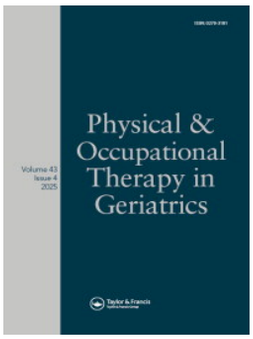

Physical & Occupational Therapy In Geriatrics

ISSN: 0270-3181 (Print) 1541-3152 (Online) Journal homepage: www.tandfonline.com/journals/ipog20

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To cite this article: Andreia Carvalho, Vânia Cerqueira Palma & Maria Teresa Tomás (01 Nov 2025): Exercise Prescription for Frail Older Adults: Impact on Handgrip Strength and Gait Speed – A Systematic Review, Physical & Occupational Therapy In Geriatrics, DOI: 10.1080/02703181.2025.2582063

To link to this article: https://doi.org/10.1080/02703181.2025.2582063

PHYSICAL & OCCUPATIONAL THERAPY IN GERIATRICS
https://doi.org/10.1080/02703181.2025.2582063

Exercise Prescription for Frail Older Adults: Impact on Handgrip Strength and Gait Speed – A Systematic Review

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ABSTRACT

Introduction: Frailty necessitates effective exercise interventions, yet optimal prescriptions remain unclear. This study aimed to determine such prescription to improve gait speed and/or handgrip strength in frail older adults.

Methods: A systematic review following PRISMA, using PEDro, MEDLINE, Scopus, and Web of Science databases, was performed. The evidence certainty was assessed with GRADE (Grading of Recommendations Assessment, Development, and Evaluation).

Results: Six studies (628 frail older adults) were included. Combined exercise program, with a frequency between two-three times a week, an intensity moderate-intense, and a duration of each session of 45–60 minutes, yielded the most significant improvements in gait speed (good evidence with very low certainty) and handgrip strength (good evidence with low certainty).

Discussion: Handgrip strength and gait speed are likely to improve or be maintained after a combined exercise program of moderate or high intensity performed two-three times a week for at least 45 minutes, in frail older adults.

ARTICLE HISTORY
Received 11 April 2024
Accepted 24 October 2025

KEYWORDS
Frailty; frail older adults; exercise; rehabilitation; physical performance

REGISTRATION
PROSPERO (CRD42021238494)

Introduction

Until the early 1990s, a 'frail older person' was stereotypically described as someone of advanced age who was dependent, disabled, or affected by multiple illnesses, and their identification was subjective and arbitrary.[1] Nowadays, there is a consensus that physical frailty is "a medical syndrome with multiple causes and contributors that is characterized by diminished strength, endurance, and reduced physiologic function that increases an individual's vulnerability for developing increased dependency and/or

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death".[2] Frailty is one of the priority public health issues,[3–5] since it is one of the most prevalent geriatric syndromes in the older adult population and a strong predictor of negative outcomes, such as disability, hospitalization, institutionalization, and death.[6–9] Frailty affects individual quality of life and the sustainability of health and social services.[3]

Currently, there is no gold standard instrument for assessing frailty.[10–12] Several measurement tools for identifying frailty are described as valid.[13] The Fried's frailty phenotype from the Cardiovascular Health Study (CHS)[6] is one of the most commonly used methods for assessing frailty both in the research context and the clinical practice,[10–12,14] being considered the most appropriate method for identifying physical frailty.[9] According to the Fried Phenotype – CHS, frailty syndrome requires the presence of at least three of the following characteristics: involuntary weight loss, muscle weakness, slowness, tiredness, and low physical activity.[6] In older adults, handgrip strength and gait speed are considered sensitive, accurate, and specific measures to represent frailty,[15,16] representing two parameters of the components of frailty – muscle weakness and slowness.[17] They are also deemed to be predictive of mortality risk and adverse outcomes.[18]

