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# Associations of Balance, Strength, and Gait Speed with Cognitive Function in Older Individuals over 60 Years: A Cross-Sectional Study

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**Abstract:** This research examined the association between the risk of falls and cognitive function in older individuals at risk of mild cognitive impairment. One hundred seventy-five older adults were included in 2021. Balance confidence was scored using the Activities-Specific Balance Confidence Scale (ABC), gait speed was assessed by the 4 m test, handgrip strength by a digital dynamometer, and balance by the Timed Up-and-Go Test (TUG). The Mini-Mental State Examination (MMSE), The Controlled Oral Word Association Test, and The Boston Naming Test short-version questionnaires assessed global cognitive function, verbal fluency, and language, respectively. A bivariate correlation analysis and multivariate linear regressions were applied, adjusting for confounders (BMI, sex, age, and educational level). Shorter time in the TUG and greater educational status were independently associated with improved scores on the MMSE. Lower age and greater educational status were independently associated with increased phonological fluency. Better ABC and performance on the TUG and higher educational attainment were independently associated with enhanced semantic fluency. Higher education level and gait speed were independently associated with increased language (all $p < 0.05$). Improved physical factors, such as gait speed, grip strength, balance, and balance confidence enhanced cognitive function, particularly global cognitive function, verbal fluency, and language, in individuals over 60, with education as a potential confounder.

**Keywords:** older adults; aging; accidental falls; cognitive impairment; physical fitness



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## 1. Introduction

Falls constitute a major health issue and are the number two cause of unintentional injuries leading to fatalities globally [1]. Due to changes in various physiological systems associated with aging, older individuals face the greatest susceptibility to falling, affecting between 30–40% of this population [2,3]. In particular, the highest number of fatal falls occurs after the age of 60 [1]. Falls are multifactorial and their consequences are not only physical, such as injury and disability, but also psychological, especially the apprehension about falling, and social, such as social seclusion and institutionalization [2]. These conditions have an impact on the well-being of older individuals and may be costly for our public health system [2,3].

In older individuals, diminished physical capabilities stand out as a primary contributor to falls [4]. Therefore, enhancing functional capacity, which is defined as the ability of the person to independently perform activities of daily living (ADLs), was shown to be efficacious in preventing falls among seniors [5]. Recent research showed that prescribing physical exercise with a focus on mitigating strength and muscle mass loss while maintaining balance and gait is effective in this population [5].

Slow gait is a well-established factor indicating the risk of falls among elderly individuals [6]. Walking involves coordinated functioning of the nervous, sensory, cardiorespiratory, and musculoskeletal systems, which are influenced by age [6]. During aging, gait abnormalities due to poor joint range of motion and decreased muscle strength, among other disorders, become more prevalent [7]. Approximately 10% of older adults aged 60–70 years suffer from gait abnormalities, rising to more than 60% in those over 80 years of age [6]. Consequently, gait speed is considered a valuable tool for the early detection of vulnerability to falls, and recent studies established potential gait speed cut-off points for older adults [8,9].

Similarly, balance disorders also contribute to an increase in falls [10]. Balance skills enable individuals to control their posture and react to disturbances; dynamic balance refers to maintaining equilibrium during movement [11]. Postural imbalance, limitation of the functional peripheral visual field, proprioceptive impairment, and further complaints that greatly compromise balance are most often manifested in senescence [10].

Another element linked to a heightened risk of falls is the gradual decrease in skeletal muscle mass and strength that accompanies the aging process, which is a condition known as sarcopenia [12]. This geriatric syndrome is influenced by aging, hormonal changes, chronic diseases, inflammation, and malnutrition, among other factors [13]. A substantial body of scientific evidence [14] underscores the significance of grip strength as a biomarker for successful aging. However, it is not directly associated with ADLs like walks, which serve as an index of mobility in older individuals.

It is evident that cognitive function, which progressively declines with advancing age, is inversely related to fall risk [2]. However, a recent systematic review and meta-analysis [15] regarding the risk of falls in seniors with cognitive impairment found no relationship between the level of cognitive functioning and falls in this population, whereas functional performance was linked.

