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Physical Performance Tests for Preliminary Cognitive Screening in Older Adults: A Systematic Review of Strength, Walking, and Balance Assessments

Pau Ferrer-Ramos[a,b], Manuel V. Garnacho-Castaño[c], Montserrat Girabent-Farrés[c,*], Marcos Faundez-Zanuy[d], Noemí Serra-Payá[c]

[a]Department of Health Sciences, TecnoCampus, Research Group in Technology Applied to High Performance and Health, Universitat Pompeu Fabra, Mataró, Barcelona, Spain.

[b]Faculty of Psychology, Education and Sport Sciences, Universitat Ramon Llull, Barcelona, Spain.

[c]Campus Docent Sant Joan de Déu, Universitat de Vic - Universitat Central de Catalunya (UVIC-UCC), C/ Sant Benito Menni, 18-20, 08830, Sant Boi de Llobregat, Spain. Grupo de Investigación DAFNiS (Dolor, Actividad Física, Nutrición y Salud).

[d] Tecnocampus, Universitat Pompeu Fabra.

*Corresponding author: montserrat.girabent@sjd.edu.es

Abstract

Objective: The aim of this systematic review is to determine which physical tests, particularly those assessing strength, walking abilities and balance stability, can provide the most pertinent information for a preliminary screening of cognitive status, facilitating further cognitive evaluation.

Methods: A systematic search was conducted using the PubMed and Web of Science databases. Studies that assessed both strength or balance stability and cognitive state in community-dwelling adults aged ≥60 years old were selected for inclusion.

Results: The search strategy identified a total of 864 studies. After removing duplicates and applying inclusion and exclusion criteria, ten studies comprising a total of 6868 subjects were included in the review. According to the GRADE system, the studies were classified as low quality. Cognitively healthy individuals exhibited better balance, higher strength levels, greater gait speed and higher instrumental activities of daily living scores compared to those with mild cognitive impairment or cognitive impairment.

Conclusion: The assessment of physical function in older adults may serve as a useful tool in identifying impairments associated with physical frailty, sarcopenia, and cognitive decline. Early screening based on physical performance could assist healthcare professionals in determining the need for further cognitive assessment, potentially aiding in the prevention or early detection of cognitive decline.

Key words: older people, physical test, balance stability, cognitive impairment, activities of daily living.

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1. Introduction

It is a reality that we are currently facing an aging population. According to the WHO (United Nations, 2019), between 2015 and 2050 the percentage of the world's inhabitants over 60 is expected to almost double, raising from 12% to 22% and, in 2050, it is predicted that 80% of the elderly will live in low- and middle-income countries. Thus, it is clear that the rate of population aging has accelerated compared to previous decades.

The increase in life expectancy is also associated with an increase in pathologies related to aging that can cause frailty in this population group. The concept of frailty is defined as a medical syndrome with multiple causes and contributors characterized by a decrease in strength, resistance and reduced physiological function that increases an individual's vulnerability to developing dependence and/or death (Morley et al., 2013), in addition to being accompanied by weight loss, exhaustion, weakness, slowness and reduced physical activity, marking an underlying physiological state of multisystem and energy deregulation (Fried et al., 2004). To assess frailty, the Fried criteria (Fried et al., 2001) were proposed in which it was determined that a person was fragile if presents at least three of the following criteria: weight loss, exhaustion, poor physical activity, weakness, and low walking speed. It is acknowledged that physical exercise can reduce or delay the appearance of frailty in the elderly (Coelho-Júnior et al., 2021), as well as prevent falls (Sherrington et al., 2020). Falls are known to potentially result in hip fractures and other fall-related injuries that are associated with worse disability outcomes and a higher likelihood of long-term nursing home admissions (Xu et al., 2022). Therefore, encouraging the habit of physical activity and exercise should be considered as a primary tool to promote healthy aging.

To detect changes in the functionality of older people, many tests have been proposed to measure muscle function and balance, such as Handgrip test, Timed Up and Go test (TUG), 6-Minute Walking Test (6MWT), Berg Balance Score (BBS), One leg stand test, Short Physical Performance Battery (SPPB) or 400m walk tests, among others, which are reliable and safe for elderly people with and without associated cognitive pathologies (Espejo-Antúnez et al., 2020; Giannitsi et al., 2019; Mehmet et al., 2020; Steffen & Seney, 2008; Toro-Román et al., 2024).

It has been observed that during aging, the functional decline is also associated with the cognitive condition (Biasin et al., 2023). This decline can be predicted by the level of frailty and/or sarcopenia of the subject (Auyeung et al., 2011; Scisciola et al., 2021) and even improved through the application of physical exercise protocols (W. Li et al., 2023; Rogge et al., 2017). Therefore, having early detection can allow to reduce or delay the cognitive decline of the subject by applying the necessary medical and exercise protocols to mitigate the progress of the disease. Various assessment techniques have been suggested for identifying cognitive decline, either verbal question or writing tests such as Mini-Mental State Examination (MMSE) (Arevalo-Rodriguez et al., 2021), Trail Making Test (TMT) (Bossers et al., 2012) or others, and physical tests such as balance tests or walking speed, which has been observed that exist a relationship between these and cognition (Gore et al., 2023; Kuan et al., 2021). Furthermore, new tests appeared applying eye tracking technology, which has been proven to be effective (D. Li et al., 2024; Wolf et al., 2023), although it is still a very expensive technology.