Regarding the treatment of frailty syndrome, the guidelines for physical exercise emerge as one of the main recommendations, with moderate evidence.[9] Studies conducted on the older population suggest that physical exercise, especially combined exercise, has effects on some components of frailty, such as muscle strength and sarcopenia, balance, and falls.[9,19–26] Some evidence indicates that exercise also improves mobility and functionality, reduces the effects of frailty, and increases quality of life.[22,27–29] Several systematic reviews,[20,24,29,30] have shown that physical exercise is beneficial for frail individuals. However, some limitations have been noted in these reviews. First, the lack of a reference definition of frailty makes it difficult to compare outcomes due to the variety of criteria used to define frail subjects.[31,32] The inclusion of groups of frail older adults and prefrail older adults in the study samples;[9,21,24,30,33] prefrail individuals are more likely to participate in physical rehabilitation programs than frail individuals and tend to show better outcomes following physical exercise programs in terms of mobility and functionality.[34] Differences in the prescription of physical exercise for frail older adults are based on the hypothesis that recovery is more challenging in individuals with greater disability.[35] So, physical exercise programs for frail older adults should be prescribed with consideration of the characteristics and risks associated with frailty,[36] but should also be challenging enough to generate an adaptive response.[37]

Thus, in the available literature, the optimal physical exercise prescription [frequency, intensity, time, and type (FITT)] for enhancing two key components of physical frailty – slowness and muscle weakness – remains unclear. Therefore, this systematic review aimed to determine which is

the optimal physical exercise program to improve gait speed and/or handgrip strength in older adults diagnosed with frailty.

Method

This systematic review is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA), and was registered in PROSPERO (CRD42021238494) on April 6, 2021.[38,39]

Identification and selection of studies

Searches were conducted on the PEDro, PubMed (MEDLINE), Scopus (Elsevier), and Web of Science (Clarivate) databases. Eligible studies had to be randomized controlled trials (RCT). No limits were placed on geographical location or date of publication. Studies should include participants diagnosed with frailty syndrome assessed by Fried's frailty phenotype – CHS,[6] Frailty Index (FI),[7] Rockwood's Clinical Frailty Scale (CFS),[40] Edmonton Frailty Scale,[41] FRAIL scale,[8,42] Groningen Frailty Indicator (GFI),[43] or PRISMA-7.[44]

The research equations used were: ((frail) OR (frailty) OR (frail elderly)) AND ((exercise) OR (exercise training) OR (physical activity) OR (resistance training) OR (aerobic) OR (strengthening) OR (physiotherapy) OR (fitness)) AND (control*) AND ((handgrip strength) OR (strength prehension) OR (hand grip strength) OR (hand strength) OR (grip strength) OR (walk speed) OR (walking speed) OR (speed gait) OR (gait speed)). The final search was conducted on April 15, 2023.

The search results were imported into Rayyan tool[45] for deduplication and study selection. This review was conducted in three steps: (1) records were identified through a database search (identification), and (2) two reviewers independently examined their titles and abstracts, after which the relevant studies were included based on the eligibility criteria (screening). (3) Relevant full texts were analyzed for eligibility (eligibility), and all studies that fulfilled the eligibility criteria were included in the systematic review. Trials were included if they met the predefined eligibility criteria, which were summarized according to the Population, Intervention, Comparator, Outcome, and Study (PICOS) design[39] (Figure 1). Trials written in languages other than Portuguese, English, French, or Spanish were excluded due to the language proficiency of the review team, ensuring accurate screening and data extraction. Studies that simultaneously included prefrail and frail individuals in the sample and did not present a separate analysis of results by group (prefrail and frail) were also excluded. A manual search was performed by screening the reference lists of the studies included. Disagreements throughout the steps were resolved by discussion.