Given the strong relationship between cognitive function and fall risk, knowing whether physical status factors that influence falls are also related to cognitive function level will allow for a better understanding of the relationship between physical and cognitive functioning on fall risk in older adults. This information could provide a more complete insight into the mechanisms underlying falls and cognitive dysfunction and help to identify more effective interventions to prevent them. Therefore, this research work aimed to explore the associations between fall risk based on predictors of functional capacity and cognitive function in older individuals at risk of mild cognitive impairment (MCI). Our hypothesis was that individuals with a higher risk of falls, specifically those with lower gait speed, handgrip strength, and poorer dynamic balance, would exhibit lower cognitive performance, specifically in language and semantic and phonological fluency, in older people over the age of 60 years.

## 2. Materials and Methods

### *2.1. Participants*

The current study was a cross-sectional descriptive and analytical study that was carried out between February and March 2021. A total of 175 people were randomly chosen by means of the Social Affairs departments of Malaga City Council and Pizarra City Council (Malaga) (Figure 1). Participants were included if they were at least 60 years of age, resided in Malaga or Pizarra (Malaga), able to communicate without problems, and could read and understand the informed consent form and the object of the study. In addition, they were excluded if they had central or peripheral neurological disorders, rheumatological diseases; severe somatic or psychiatric diseases; severe cognitive impairment; pacemakers or prostheses; auditory or vestibular pathologies; or any other conditions that could affect balance, functional activity, and hinder an accurate functional assessment. Additionally, individuals involved in concurrent research studies that could potentially impact this project were also excluded.


**Figure 1.** Flowchart of the study participants.

In cases where a selected individual was not eligible for inclusion in the sample due to lack of access, unwillingness, or failure to meet the inclusion criteria, the following person from the list replaced them to maintain the sample size. The sample size determination was carried out with version 3.1.9.2 of G*Power.

Based on an estimated incidence of 30% of falls (at least once a year) in the target group, the study sample size was obtained using the formula for estimating the proportion, where the assumed rate was 0.3, with $\alpha$ = 0.05 and a precision of $\pm$0.06. A 25% safety margin was added to account for registration failures, drop-outs, or individuals who did not want to participate; therefore, a required sample size of 175 subjects was calculated.

Initially, we provided an overview of the primary objectives and motivations behind the study. Subsequently, we briefly outlined the potential risks associated with the study. All procedures were conducted in an anonymous manner. Prior to enrolment, each participant provided informed written consent. Approval for this study was granted by the Ethics Committee of the University of Jaén (DIC.17/5.TES 19 February 2018) and adhered to the principles of the Declaration of Helsinki, good clinical practices, and relevant laws and regulations.

## 2.2. Sociodemographic and Anthropometric Information

Sociodemographic details, i.e., date of birth, marital status, level of education, and place of residence, were documented. Anthropometric parameters, including weight, height, waist-hip ratio, and BMI, were recorded. For these assessments, individuals were without shoes and dressed in undergarments. Additionally, behavioral patterns pertaining to physical activity, including type and frequency, as well as information on smoking and any falls encountered in the previous year, were gathered.

For the measurement of waist circumference, a 1.5-m flexible measuring tape (Lufkin, W606PM, Sparks, MD, USA) was utilized, with the midpoint between the last rib and the iliac crest serving as the reference point. Two measurements were taken while the participant stood upright.

## 2.3. Fall Risk Outcomes

### 2.3.1. Balance Confidence

The Activities-Specific Balance Confidence Scale (ABC) is a structured survey designed to assess an individual's confidence in performing activities without experiencing balance issues. Comprised of 16 items, with each one assessed on a scale from 0% to 100% (where 0% denotes no confidence and 100% signifies full confidence), the questionnaire generates an aggregate score calculated by summing the scores of all items and dividing the total by 16. This resultant aggregate score also spans from 0% to 100%. The Spanish version demonstrated outstanding internal consistency (Cronbach's $\alpha$ = 0.92) and significant test-retest reliability, as indicated by an intraclass correlation coefficient (ICC) of 0.86 [16].

### 2.3.2. Gait Speed

The 4 m walking test of the Short Physical Performance Battery (SPPB) [17] was aimed at assessing the gait speed at a normal walking pace. It has been employed as a predictive instrument for potential disability and can assist in the assessment of function in later life. The duration, measured in seconds, required to complete the specified route was reported. The SPPB was shown to be reliable with an ICC of 0.87 [17].