Cognitive functions refer to mental processes involved in the acquisition of knowledge, manipulation of information, and reasoning. It includes the domains of perception, memory, learning, attention, decision making, and language abilities (Kiely, 2014) and have a significance in performing daily tasks.

Cognitive dysfunction is correlated with diminished functionality and is associated with age-related neurodegenerative diseases such as Alzheimer's disease (AD) (Martyr & Clare, 2012). Clinical history and examination enable clinicians to characterize the level of impairment. Mild cognitive impairment (MCI) pertains to patients who express concerns about cognitive changes, exhibit evidence of cognitive deficits in one or more domains, yet retain a degree of independence that precludes a diagnosis of dementia. Individuals with MCI demonstrate reduced efficiency in performing instrumental activities of daily living (IADLs)(McCollum & Karlawish, 2020; Petersen, 2016). Conversely, dementia encompasses concerns regarding cognitive decline (CD), objective cognitive impairment (CI), and resultant disability. It is distinguished from MCI by the severity of cognitive symptoms, which significantly interfere with daily activities (Gale et al., 2018; McCollum & Karlawish, 2020). Dementia can be categorized as mild, moderate, or severe, contingent upon the patient's functional status in executing basic activities of daily living (BADLs) or IADLs (McCollum & Karlawish, 2020).

Although there is a lot of literature that addresses the relationship between cognitive function and physical performance in older adults, there remains a gap in understanding which specific assessments can be used for an initial evaluation of cognitive status. Thus, the aim of this systematic review is to analyze the scientific literature to identify which physical test or set of tests may provide the most informative basis through strength, walking abilities and balance stability for a preliminary cognitive screening, enabling the referral of individuals for further cognitive evaluation by a physician.

2. Materials and Methods

The present systematic review was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Page et al., 2021). A specific question was constructed according to the PICOS (Participants, Intervention, Comparation, Outcomes and Study designs) principle. Participants: Older adults aged 60 years or older, cognitively healthy, MCI, CI, CD, mild dementia (MD) or dementia; Intervention: no intervention or exercise intervention protocol as a treatment; Comparation: Passive (no intervention) or active controls (same or different intervention than intervention groups); Outcomes: Evaluate cognitive status or cognitive score on a specific cognitive test and compare it with a minimum of two physical variables such as balance, strength, walking ability or activities of daily living; Study designs: Randomized and non-randomized controlled clinical trials, non-controlled clinical trials and observational studies. The specific question purposed was "Which physical performance tests assessing strength, walking abilities, and balance stability provide the most informative basis for preliminary cognitive screening in older adults, and how do these measures correlate with cognitive status across different levels of cognitive function?".

2.1. Search strategy, study selection and data extraction

The systematic literature search for studies selection was carried out with Rayyan.ai software (https://rayyan.ai, accessed in July 2024) (Ouzzani et al., 2016) to identify relevant articles from titles and abstracts and to eliminate duplicate works from PubMed and Web of Science. Once duplicate papers were removed, articles were independently screened by 2 reviewers – N.S.P. and P.F.R. – to identify target articles by the titles and abstracts. In instances of disagreement, a third reviewer – M.G.F. – would serve as an arbitrator to resolve the discrepancies. The criteria used by the two reviewers was to select only those works related to the studied topic and older adults. A standardized form was used by both reviewers consisting of the first author's last name, year of publication, study design, intervention, study variables and results.

2.2. Eligibility criteria

The following inclusion criteria were applied: (1) original research studies; (2) studies involving participants with a mean age of 60 years or older; (3) research conducted on community-dwelling individuals; (4) studies published in English; (5) studies where (5.1) strength or (5.2) balance stability and (5.3) cognitive state was analyzed; (6) studies with accessible data; (7) participants who were cognitively healthy or were diagnosed by MCI, CI, CD, MD or dementia. The following exclusion criteria were applied: (1) articles that did not provide original data; (2) studies published before 2010; (3) research that did not undergo a peer-review process; (4) studies involving subjects with motor pathologies, neurodegenerative diseases that impact motor function or cardiovascular diseases; (5) studies that included nutritional interventions. Studies meeting the inclusion criteria will be described in terms of their characteristics, and their quality and level of evidence will be analyzed using the scale proposed by Melnyk & Fineout-Overholt (2023).

3. Results

3.1. Study selection

The initial search provided a total of 864 studies. After removing duplicates, a total of 863 potential studies were initially considered to be included in the study which were filtered based on their title and abstract, remaining 50. After reading full texts, 40 studies were rejected because of the outcome, not available data or wrong population. Therefore 10 studies were included in the systematic review. The PRISMA flow diagram for study selection is detailed in Fig. 1.