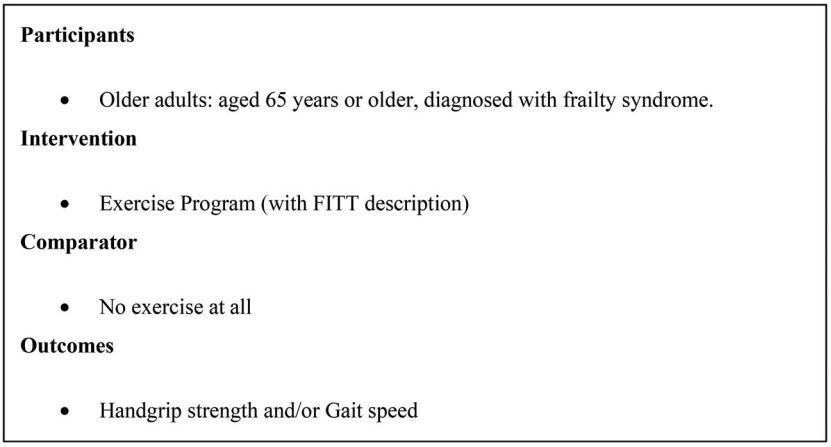

Figure 1. Inclusion criteria.

When consensus could not be reached, a third reviewer acted as an arbitrator, making the final decision.

Assessment of trial characteristics

Quality

The methodological quality and risk of bias of the included studies were assessed by PEDro Scale, extracting the scores from the Physiotherapy Evidence Database (www.pedro.org.au). Studies that obtained a score equal to or greater than five were included in this review, as they are considered to have adequate methodological quality.[46,47]

Participants

Individuals aged 65 years or older, diagnosed with frailty syndrome assessed by one of these instruments: Fried's frailty phenotype – CHS;[6] Frailty Index (FI);[7] Rockwood's Clinical Frailty Scale (CFS);[40] Edmonton Frailty Scale:[41] FRAIL scale:[8,42] Groningen Frailty Indicator (GFI)[43] and PRISMA-7.[44]

Intervention

Exercise programs with a detailed prescription: frequency, intensity, time, and type (FITT).

Outcomes

The outcomes of interest were handgrip strength (HGS) and gait speed. The measurement of gait speed (regardless of test distance or specific protocol) must be reported as a relationship between distance and time.

Certainty of evidence

All authors analyzed the certainty of evidence using Grading of Recommendations, Assessment, Development, and Evaluation (GRADE).[48] GRADE is a widely used system to rate the quality of evidence and the strength of recommendations in systematic reviews. In this review, certainty was classified as high, moderate, low, or very low. Because only randomized controlled trials were included, analysis initially started at high certainty and were downgraded if concerns arose regarding: risk of bias (limitations in study design or execution), inconsistency (unexplained heterogeneity across studies), indirectness (differences in population, intervention, comparator, or outcomes from the research question), imprecision (wide confidence intervals or small sample sizes leading to uncertainty), or publication bias.

Results

The flow of studies through the review

A total of 1400 articles were identified through a search of the different databases, of which 385 duplicates were removed. After reading the titles and abstracts, 970 articles were excluded; after full reading, 39 articles were excluded because they did not meet the eligibility criteria. Thus, 6 studies were included in this systematic review. The selection process is presented in the PRISMA flow diagram[39] (Figure 2).

Characteristics of the studies

The characteristics of the included studies in this systematic review are summarized in Table 1.

The six trials involved 628 frail older adults. Two trials included people aged above 65 years,[49,50] one trial over 70 years,[51] another two above 75 years,[52,53] and another one aged between 80 and 90 years.[54] One trial included only women,[53] and the other five had mixed samples.

