises, psychoeducation, communication skills training, and pleasant activities. The results showed no significant effect on cognition, although the authors did find a small, significant effect on an attention task.

Technology, home-based physical exercises, and cognition

Home-based physical exercise strategies have also been combined with video games to increase the quality of life of older adults. One such example is the use of exergames – games that are also a form of physical exercise. Vieira et al.²⁹ demonstrated that a virtual reality home-based physical exercise

format, in which a simulated physiotherapist performs the exercise and provides guidance on the quality of execution, improved selective attention and conflict resolution capacity in older adults with coronary artery disease. This trial analyzed the effect of phase III cardiac rehabilitation on executive function in two home-based training groups, one with the virtual reality intervention and the other with a conventional paper-booklet intervention, and a control group that received standard care. It should be noted that the exercise protocol was the same for both home exercise intervention groups; the only difference was that one group used the Kinect, a body motion sensor originally designed for video games.

Brinke et al.³³ randomized 124 older adults to 8 weeks of an intervention consisting of computerized cognitive training with or without home-based physical exercise. All were assessed for memory and executive functions. Games were performed on an iPad, and consisted of 38 games targeting one of six domains: focus, speed, memory, visual, problem solving, and language. No significant difference was observed in memory outcomes, but performance in cognitive tests showed a significant difference when preceded by exercise protocols: Stroop Test (-7.95 , 95%CI -13.77 to -2.13); Trail Making Test (-13.65 , 95%CI -26.09 to -1.22); Flanker Test (6.72 , 95%CI 2.55 to 10.88); and Dimensional Change Card Sort Test (6.75 , 95%CI 0.99 to 12.50).

Song et al.,³¹ in their single-blind randomized clinical trial, allocated 60 older adults with Parkinson's disease to home-based exergame training for 15 minutes a day, three times a week, for 12 weeks. Participants were assessed for reaction time, functional gait, and physical and neurological measures associated with falls in the past 6 months. The intervention group reported improvement in mobility and physical function, but cognitive measures did not show any significant response.

Limitations and practical applications

Limitations include the heterogeneity of the included studies and the fact that using Google Scholar may have led to the inclusion of non-peer-reviewed publications. Practical implications of this review include updated guidance on the evidence and recommendations for home-based physical exercise for older adults, aiming at benefits in cognition, with the assessment of risk of bias and a systematic investigation of the literature as its strengths.

From a clinical standpoint, home-based physical exercise programs have been shown to improve important aspects in the cognitive functioning of older adults, further reinforcing the importance of physical activity for this population.¹⁶ However, future trials should investigate which

protocol is best and the extent to which supervision by a professional is important, since older adults are known to achieve better outcomes when their physical exercise practices are supervised.⁵

CONCLUSION

We conclude that interventions consisting of home-based physical exercise programs, whether strength training alone or combined with aerobic and balance exercises, performed three times a week in 60-minute sessions for a minimum duration of 8 weeks, contribute to cognitive performance in older adults, with particular impact on executive function. Therefore, home-based physical exercises constitute a strategy to minimize the negative implications associated with cognitive impairment in older adults.

Conflict of interest

The authors report no conflicts of interest.

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Authors' contribution

JDAS: formal analysis, conceptualization, data curation, writing – original draft, writing – review & editing, investigation, methodology, project administration, visualization. DCMM: formal analysis, writing – review & editing, investigation, methodology, visualization. RVCS: formal analysis, writing – original draft, investigation, methodology, visualization. GKBS: formal analysis, writing – original draft, investigation, methodology, visualization. JCLS: formal analysis, writing – original draft, investigation, methodology, visualization. ASC: project administration, conceptualization, writing – review & editing, methodology, supervision, visualization. ALTP: project administration, conceptualization, writing – review & editing, methodology, supervision, visualization.

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