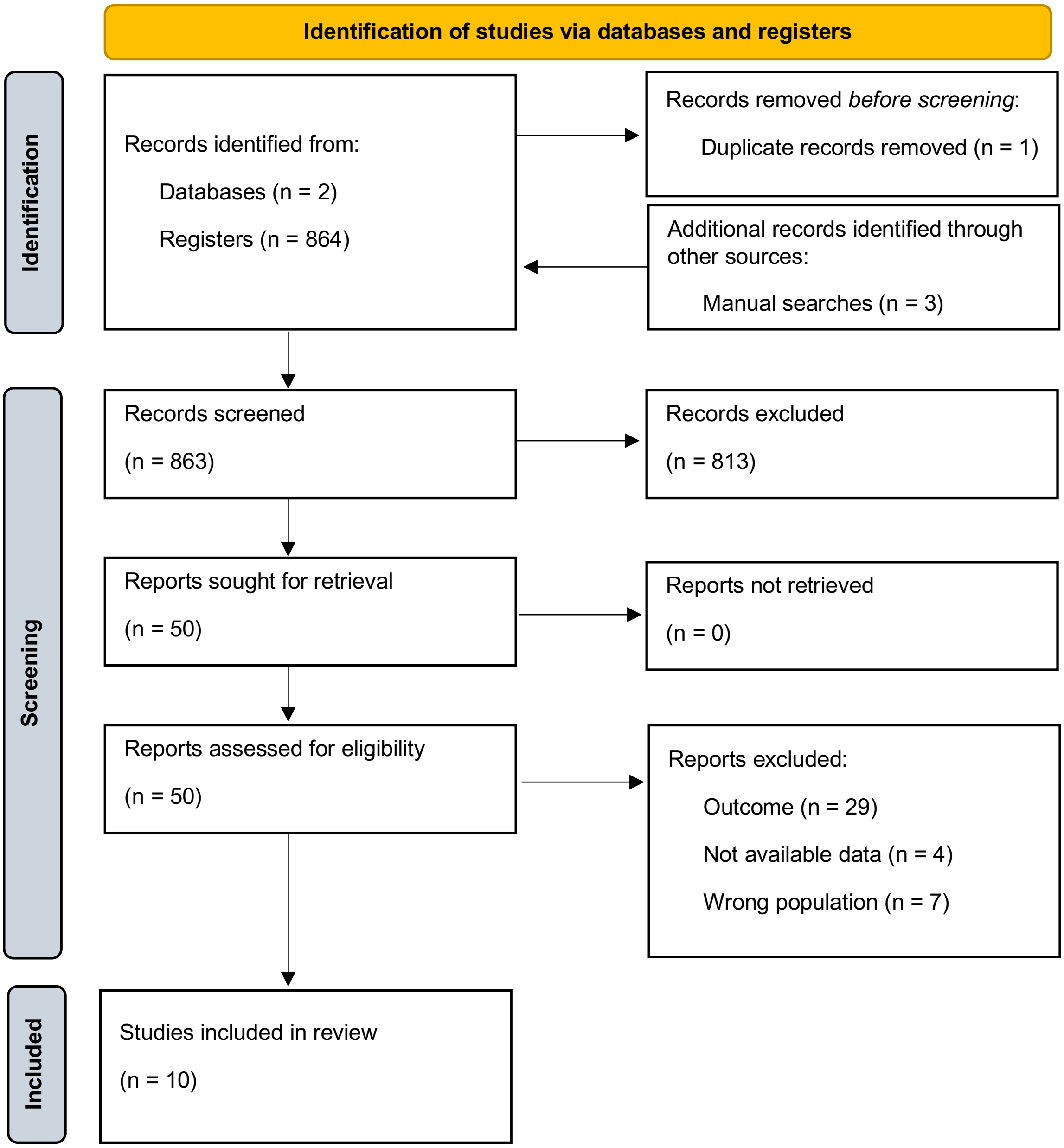

Figure 1. PRISMA 2020 flow diagram.

3.2. Study characteristics

In Table 1 we summarize the sample, study characteristics, measuring methods and main results/findings obtained of all articles included in this review (Aoyama et al., 2011; Auyeung et al., 2011; Goda et al., 2021; Kuan et al., 2021; Liu et al., 2021; Martin et al., 2013; Martins et al., 2024; Ng et al., 2022; Veronese et al., 2016; Won et al., 2014). A total of 6868 older adults over 60 years old were included in this systematic review. The sample has an average age between 66.0±4.6 and 80.5±5.7 years old. Regarding study variables, cognitive state was assessed using the Mini Mental State Examination (MMSE) (Auyeung et al., 2011; Goda et al., 2021; Kuan et al., 2021; Liu et al., 2021; Martins et al., 2024; Ng et al., 2022; Veronese et al., 2016; Won et al., 2014), Cognitive Abilities Screening Instrument test (CASI) (Kuan et al., 2021) and Cognitive Functional Independence Measurement (Aoyama et al., 2011). Three studies (Martin et al., 2013; Ng et al., 2022; Won et al., 2014) employed a neurocognitive battery of tests which evaluate specific cognitive functions, including attention, learning, memory, motor speed and executive functions. Physical variables were categorized into balance stability, strength, and walking abilities. IADLs were considered to compare and establish relationships between physical and cognitive variables.