All these studies entailed older adults diagnosed with frailty syndrome assessed with Fried's frailty phenotype – CHS.[6]

In five studies,[49,51–54] intervention consisted of combined or multicomponent exercise programs. The studies by Sadjapong et al.[49] and Fairhall et al.[51] included aerobic training, muscle strengthening, and balance exercises. The programs in Kim et al.[53] and Giné-Garriga et al.[54] focused on strengthening, balance, and gait training. Lee et al.[50] investigated a high-speed power training program using elastic bands, primarily targeting muscle strength and neuromuscular function. García-Gollarte et al.[52] implemented a supervised group-based exercise program, which included

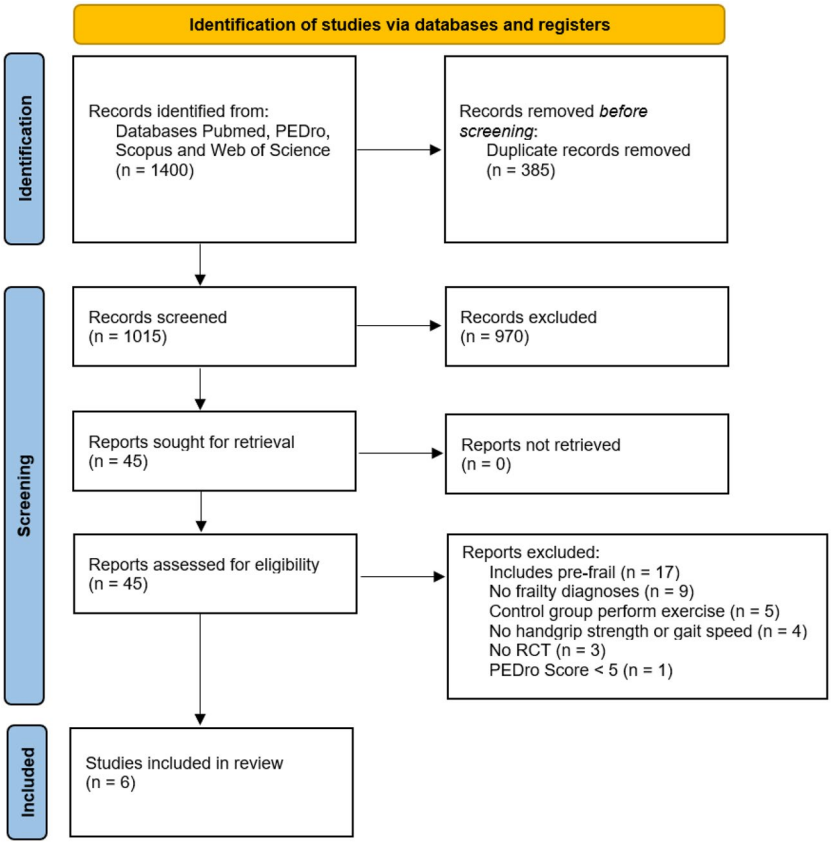

Figure 2. PRISMA flow diagram.

strength, balance, and functional mobility exercises specifically tailored for institutionalized older adults. Across the included studies, exercise intensity was generally monitored using perceived exertion scales (RPE), such as the Borg, typically aiming for an effort around 12–14 on the RPE scale. Only one study[49] quantified intensity using a percentage of one-repetition maximum (1RM). Most interventions applied principles of progressive overload, gradually increasing resistance, training repetitions, and sets, or task complexity to adapt to participants' improving capacity.

Regarding outcome results, gait speed (GS) was assessed in five studies, of which four[50–54] reported significant improvements following the intervention, particularly when moderate to high intensity exercise was performed at least two times per week. Handgrip strength (HGS) was evaluated in three studies,[49,52,53] with two showing post-intervention gains, especially in protocols including combined training modalities. García-Gollarte et al.[52] reported no significant changes (Table 1). Among all included studies, only one[52,53] quantified the magnitude of effects using partial eta squared (η^2_p), while five[49,51–54] of the six included studies reported a priori power analysis to estimate the required sample size, typically aiming for 80% power.

Table 1. Characteristics of the publications included in the current systematic review.