### 2.3.3. Handgrip Strength

The evaluation of upper body muscular strength, specifically handgrip strength, was conducted using a digital dynamometer (TKK 5101 Grip-D; Takei, Tokyo, Japan). During the dynamometry measurement, participants were required to preserve a standard bipedal position with the arm fully extended throughout the entire test. Individuals were instructed to perform three attempts of maximum grip strength using their dominant hand, with a 30-s pause between each trial. To ensure accuracy, the dynamometer was calibrated to size 5.5 for males, whereas for females, the ideal grip size was customized according to hand dimensions [18]. A standard of 16 kg for females and 27 kg for males was applied to determine low muscle strength [19]. This test demonstrated validity and reliability, with an ICC exceeding 0.80 [20].

### 2.3.4. Dynamic Balance

The Timed Up-and-Go Test (TUG) is designed to evaluate dynamic balance and functional mobility in older adults [21]. The test involves a patient transitioning from a seated to a bipedal position, walking three meters, turning around, returning, and sitting back in the chair. The length of time the individual spent completing this sequence was recorded. Each participant underwent the test twice, and the top time achieved was recorded [22]. This test has demonstrated reliability, with an ICC ranging between 0.95 and 0.99 [23].

### 2.4. Cognitive Function Outcomes

#### 2.4.1. Global Cognitive Function and Screener for Mild Cognitive Impairment

The Folstein Mini-Mental State Examination (MMSE) is a cognitive function assessment comprising 30 questions. It evaluates various cognitive domains, including attention and orientation, memory, registration, recall, calculation, language, and the ability to draw a complex polygon [24]. The combined score derived from the evaluation acts as a measure of overall cognitive function. It is also a recognized screener for MCI [25], where the most sensitive cut-off points for this condition are [26] 30–28 points, which shows the individual is healthy with cognitive function intact; 27–24 points, which indicates possible MCI; and 23 points or less, which can indicate moderate-to-severe cognitive impairment.

#### 2.4.2. Verbal Fluency

The Controlled Oral Word Association Test (COWAT) is a frequently employed neuropsychological measure aimed at assessing phonologic and semantic fluency [27,28]. This verbal fluency test gauges the capacity to generate words either starting with a designated letter (phonological) or falling within the same classification (semantic). Within a 1-min timeframe, participants are tasked with articulating the maximum number of words they can that either commence with a specific alphabet letter (F, A, or S) or fall within a designated category (kitchen, animals, or countries). Proper names and word-derived variations are excluded. The COWAT is widely utilized for evaluating verbal fluency and is recognized as a sensitive indicator of brain dysfunction. It is acknowledged that the administration of verbal fluency tests is a crucial component in conducting a comprehensive assessment of neuropsychological functioning [27,28].

#### 2.4.3. Language

Language was measured with The Boston Naming Test short version (BNT-30). Summation scores span from 0 to 30. Lower scores point toward heightened obstacles in lexical retrieval. The cumulative score for this test comprises the addition of the correct responses provided spontaneously plus those produced with semantic stimulus cues [29]. Its validity and reliability are well established and reviewed elsewhere [28].

### 2.5. Statistical Analysis

Continuous variables are displayed as means and deviations from the mean, while categorical variables are depicted as proportions and occurrence frequencies. The normal distribution of all variables was evaluated using the Kolmogorov–Smirnov examination. Bivariate correlation analysis was utilized to explore potential individual associations between a range of factors (independent variables, such as balance confidence, gait speed, handgrip strength, and dynamic balance, alongside other covariates, such as BMI, sex, age, and educational level) and global cognitive function, language, and semantic and phonologic fluency. To investigate the independent associations between the present variables, both a multivariate linear regression model and a step-by-step method were implemented to incorporate variables into the model. Cognitive status was documented as the dependent variable in separate models, considering the significance in bivariate correlation ($p < 0.05$), and was integrated into the multivariate linear regression. The adjusted $R^2$ was used to calculate the effect size coefficient of multiple determinations in linear models. An $R^2$ less than 0.02 was considered insignificant, moderate if ranging between 0.02 and 0.15, and substantial if it surpassed 0.35. A confidence level of 95% was adopted ($p < 0.05$). The analysis of data was carried out utilizing the SPSS statistical package for Windows (SPSS Inc., Chicago, IL, USA).