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1 Table 1. Main characteristics and results of the studies included.

Study	Study design	N	Mean age (±SD)	Groups; Control group	Cognitive status	Cognitive measurement	Balance measurement	Strength measurement	Walking measurement	IADL evaluation	Main results/findings
Aoyama et al. (2011)	Observational	58	80.5±5.7	Fallers and non-fallers. No control group	Ns	Cognitive FIM	BBS, FR test, Postural sway, TUG test	Handgrip, Hip flexion, Knee extension, Angle dorsiflexion, Ankle plantar flexion, MFS	Step length	Barthel Index (0-100); Motor FIM	Significant correlations between cognitive FIM and muscle strength of the hip flexor and knee extensor in non-fallers. Significant correlations between muscle strength of ankle dorsiflexor and plantar flexor and cognitive FIM in fallers. The relationship between reduction of muscle strength and difficulties in ADL may reflect an association with frailty. It appears to be important in older women.
Auyeung et al. (2011)	Observational	2737 (1514 men; 1223 women)	71.6±5.58 (men), 71.5±4.85 (women)	Men and women. No control group	Cognitively normal at baseline	MMSE	-	Handgrip strength, 5 stand test, NMC score	Walking speed, Narrow walking speed, Step length	-	Muscle loss did not predict cognitive decline in multivariate analysis. Weak grip strength persisted to be a significant predictor. Muscle mass measurement could be replaced by hand grip strength in frailty assessment. Physical frailty, as represented by being underweight, weaker grip strength, slower chair-stand test, shorter step- length in men and weaker grip strength in women, was associated with cognitive decline over a four-year period.
Goda et al. (2021)	Observational	291 (n=138 MCI group; n=153 non-MCI group)	MCI group 79.49±3.67; non-MCI group 78.79±2.88	MCI group and non-MCI group	MCI and non-MCI	MMSE	One leg stand test, TUG test	Sit-up, Chair stand test, handgrip strength, knee-extension strength, toe-grip strength	5-meter walking time	-	One-legged standing time is an index that can be easily performed in daily practice, being useful as a screening index for detecting MCI in the late elderly.
Kuan et al. (2021)	Observational	90 (n= 30 MCI group; n=30 mild dementia group; n= 30 control group)	MCI: 74.0±6.7; Mild dementia: 76-0±5.0; Control: 72.9±6.7	MCI, mild dementia and control group	MCI (amnestic), Mild dementia (AD) and healthy controls	MMSE, CASI	BSS, AP, ML, FR, EOFIS, ECFIS, EOFOS, ECFOS	Handgrip strength	Gait speed, stride length, variability	-	Balance and gait performance significantly differed between healthy controls and the early stage of cognitive impairment. Scores of BBS and indices of FR and sensory integration significantly differed among the three groups. EOFIS and EOFOS indices of balance in mild dementia were significantly worse than in MCI. The gait speed and stride length also significantly differed among the three groups. Balance parameters identified as significant discriminators

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Study	Study design	N	Mean age (±SD)	Groups; Control group	Cognitive status	Cognitive measurement	Balance measurement	Strength measurement	Walking measurement	IADL evaluation	Main results/findings
											were AP and ML sway position in the eyes-open condition but not in the eyes-closed condition.
Liu et al. (2021)	Observational	956 (56.8% female)	72.56±5.43	Ns	138 participants had MCI	MMSE	TUG test	Handgrip strength	4-meter walking test	IADL	The physical performance (grip strength, TUG, and 4-m walking speed) was found to correlate with MCI. The 4-meter walking speed was related to overall cognition and various cognitive domains, except recall.
Martin et al. (2013)	Observational	386 (n=214 [133 men] no falls group, n=94 [46 men] single fall group, n=78 [36 men] multiple falls group)	71.3±6.8 no falls group, 72.4±6.3 single fall group, 74.3±8.4 multiple falls group	No falls group, single fall group and multiple falls group.	Ns	Victoria Stroop tests, Digit Span test, Verbal fluency tests, Hopkins verbal learning tests, Rey complex figure test, Digit symbol test, GDS, Reaction time	Sway	Leg strength	Gait speed	Steps per day	Poorer cognitive summary scores were generally associated with greater age, worse mood, lesser physical activity, slower gait speed, and poorer physiological function. No significant associations were observed between cognitive function and the risk of single falls. Impaired performance in three of the executive component tests (Stroop dot subtest, Stroop words subtest and category fluency) was associated with a greater risk of multiple falls, in addition, poorer visuospatial function was significantly associated with risk of multiple falls too.
Martins et al. (2024)	Observational	221 (n=174 without CI, n=47 CI)	74.1±7.3 CI group	CI and non-CI; age group 60-69 y.o., 70-79 y.o., ≥80 y.o.	CI and non-CI	MMSE	TUG	Chair stand test	6MWT	Advanced ADL scale	Muscle strength, functional mobility, cardiorespiratory fitness, age group, quality of life environment domain, autonomy domain and activities of daily living were significantly associated with cognitive impairment. CI classification was associated with lower muscle strength, reduced functional mobility and lower functional exercise capacity. Involvement in activities of daily living, environment and autonomy seem to influence cognitive impairment.
Ng et al. (2022)	Observational	716 (n=562 cognitively normal; n=154 MCI).	67.94±5.65 cognitively normal group, 68.27±7.03 MCI group	Cognitively normal and MCI	MCI and cognitively healthy	MMSE, RAVLT, semantic fluency, block design test, digit span, color trail test	TUG test,	Chair stand test	Fast gait speed	-	Significant associations were found between MMSE and physical performance tests - lower MMSE scores associated with higher scores on physical performance tests-. Higher TUG remained associated significantly with lower MMSE scores, lower digit span backward scores, higher CTT2 scores and lower CTT interference.