Author/year	Title	Participants	Age mean (SD)	Female (%)	Intervention	Outcomes		Study design
						PP	BG	
García-Gollarte et al., 2023[52]	Effectiveness of a Supervised Group-Based Otago Exercise Program on Functional Performance in Frail Institutionalized Older Adults: A Multicenter Randomized Controlled Trial	*N* = 111 IG =39 IG+*N* = 38 CG = 34	 86.0(5.9) 84.9(6) 87.3(5.3)	 76.9 68.4 61.8	24 wk F – 3x/week I – moderate T – 45–60 min. T – combined	HGS ↑ GS ns	≠ $p < 0{,}001$ ns	RCT
Lee et al., 2020[50]	Effects of High-Speed Power Training on Neuromuscular and Gait Functions in Frail Elderly with Mild Cognitive Impairment Despite Blunted Executive Functions: A Randomized Controlled Trial	*N* = 40 IG = 18 CG = 22	 73.7(4.6) 74.2 (4.4)	 61.1 59.1	8 wk F – 3x/week I – moderate T – 50 min. T – power training	 GS ↑ $p < 0{,}05$	 ≠ $p < 0{,}05$	RCT
Sadjapong et al., 2020[49]	Multicomponent Exercise Program Reduces Frailty and Inflammatory Biomarkers and Improves Physical Performance in Community-Dwelling Older Adults: A Randomized Controlled Trial	*N* = 64 IG = 32 CG = 32	 76.6(1.1) 78.8(1.3)	 71.9 50.0	12 + 12 wk F – 3x/week I – moderate-intense T – 60 min. T – combined	HGS ↑ $p < 0{,}05$	12 wk ≠ $p < 0{,}05$ 24 wk ns	RCT
Kim et al., 2015[53]	Effects of Exercise and Milk Fat Globule Membrane (MFGM) Supplementation on Body Composition, Physical Function, and Hematological Parameters in Community – Dwelling Frail Japanese Women: A Randomized Double Blind, Placebo-Controlled, Follow-Up Trial	*N* = 131 GI = 33 MFGM = 32 GI+MFGM = 33 CG = 33	 81.1 (2.8) 81.0 (2.8) 81.9 (2.6) 80.3 (3.3)	100	12 wk F – 2x/week I – moderate T – 60 min. T – combined	HGS ns GS ↑ $p = 0{,}026$	ns ≠ $p = 0{,}005$	RCT
Fairhall et al., 2012[51]	Effect of a multifactorial interdisciplinary intervention on mobility-related disability in frail older people: randomized controlled trial	*N* = 241 GI = 120 GC = 121	 83.4 (5.8) 83.2 (5.9)	 67.0 68.0	12 months F – 3–5x/week I – moderate-intense T – 45 – 60 min. T – combined	GS ↑ $p = 0{,}03$	≠ $p < 0{,}05$	RCT
Giné-Garriga et al., 2010[54]	The Effect of Functional Circuit Training on Physical Frailty in Frail Older Adults: A Randomized Controlled Trial	*N* = 41 GI = 22 GC = 19	 83.9 (2.8) 84.1 (3)	 59.1 63.2	12 wk F – 2x/week I – moderate T – 45 min T – combined	GS↑ $p < 0{,}001$	≠ $p < 0{,}001$	RCT

*Abbreviations: CG – Control Group; IG – Intervention Group; MFGM – Supplementation with Milk Fat Globule Membrane Group; F – Frequency; I – Intensity; T – Time; T – Type; GS – gait speed; HGS – handgrip strength; PP – Pre and post intervention; BG – Between groups; ↑ – improve; ≠ – difference between groups; ns – Not significant; RCT – Randomized Controlled Trial.

Methodological quality analysis

Four of the six trials included in this systematic review had a PEDro score equal to or greater than seven, with three scoring eight. The other two had scores between five and six (Table 2).

Certainty of evidence

Due to the small number of studies, the risk of publication bias could not be assessed.[55] Based on the GRADE criteria, the degree of certainty was classified as low for handgrip strength and very low for gait speed (Table 3).