## 3. Results

Descriptive characteristics of the participants are shown in Table 1 for all participants together (n = 175) and separately by sex (n = 137 women, 78%). The majority of the participants were either married or cohabiting (69.14%), had completed primary education or had lower educational attainment (80.56%), and the average BMI was 29.80 ± 4.78 kg/m$^2$. Descriptive statistics for the variables examined in the current research work indicated that the TUG duration was 7.09 ± 1.53 s. The handgrip strength was 25.59 ± 8.12 kg. The balance confidence measured with ABC showed 76.27 ± 21.61 points as the score total. Finally, as an independent variable, the gait speed showed 2.283 ± 0.50 s in the 4 m walking test. Regarding the dependent variables, the score total of the MMSE, which served as a global indicator of cognitive function, averaged 25.95 ± 3.01, falling within the range indicative of possible MCI. The total numbers of words given for the phonologic and semantic fluency from the COWAT were 32.07 ± 12.69 and 31.75 ± 10.25, respectively. Regarding language measured with BNT, the total correct score was 10.45 ± 2.86.

**Table 1.** Descriptive data of the study sample.

| Characteristics | | Total (n = 175) | | Men (n = 38) | | Women (n = 137) | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD |
| Age (years) | | 66.64 | 5.58 | 64.98 | 4.84 | 67.11 | 5.70 |
| BMI (kg/m$^2$) | | 29.80 | 4.78 | 30.14 | 3.93 | 29.71 | 5.01 |
| | | N | Percentage | N | Percentage | N | Percentage |
| Occupational status | Retired | 150 | 85.71 | 26 | 69.42 | 124 | 94.51 |
| | Working | 6 | 3.42 | 4 | 10.52 | 2 | 1.46 |
| | Unemployed | 19 | 10.87 | 8 | 10.06 | 11 | 4.03 |
| Marital Status | Single | 5 | 2.85 | 4 | 10.52 | 1 | 0.73 |
| | Married/cohabiting | 121 | 69.14 | 7 | 18.42 | 114 | 83.21 |
| | Separated/divorced/widowed | 49 | 28.01 | 27 | 71.06 | 22 | 16.06 |
| Educational level | No formal education | 60 | 34.28 | 12 | 31.58 | 48 | 35.03 |
| | Primary education | 81 | 46.28 | 17 | 44.75 | 64 | 46.71 |
| | Secondary education | 24 | 17.51 | 6 | 15.78 | 18 | 13.13 |
| | University | 10 | 5.71 | 3 | 7.89 | 7 | 5.13 |
| | | Mean | SD | Mean | SD | Mean | SD |
| MMSE (score) | | 25.93 | 3.01 | 26.47 | 2.44 | 25.78 | 3.15 |
| Phonologic fluency (w) | | 32.07 | 12.69 | 37.05 | 12.19 | 30.70 | 12.51 |
| Semantic fluency (w) | | 31.75 | 10.25 | 34.79 | 13.65 | 30.90 | 8.98 |
| Language (score) | | 10.45 | 2.86 | 11.79 | 2.50 | 10.08 | 2.85 |
| TUG (s) | | 7.09 | 1.53 | 6.77 | 1.47 | 7.17 | 1.55 |
| Handgrip strength (kg) | | 25.59 | 8.12 | 37.77 | 7.28 | 22.21 | 4.14 |
| ABC (score) | | 76.27 | 21.61 | 83.77 | 17.45 | 74.20 | 22.25 |
| Gait speed (s) | | 2.283 | 0.50 | 2.09 | 0.46 | 2.33 | 0.51 |

ABC: Activities-Specific Balance Confidence Scale. BMI: body mass index. MMSE: Mini-Mental State Examination. TUG: Timed Up-and-Go Test.

Table 2 displays the bivariate analysis, which demonstrated that the dependent variables in this study (namely, the MMSE as a screener for MCI, phonologic and semantic fluency, and language) significantly positively correlated with educational level. When analyzing the MMSE score, significant negative associations with the TUG and gait speed were also found. When more words were given in the phonologic fluency test, a correlation between an increase in the handgrip strength and a higher score in confidence balance was observed. When analyzing the semantic phonologic and language results, significant negative correlations were also found with the TUG and gait speed. Furthermore, handgrip strength and ABC showed a positive correlation with semantic fluency and language. Regarding the covariates incorporated in the analysis, sex showed correlations with phonologic and semantic fluency and language. Furthermore, age was observed in correlations with the MMSE score, semantic fluency, and language.