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Study	Study design	N	Mean age (±SD)	Groups; Control group	Cognitive status	Cognitive measurement	Balance measurement	Strength measurement	Walking measurement	IADL evaluation	Main results/findings
Veronese et al. (2016)	Observational	1249 (n=864 normal cognitive status group, n=131 cognitive decline group, n=254 cognitive impairment group)	71.0±5.1 normal cognitive status group, 72.4±5.5 cognitive decline group, 76.5±6.4 cognitive impairment group	Normal cognitive status group, cognitive decline group and cognitive impairment group	Cognitively healthy, CD and CI	MMSE, GDS	SPPB	Handgrip strength, Leg flexion strength, Leg extension strength, Chair stand test	4-meter walking speed, 6-minute walking test	ADL, IADL	Poorer SPPB scores were significantly associated with the onset of CI. Chair stand time predicts the onset of CI, although only in women. Low 6MWT values were significantly associated with higher risk of CI, particularly in men. Slow walking speed appears to be an independent predictor of cognitive decline and impairment over a 4.4-year follow-up. Lower limbs strength and handgrip tests appear not to be associated with cognitive status at the follow-up. People with CI had significantly lower IADL and higher GDS scores than those with normal cognitive status.
Won et al. (2014)	Observational	164 (66.5% female)	66.0±4.6	Ns	Ns	MMSE, clock drawing test, RAVLT, digit span, digit symbol, matrix reasoning, block desing, GDS.	TST, SPPB, FR test	Chair stand test	4-m walking speed	-	Negative and significant correlation between TST and digit span, digit symbol, clock drawing test, matrix reasoning, RAVLT and MMSE. Positive and significant correlation between dynamic balance and digit symbol test, clock drawing test and matrix reasoning. Positive and significant correlation between SPPB and digit span test, digit symbol test and clock drawing test. Relationship between static balance and all cognitive measures was not significant. Agility assed through TST was a significant predictor of digit span test, clock drawing test and MMSE.

AD: Alzheimer disease; AP: Anterior-posterior index; BBS: Berg Balance Scale; CASI: Cognitive Abilities Screening Instrument; CD: Cognitive decline; CI: Cognitive impairment; COWAT: Controlled oral word association test; CTT: color trails test; ECFIS: Eyes closed with firm surface index; ECFOS: Eyes closed with foam (unstable) surface index; EOFIS: Eyes open with firm surface index; EOFOS: Eyes open with foam (unstable) surface index; Cognitive FIM: Cognitive functional independence measure; FR: Fall risk index; FR test: Functional Reach test; GDS: Geriatric depression scale; IADL test: Instrumental activities of daily living test; RAVLT: Rey auditory verbal learning test; MCI: Mild cognitive impairment; MFS: Motor Fitness Scale; ML: Medial-lateral index; MMSE: Mini-mental state examination; Motor FIM: Motor functional independence measure; NMC score: Neuromuscular composite score; Ns: No specified; TST: ten step test; TUG test: Timed up and go test.

3.3. Level of evidence and quality

The level of evidence of the articles included in this systematic review is 6 in a range of 1-7 levels (being 1 the higher evidence and 7 the lower evidence) in the scale proposed by Melnyk & Fineout-Overholt (2023) and low level of quality based on GRADE system (Aguayo-Albasini et al., 2014).