Discussion

This systematic review aimed to verify which physical exercise prescription improves handgrip strength and/or gait speed in older adults diagnosed with frailty. This study shows that a combined exercise program of moderate or high intensity performed two to three times a week for 45 to 60 minutes seems to have positive effects on the improvement or maintenance of handgrip and gait speed.

This review included six trials that compared an intervention with an exercise program to an intervention without any type of exercise, ensuring that the results could be attributed primarily to exercise. To our knowledge, this is the first review to compare the effects of exercise on clinically relevant outcomes such as handgrip strength and gait speed in older adults diagnosed with frailty through recommended methods of assessment.[13] Therefore, comparison with previous results was challenging and limited.

Handgrip strength

This systematic review provided three studies with good methodological quality and low certainty of evidence that an exercise program can be effective for improving or maintaining handgrip strength in frail older adults. An increase in handgrip strength was found in two studies,[49,52] from baseline to the end of the intervention. However, one study[53] revealed that there was no significant improvement in handgrip strength in the groups that performed the exercise program. Exercise programs with a frequency of three times a week and that increased intensity from moderate to high in the muscle strength component of the program had positive effects.[49,52] One of these studies[52] showed a significant worsening in handgrip strength in the control group after the 6-month intervention, while the exercise group showed an improvement. In another trial,[49] the intervention took place in two phases: in the first phase (12 weeks), the

Table 2. PEDro Scale score.

Author/year	Eligibility	Random allocation	Concealed allocation	Groups similar at baseline	Participants blinding	Therapist blinding	Assessor blinding	<15% lost to follow-up	Intention-to-treat analyses	Between-group difference reported	Point estimate and variability reported	Total*
García-Gollarte et al., 2023[52]	1	1	1	1	0	0	1	1	1	1	1	8
Lee et al., 2020[50]	1	1	0	1	0	0	0	1	0	1	1	5
Sadjapong et al., 2020[49]	0	1	1	1	0	0	1	1	1	1	1	8
Kim et al., 2015[53]	1	1	0	1	0	0	1	1	1	1	1	7
Fairhall et al., 2012[51]	1	1	1	1	0	0	1	1	1	1	1	8
Giné-Garriga et al., 2010[54]	1	1	1	1	0	0	1	0	0	1	1	6

*Eligibility criteria item 1 does not contribute to the total score.

Table 3. GRADE assessment of certainty of evidence.

Outcomes	Study design	Risk of bias in individual studies	Risk of publication bias	Inconsistency	Indirectness	Imprecision	Certainty of evidence
Handgrip strength	3 RCT	Low[1]	Not assessed[3]	Moderate[4]	Low[5]	High[6]	⊕⊕⊖⊖ Low[7]
Gait speed	5 RCT	Low to moderate[2]	Not assessed[3]	Moderate[4]	Low[5]	High[6]	⊕⊖⊖⊖ Very-low[8]

[1]Three studies with good methodological quality; [2]One study with fair methodological quality and four studies with good methodological quality; [3]Not assessed due to the small number of studies; [4]Moderate methodological heterogeneity (interventions, study designs, and outcomes assessment); [5]The population was clearly defined and corresponded to our goals (older adults diagnosed with frailty syndrome based on Fried's frailty phenotype – CHS and the outcomes gait speed and handgrip strength were directly measured); [6]Large 95% CI or no CI; [7]Downgraded due to risk of publication bias and high imprecision; [8]Downgraded due to risk of bias, risk of publication bias, and high imprecision.

exercise program consisted of face-to-face group classes, and in the second phase, 12 weeks of self-training at home. Handgrip strength in the exercise group increased after the first 12 weeks and slightly decreased at 24 weeks compared to the 12-week value, but remained higher than baseline. This raises the question of whether a supervised exercise program is more beneficial for frail individuals in improving handgrip strength, compared to home-based programs. Actually, previous studies[32] have noted that, despite the feasibility of the home-based exercise intervention, there was a lack of evidence of a beneficial effect on skeletal muscle or lean mass, outcomes that can be associated with muscle strength.