**Table 2.** Pearson's correlations among variables analyzed in this study.

| | MMSE | Phonologic Fluency | Semantic Fluency | Language |
|---|---|---|---|---|
| TUG | −0.236 ** | −0.122 | −0.303 ** | −0.219 ** |
| Handgrip strength | 0.140 | 0.201 ** | 0.190 * | 0.264 ** |
| ABC | 0.135 | 0.161 * | 0.277 ** | 0.205 ** |
| Gait speed | −0.150 * | −0.139 | −0.352 ** | −0.297 ** |
| Age (years) | −0.149 * | -0.144 | −0.385 ** | −0.353 ** |
| Sex | −0.095 | −0.207 ** | −0.157 * | −0.246 ** |
| Educational level | 0.330 ** | 0.509 ** | 0.318 ** | 0.542 ** |
| BMI (kg/m$^2$) | −0.068 | 0.046 | −0.110 | −0.066 |

ABC: Activities-Specific Balance Confidence Scale. BMI: body mass index. MMSE: Mini-Mental State Examination. TUG: Timed Up-and-Go Test. * $p < 0.05$. ** $p < 0.01$.

The multivariate linear regression analysis, as indicated in Table 3, unveiled various independent associations with distinct cognitive domains in this investigation. A shorter time in the TUG was associated with an elevated MMSE total score, and an increase in the educational level was associated with a total score in the MMSE ($R^2$ = 0.149). A higher education level was associated with an increase in the number of words answered in the phonologic fluency test and age was linked to a decline in the word count answered in the phonologic fluency test ($R^2$ = 0.320). Lower times in the TUG and gait speed were associated with an increase in the total number of words answered in the semantic fluency test and lower educational level and total score in the ABC were associated with a decrease in the total number of words answered in the semantic fluency test ($R^2$ = 0.133). Lastly, a higher level of education correlated with an elevation in the comprehensive language score, whereas gait speed exhibited an association with a decrease in the total language score ($R^2$ = 0.372).

**Table 3.** Multivariate linear regression analyses for variables related to cognitive function factors.

| Variable | | B | β | t | 95% CI | | *p*-Value |
|---|---|---|---|---|---|---|---|
| MMSE | TUG | −0.538 | −0.275 | −2.254 | −1.09 | −0.67 | 0.025 |
| | Educational level | 1.268 | 0.319 | 3.838 | 0.616 | 1.920 | <0.001 |
| Phonologic fluency | Educational level | 7.360 | 0.041 | 5.965 | 4.921 | 9.797 | <0.001 |
| | Age | −0.554 | −0.244 | −3.551 | −0.862 | −0.246 | <0.001 |
| Semantic fluency | Educational level | 3.678 | 0.273 | 3.364 | 1.520 | 5.873 | 0.001 |
| | Gait speed | −4.931 | −0.241 | −1.970 | −9.873 | 0.011 | 0.049 |
| | TUG | −1.378 | −0.207 | −2.572 | −2.437 | −0.320 | 0.011 |
| | ABC | 0.077 | 0.163 | 2.045 | 0.003 | 0.152 | 0.042 |
| Language | Educational level | 1.796 | 0.476 | 6.613 | 1.260 | 0.233 | <0.001 |
| | Gait speed | −1.654 | −0.290 | −2.661 | −2.882 | −0.427 | 0.009 |

B: unstandardized coefficient. β: standardized coefficient. CI: confidence interval. ABC: Activities-Specific Balance Confidence Scale. MMSE: Mini-Mental State Examination. TUG: Timed Up-and-Go Test.

## 4. Discussion

The aim of the current study was to investigate whether the risk of falls, as determined by predictors of functional ability, may be related to cognitive function in older individuals at risk of MCI. Our findings suggest that older individuals with higher dynamic balance, handgrip strength, or gait speed, as well as increased confidence in their balance or higher levels of education, demonstrated better cognitive function across most of the dimensions we assessed. Additionally, diminished dynamic balance emerged as a significant predictor of lower MMSE scores and decreased semantic fluency, while reduced gait speed was a strong predictor of reduced semantic fluency and language skills, even when controlling for educational level. Notably, the population showed a mean MMSE score that reflected that a proportion of the sample may have MCI, although these data should be treated with caution.