3.4. Cognitive status in relation to physical variables in older adults

3.4.1. Cognitive status and Balance

Five articles (Goda et al., 2021; Kuan et al., 2021; Martin et al., 2013; Ng et al., 2022; Won et al., 2014) described relationships between cognitive status and balance. Individuals with CI or MCI exhibited shorter one-legged stand times and prolonged TUG times compared to those without MCI (Goda et al., 2021; Ng et al., 2022). Additionally, balance performance, assessed through the BBS and Fall Risk Index, appeared to differ between healthy controls and individuals with early-stage CI (Kuan et al., 2021). TST seems to be a significant predictor for cognitive performance after adjusting for sex, age, education and medical condition (Won et al., 2014). No significant associations were observed between cognitive function and the risk of single falls (Martin et al., 2013) and between cognition measurement and static balance (Won et al., 2014).

3.4.2. Cognitive status and strength

The relationship between cognitive status and strength was reported by seven studies (Aoyama et al., 2011; Auyeung et al., 2011; Liu et al., 2021; Martins et al., 2024; Ng et al., 2022; Veronese et al., 2016; Won et al., 2014). Strength, measured by handgrip test, was found to be associated with various cognitive domains, including overall cognition, time orientation, recall, and language (Liu et al., 2021). Furthermore, weak grip strength remained a significant predictor of cognitive decline (Auyeung et al., 2011). In terms of lower limbs strength, the chair stand test time was identified as a predictor of cognitive impairment onset, though only in women (Veronese et al., 2016). Significant correlations were also observed between cognitive FIM and the strength of hip flexors and knee extensors in a group of non-fallers (Aoyama et al., 2011) and between cognitive status and muscle strength through chair stand test or TST (Martins et al., 2024; Ng et al., 2022; Won et al., 2014).

3.4.3. Cognitive status and walking speed

Five studies (Kuan et al., 2021; Liu et al., 2021; Martins et al., 2024; Ng et al., 2022; Veronese et al., 2016) investigated the relationship between cognitive status and the ability of walk. The results indicated that both the TUG test and 4-meter walking speed were correlated with overall cognitive function and several cognitive domains, except recall (Liu et al., 2021), and gait speed serves as a predictor for both CI and CD (Veronese et al., 2016) and it is effectively distinguished between patients with MCI or CI and healthy controls (Kuan et al., 2021; Martins et al., 2024; Ng et al., 2022).

3.5. Balance stability in relation to physical parameters in older adults

Two studies (Aoyama et al., 2011; Martin et al., 2013) reported results between balance and strength. Postural sway control and inadequate anteroposterior stability were identified as important predictors of falls. Reduced muscle strength and diminished physical performance may further impair postural reflexes, thereby increasing the risk of falls (Aoyama et al., 2011). In distinguishing between single fallers and non-fallers, individuals who experienced a fall demonstrated slower gait speed and lower muscle strength compared to those who did not fall (Martin et al., 2013).

3.6. Activities of daily living

Four studies (Aoyama et al., 2011; Martin et al., 2013; Martins et al., 2024; Veronese et al., 2016) reported relationships among IADLs. A significant association between reduced muscle strength and difficulties in performing IADLs, particularly indicating a link with frailty in older women (Aoyama et al., 2011). Lower cognitive summary scores were also associated with decreased physical activity, including fewer steps per day (Martin et al., 2013) and involvement in perform ADLs (Martins et al., 2024). Furthermore, individuals with CI exhibited significantly lower IADL scores and higher Geriatric Depression Scale (GDS) scores compared to those with normal cognitive function (Veronese et al., 2016).

4. Discussion

The purpose of this systematic review is to identify and evaluate physical tests that can provide significant information about cognitive status. Specifically, the review aims to determine which physical tests are most correlated with cognitive performance or decline, thereby offering a valuable tool for initial screening.

Due to the importance of cognition state on balance stability (Borges et al., 2016; Tangen et al., 2014), in this study we have related balance with other physical parameters in this population to compare whether it has influence in the IADL of these people, which is known that people with CI had significantly lower IADL(Veronese et al., 2016).

4.1. Cognition in relation to physical parameters in older adults

Cognitive status appears to influence balance, evidenced by diminished score in static tests such as BBS and one-legged stand time, alongside increased execution times in dynamic tests such TUG (Goda et al., 2021; Kuan et al., 2021). These findings suggest that tests conducted with eyes open serve as notable indicators associated with the incidence of MCI. Furthermore, balance parameters identified as significant discriminators were the anterior-posterior and medial-lateral sway positions in the eyes-open condition, but not in the eyes-closed condition (Bahureksa et al., 2017). It is proposed that balance screening could facilitate the early detection of balance dysfunction before it progresses, thereby allowing for the development of targeted interventions aimed at addressing specific deficits and potentially mitigating the progression of dementia (Goda et al., 2021; Kuan et al., 2021). This assertion is consistent with the conclusions of Tavares et al. (2020), who observed that groups with potential cognitive decline had poorer balance, increased fear of falling, and higher rates of fall recurrence. Their research underscores the impact of cognitive function on balance, identifying cognitive impairment as a primary factor affecting balance. In contrast, Martin et al. (2013) did not find significant associations between cognitive function and the risk of single falls, suggesting that the risk of falling in older adults increases with poorer performance on balance tests. This may be relevant when considering a single fall, which could occur due to instability during a specific action. However, for multiple falls—where an individual loses balance on more than one occasion—, an association was found with impaired performance in three executive