Gait speed

This systematic review presented one study with fair methodological quality and four studies with good methodological quality and very low certainty of evidence that an exercise program can be effective for improving or maintaining gait speed in frail older adults.

Improvements in gait speed are clinically significant in most of the studies,[50,51,53,54] as gait speed increased by at least 0.1 m/s in all intervention groups. This threshold is considered to be clinically significant in several studies.[56–60] There is only one trial[52] that found no improvements in gait speed. The authors suggested that the lack of improvement in gait speed may be related to the use of walking aids, as only 26,1% of the individuals do not need to use them; however, they do not express these results, which could be an important clinical implication and raise a question for future research.

In studies that presented follow-up measurements after the end of the exercise program,[53,54] a decline in the results of these measurements was verified, suggesting that stopping exercise may decrease its positive effects and cause regression in gait speed. It should be noted that in all studies, gait speed was assessed at the participant's comfortable/usual pace. Only one study[54] evaluated both usual and fast gait speed. While both improved

significantly during the intervention, fast gait speed showed a slight (non-significant) decline at follow-up, indicating it may be more sensitive to detraining effects. These results are in line with those described in another study,[61] which found that after the end of the exercise program, the effect tended to decrease, showing a small retention of the gain.

It is also important to note that no adverse events were reported in any of the studies included in this systematic review. Only one study[51] documented the existence of two subjects with previous musculoskeletal pathology who reported an increase in lower back pain after the start of the intervention. In this regard, the results of this study showed that physical exercise programs are safe for frail older adults.

The main limitation of this systematic review was the small number of articles that met the eligibility criteria. However, these criteria were defined based on the literature, namely the use of appropriate methods for identifying physical frailty, which in turn showed the weaknesses of previous investigations. We also acknowledge that the total number of participants across all included studies may restrict the generalizability of the findings. Furthermore, although the language restriction aimed to ensure accuracy in data interpretation, it may have led to the omission of relevant studies. Finally, heterogeneity across the already limited number of studies included constrained the feasibility of quantitative data synthesis.

Despite the good methodological quality of the studies, the certainty of evidence was low to very low, mainly because of the moderate inconsistency of the studies, which can be perceived as a weakness although it mainly reflects the clinical heterogeneity differences associated with the interventions and outcomes, such as exercise program protocols and different instrument measurements; therefore, it was difficult to assess consistency in the results. We found that the imprecision of the studies was high, mainly due to the lack of confidence intervals (CI) or the large size of the CI around the effect estimate. Thus, our results highlight the need for further robust studies on the effects of exercise on handgrip strength and gait speed in frail older adults.

In conclusion, this review provides evidence that handgrip strength and gait speed are likely to improve or be maintained after an exercise program in older adults with frailty, suggesting that exercise may be an effective strategy for older adults with frailty. However, the observed benefits may diminish after program cessation, highlighting the importance of follow-up interventions to preserve these gains over time. Despite the high degree of imprecision of the studies, it seems that a combined exercise program (aerobic training and muscle strength and resistance training) with a balance training component, a frequency between two and three times a week, an intensity from moderate to intense, and a duration of each session between 45 and 60 minutes, is the one that most improves gait speed and

handgrip strength. Across the included studies, the diverse protocols may have diluted the true effects of either modality. Further research is needed to determine whether specific or combined exercise programs are appropriate.

What was already known on this topic

Evidence suggests that physical exercise, especially combined exercise, has positive effects on frailty components such as muscle strength, balance, falls, and functionality in the older population.

What this study adds

This review provides evidence that in older adults with frailty, handgrip strength and gait speed are likely to improve or be maintained after a combined exercise program of moderate or high intensity performed two to three times a week for at least 45 minutes.

Authors' contributions

Conception and design, or analysis and interpretation of the data; the drafting of the paper (AC, VP, MTT); revising it critically for intellectual content (AC, MTT); final approval of the version to be published (AC, VP, MTT). All authors agree to be accountable for all aspects of the work.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

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