### 4.1. Dynamic balance

Poorer dynamic balance performance was connected to cognitive impairment and could be a risk factor for MCI in our sample. Along this line, the study by Greene and Kenny [30], which examined the relationship between quantitative parameters of the TUG and global cognitive function assessed to the MMSE, along with our present work, reported similar associations. However, in their case, participants with a low level indicative of dementia according to the test were excluded. In contrast, Katsumata et al. [31] concluded that the TUG was not related to MMSE scores in their healthy 80-year-old population, as did another study [32] with a population and methodology more similar to our study. The latter two studies [31,32] further categorized the sample into groups based on dynamic balance performance, as opposed to our use of continuous test values. There appears to be no definitive consensus on this relationship. However, if we expand our examination with more tests on functional decline that inform about the risk of MCI, more evidence points toward an identifying and useful role for the TUG [33,34].

The relationship between dynamic balance and phonetic fluency, semantic fluency, and language was also investigated. Our results indicated that older individuals with better balance performance achieved better on these cognitive dimensions but there was no evidence for phonetic fluency. It is worth noting that previous research studies showed a relationship between TUG achievement and verbal fluency in aged individuals with and without MCI, with more studies on phonologic [31,35,36] than semantic fluency [35]. The lack of significance in the relationship with phonetic fluency in this study may have been because, although both types of verbal fluency are important components of language and communication, they focus on different aspects of language processing [37]. In the semantic fluency test, category premises, and thus, access to the semantic lexicon, have an influence [37]. This may result in a greater variety of responses and a better ability to detect cognitive function than phonological fluency in a population that does not exhibit word production problems, such as aphasia. Furthermore, there is no evidence of a relationship between lexical retrieval difficulties as a measure of language using the BNT and balance, as is the case for other physical aptitudes [38]. Therefore, this article provides a novel finding for further exploration.

In brief, dynamic balance tests may be effective in the clinical setting to detect cognitive decline in the aging stage. Moreover, future research should verify the association in older people between dynamic balance and semantic fluency and language, with the latter mainly assessed by the BNT.

### 4.2. Gait Speed

The link between gait performance and cognitive ability in aging has received increased attention due to studies that demonstrated that gait is not solely a motor activity but also involves cognitive processes [39]. In line with the aforementioned findings on dynamic balance, our results also indicate that higher gait performance was associated with better cognitive function, except for phonological fluency. On one hand, lower gait speed is strongly linked to more significant overall cognitive decline, as assessed by MMSE performance [40]. However, a recent study [34] that compared gait to other physical skills demonstrated a stronger association with dynamic balance in healthy older individuals and those with MCI. On the other hand, the relationship between gait speed and verbal fluency appears more complex. Semantic fluency was found to be correlated in one study [41] but not in another [42], while for phonological fluency [42], no significant relationship was observed, aligning with our findings. A possible explanation for the lack of connection between gait and phonological fluency might be similar to the relationship with dynamic balance. Indeed, dynamic balance and gait are closely interconnected, as gait involves effective dynamic balance. Moreover, both have an indirect link with cognitive flexibility, as the latter may influence a person's ability to adapt to changing situations where gait and dynamic balance become more crucial.

Furthermore, the specific relationship between gait and the BNT is not consistently supported. Although gait speed is the gait parameter most strongly studied with cognitive function, regarding its association with language performance according to the BNT, Valkanova et al. [38] observed that longer stride length was related to better language proficiency.

In short, gait speed testing, like dynamic balance, could be a practical tool for detecting cognitive impairment in the aging. On the other side, more studies should clarify the relationship between gait speed and verbal fluency and specifically study the gait speed variable in relation to language.

### 4.3. Handgrip Strength

A previous study [40] documented a positive relationship between handgrip strength and global cognitive function, as evaluated by the MMSE, in healthy older individuals or those with MCI. Moreover, this relationship may carry more weight in women [43,44]. In contrast, our study found no such association, which aligns with the results of several recent investigations [45–47]. In a cross-sectional study conducted by Jin et al. [45], there was no evidence to suggest that increased handgrip strength led to higher global cognitive function. It is worth noting that our study, like Jin et al.'s [45], dealt with a relatively younger sample, around 60 years old, compared with octogenarian samples. This age difference may have reduced the sensitivity of the measurement tests in detecting cognitive and physical decline at these ages.