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function tests (Stroop dot subtest, Stroop words subtest, and category fluency) and poorer visuospatial function. In addition, their results indicated that the adverse effects of several physiological factors on the risk of multiple falls are magnified by the presence of poorer cognitive function and that is consistent across all cognitive domains measured. In this way, Veronese et al. (2016) also found that poor SPPB scores were significantly associated with the onset of CI. It is well established that the nervous system and balance are interrelated (Boisgontier et al., 2016). This association helps to explain why balance impairment is linked with cognitive dysfunction, given the close relationship between cognitive impairment and the central nervous system (Arosio et al., 2023; Boyle et al., 2009). However, Won et al. (2014) observed that relationships between static balance and all cognitive measures were not significant, deviating from the findings obtained when comparing static balance with dynamic balance. These results contrast with previous studies discussed previously and can be attributed to the protocol used. Won et al. (2014) stated that they followed the same protocol as Singh et al. (2012), which involved maintaining the center of body mass within a circle displayed on the computer screen for 30 seconds. This protocol differs from the one employed by the subjects studied by Kuan et al. (2021).

Regarding cognitive status and strength, there seems to be a relationship between cognitive state and handgrip and lower limb strength for both sexes, where weak grip strength remained a significant predictor of cognitive decline (Auyeung et al., 2011; Martins et al., 2024; Ng et al., 2022), and it is associated with various cognitive domains (Liu et al., 2021). These findings provided by Liu et al. (2021) and Auyeung et al. (2011) align with other studies (Fritz et al., 2017; McGrath et al., 2020; Shaughnessy et al., 2020) that reviewed evidence indicating that handgrip strength may serve as an effective marker for assessing the onset and progression of cognitive impairment. Additionally, lower handgrip strength has been linked to declining cognitive performance over time, with each additional 5 kg of handgrip strength associated with reduced odds of both future cognitive impairment and more severe cognitive decline. One potential explanation for this relationship, as suggested by Liu et al. (2021), is that cognitive impairment might first manifest as physical inactivity, which can subsequently result in a decline in muscle mass and strength over time. Although much of the existing data is correlational, there is a growing body of evidence suggesting that the progression of sarcopenia may contribute to cognitive decline and potentially to the onset of dementia (Ogawa et al., 2018). This is supported by evidence indicating that impaired cognitive function is associated with reduced daily physical activity (Antunes et al., 2010). On the other hand, significant correlations between cognitive function, as measured by FIM and muscle strength in specific lower limbs muscle groups was found (Aoyama et al., 2011). In contrast, Veronese et al. (2016) reported that lower limb muscle strength, assessed through leg extension and handgrip strength, did not show a significant association with cognitive status during follow-up. However, they noted that prior to adjusting for potential confounding factors, low handgrip strength values were strongly associated with the onset of CI and CD. Additionally, they found that chair stand time was a predictor of cognitive impairment onset, albeit only in women. This finding could suggest that the cognitive demands of standing up might be greater than those of leg extension exercises, which could alter the outcome of the relationship.

Cognitive function has a significant impact on gait speed performance, with walking speed shown to correlate with overall cognitive function and various cognitive domains, as measured by the TUG test and the 4-meter walking test. It has been suggested that gait speed may serve as a predictor for both CI and

CD. Furthermore, low values in the 6MWT have been significantly associated with an increased risk of CI in older adults, particularly in men (Kuan et al., 2021; Liu et al., 2021; Martins et al., 2024; Veronese et al., 2016). In addition, Tuerk et al. (2016) proposed that gait speed may reflect generalized deterioration in the nervous system typical of aging, which could eventually indicate diminished cognitive function. These suggestions are aligned with findings from a longitudinal study by Rosso et al. (2017), which reported that a decline in gait speed over a 14-year period predicted the onset of CI (adjudicated MCI or dementia) in an initially healthy cohort of older adults. On the contrary, Hooghiemstra et al. (2017) conclude that markers of physical performance such as handgrip and gait speed, are seemingly not useful as an early marker of incident in clinical progression, but they are related to current cognitive status and modestly related to cognitive decline. It should be noted that subjects of their study were 55 years old and older, and they have not had cardiac problems, which has been suggested that the association between gait speed and cognitive decline might be stronger in patients suffering from cardiovascular disease (Montero-Odasso et al., 2016).

4.2. Balance stability in relation to physical parameters in older adults

In terms of balance stability and its relationship with physical parameters, evidence suggests that postural sway control serves as a significant predictor of fall risk (Aoyama et al., 2011). Decreased muscle strength and reduced physical performance may exacerbate impairments in postural reflexes, thereby increasing the likelihood of falls. The authors also propose that enhancing hip muscle strength could help restore equilibrium following perturbations, especially when the support surface is narrower than the base of the feet. This aligns with findings by Martin et al. (2013), who reported that individuals who experienced a fall were slightly older, predominantly female, exhibited slower gait speed, and had lower muscle strength compared to non-fallers. Consistent with other studies, reduced gait speed has been closely linked to impaired balance, with poorer performance in gait speed tests correlating with a higher risk of falls among older adults (Tuerk et al., 2016).

4.3. Activities of daily living in older adults

Among IADLs, there is evidence between diminished muscle strength and difficulties in performing IADLs, suggesting a link to frailty. The avoidance of activities not only reflects general physical frailty, but it is also associated with specific functional deficits, such as reduced hip and knee strength, as well as decreased handgrip strength. Consequently, older individuals who refrain from certain activities due to diminished muscle strength are likely to experience limitations in tasks such as shopping, walking, indoor mobility, and bending to pick up objects. This may further contribute to increased feelings of insecurity and anxiety, promoting higher scores in GDS and lower cognitive summary scores, something common in CI subjects (Aoyama et al., 2011; Martin et al., 2013; Martins et al., 2024; Veronese et al., 2016). In this context, Wennie Huang et al. (2010) conclude that the BBS is the most predictive performance-based measure for onset of IADLs difficulties, followed by SPPB, TUG, gait speed and handgrip strength. All these variables have been observed that correlate with cognitive status in this review.

Due to the variability in protocols for assessing cognitive diseases, there is no consensus on conducting early screening for older adults aged 60 years or older, as is established for frailty (Fried et al., 2001) and nutritional status (Vellas et al., 1999). When this population attends an examination, physicians could assess physical performance to detect potential sarcopenia or frailty, which may also provide valuable information for cognitive status evaluation. Changes such as reduced grip strength, slower walking speed, prolonged TUG test times, and lower scores on the BBS could be indicators of MCI, warranting a comprehensive cognitive assessment for the early detection and intervention. The findings of this study will help healthcare professionals decide when to refer patients for a more comprehensive cognitive assessment while they evaluate frailty or sarcopenia.

The quality of the selected studies included in this review is low based on Grade system (Aguayo-Albasini et al., 2014) which it means that there is a limited confidence in the estimated effect, and it is possible that the true effect is very different from the estimated effect. This is because the studies included in this review were observational studies. On the other hand, the level of evidence is 6 in the scale proposed by Melnyk & Fineout-Overholt (2023) given that the evidence is from descriptive studies.

Future studies are needed to examine the relationship between cognitive function and physical factors by randomized controlled clinical trials. Future research regarding the long-term effects of different type of exercise on physical factors, such as strength or motion, and cognition in older adults and explore its role in the process of cognitive aging with healthy and cognitive impaired subjects.

4.4. Clinical implications

Our research suggests that impaired cognitive function can be detected through various single tests commonly used in routine healthcare evaluations for older adults. Our results offer valuable insights into which assessments provide more comprehensive information about cognitive status. By recognizing specific indicators such as strength levels, walking abilities and balance stability during screenings, healthcare professionals can facilitate early detection of cognitive impairment, enabling timely interventions aimed at slowing disease progression and enhancing overall health -both mental and physical- and well-being.

4.5. Limitations

It is relevant to acknowledge the limitations of this systematic review to provide a comprehensive interpretation of the findings. First, the overall quality of the included studies was limited by poor methodological rigor and low levels of evidence. Additionally, the observed correlations do not indicate causation, they rather represent an interaction of multiple factors. Consequently, we can only assert that individuals with cognitive impairment exhibit the specific levels of physical parameters discussed in this review. The accumulation of these markers, however, may indicate potential cognitive deterioration, warranting further evaluation.

5. Conclusion

In conclusion, assessing physical function in older adults is crucial for identifying potential impairments associated with physical frailty, sarcopenia, and cognitive decline. Implementing a straightforward initial screening can help determine the need for further evaluation by healthcare professionals to assess cognitive function and facilitate appropriate interventions aimed at delaying or treating cognitive decline. Maintaining high levels of activity among the elderly is essential for enhancing physical function and preventing age-related deterioration, both physical and mental. Future longitudinal studies and randomized controlled clinical trials are necessary to clarify the interactions between physical function and the progression of cognitive decline in older adults, thereby improving the overall quality and evidence in this field.

Ethical approval

Ethical approval was not needed due to the materials for this study was the literature in the databases.

CRediT authorship contribution statement

All authors (P.F-R, MV. G-C, M. G-F, M. F-Z, N. S-P) contributed to the development of the systematic review. P.F-R: conceptualization, investigation and writing – original draft; MV. G-C: investigation, software and writing – review & editing; M. G-F: investigation, methodology, supervision and writing – review & editing; M.F-Z: supervision and writing – review & editing. N. S-P: conceptualization, investigation, supervision and writing – review & editing. All authors have read and agreed to the published version of the manuscript.

Declaration of competing interest

The authors declare that there is no conflict of interest.

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