On the other hand, our findings regarding handgrip strength showed a positive relationship with improved phonological and semantic fluency, as well as language outcomes. These associations are quite novel, as they were scarcely studied previously, especially in the case of the association with semantic fluency, which has limited supporting evidence in certain cross-sectional and longitudinal studies [12,48].

Therefore, it is imperative to conduct additional investigations to solidify our understanding of the correlation between handgrip strength and cognitive function. Similarly, studies that investigate handgrip strength and its relationship with verbal fluency and language are needed to support our novel findings.

### 4.4. Balance Confidence

The findings of this research also demonstrated that stronger balance confidence in everyday tasks was associated with better verbal fluency and language skills but not with overall cognitive function. As far as we are aware, no prior studies explored the association between balance confidence and global cognition, and the dimensions of verbal fluency and language in healthy older individuals. Notably, a recent study [49] investigated such associations in aged individuals with MCI attributed to Alzheimer's and Parkinson's diseases. Several cognitive tests were administered to a sample of individuals aged over 60 years, with some of these tests overlapping with the assessments used in the present research. In contrast, the research paper by Chen et al. [49] reported a significant positive correlation only within the Alzheimer's group between performance on the MMSE test and balance confidence. The differences in characteristics between our study sample and that of Chen et al. [49] may have contributed to the divergent findings, as older individuals with Alzheimer's disease often have impaired perception of danger or incapacity [49].

In this context, current literature in healthy older adults [50] primarily investigates balance confidence in relation to physical function and does not explicitly focus on its relationship with cognitive function. Exploring this connection in future research may provide valuable insights into these outcomes and help elucidate the link between the perception of subjective balance and cognition.

### 4.5. Covariates

All controlled covariates, except BMI, partnered with cognitive function, and educational level influenced the relationships between cognitive function and risk factors for falls. It is widely acknowledged that educational level has a significant impact on cognitive function [51], and even on areas of physical function, including walking speed and strength in old age [38,48]. Formal education fosters the development of cognitive skills that can help individuals maintain better cognitive performance as they age [51]. Similarly, age, reflecting the aging process, and gender, which implies physiological differences in aging and even cultural disparities in access to education [51], also play roles.

BMI appears to have some connection with the progression of MCI in individuals [51]. However, in the present research, the sample was primarily composed of individuals who were overweight or obese, and this data distribution has not facilitated a precise study of the impact of BMI.

### 4.6. Limitations and Strengths

Admittedly, these findings should be cautiously interpreted, as the current research is limited in certain respects. Perhaps the most important limitation is the cross-sectional design, which prevents the establishment of causal associations. Notably, the limited number of male individuals in the sample did not allow for a balanced distribution of the sexes. Additionally, the majority of the sample was overweight or obese, which complicated the understanding of the impact of BMI on associations in older individuals.

However, despite the aforementioned limitations, this research possesses several strengths. Cognitive function was assessed across multiple dimensions using validated questionnaires. The physical tests employed to evaluate physical function are validated and suitable for the target population. Furthermore, cognitively relevant covariates were included, and the age of the sample is crucial for the early detection of MCI.

### 4.7. Implications and Future Research

The evidence presented in this paper implies that the strategies targeted at achieving a high level of physical functioning may be successful in mitigating the risk of MCI and preserving cognitive function in older individuals. Furthermore, our results also suggest that the assessment of dynamic balance and gait speed could be useful tools at the clinician level for the screening of cognitive impairment in aging people. Subsequent investigations should validate the associations observed within this particular age group and explore their long-term implications.

## 5. Conclusions

Increased gait speed, handgrip strength, balance, and balance confidence, which lead to a reduced risk of falls, contribute to improved cognitive performance overall, including the dimensions of verbal fluency and language, in individuals over the age of 60. Furthermore, the level of education seems to play a role as a confounding factor in these relationships. At the clinical implementation level, the assessment of dynamic balance and gait speed could be useful tools for the screening of cognitive impairment in aging people. Forthcoming studies ought to confirm the relationships identified within this specific age range and delve into their potential long-term consequences.

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