**Grip Strength, Fall Efficacy, and Balance Confidence as Predictors of Fall Risk in Community-Dwelling Older Adults**

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Abstract

**Background:** Falls are a major public health concern among older adults, often resulting in injury, functional decline, and reduced quality of life. While handgrip strength (HGS), fall efficacy, and balance confidence have individually been associated with fall risk, their combined predictive value remains underexplored, particularly in physically active older adults. This study aimed to investigate the relationship between HGS, fall efficacy, and balance confidence as predictors of fall risk in community-dwelling older adults engaged in regular exercise programs. **Methods:** A cross-sectional study was conducted with 280 participants aged 55 and over from community exercise programs near Lisbon, Portugal. Fall risk was assessed through self-reported falls in the past 12 months. HGS was measured with a dynamometer, fall efficacy using the Falls Efficacy Scale-International (FES-I), and balance confidence using the Activities-specific Balance Confidence (ABC) Scale. Statistical analyses included Spearman correlations and binary logistic regression. **Results:** Falls were reported by 26.4% of participants. Fall efficacy and balance confidence were significantly associated with fall history, while HGS was not a direct predictor. Fall efficacy showed a positive correlation with fall risk (OR = 3.37, p < 0.001), whereas balance confidence was negatively associated (OR = 0.95, p < 0.001). HGS was positively correlated with balance confidence but not with fall incidence. **Conclusion:** Psychological factors, particularly fall efficacy and balance confidence, play a critical role in fall risk among physically active older adults. These findings support the integration of simple, validated psychological assessments into fall prevention strategies in community settings.

**Keywords:** Fall risk, Fall Efficacy, Balance Confidence, Old Adults.

**Introduction**

During the aging process, numerous physiological changes occur, that can significantly compromise the functionality of older adults (Taffet, 2024). Of particular concern are age-related alterations in the sensorimotor control loop, which encompasses the vestibular, visual, and proprioceptive systems, all of which play a crucial role in maintaining balance and mobility (Reimann et al., 2020; Wang, Li, Yang, & Jin, 2024). Simultaneously, the musculoskeletal system undergoes progressive degeneration, characterized by a decline in muscle mass and strength, as well as reductions in bone mineral density due to demineralization (Agostini et al., 2023; Pignolo, Law, & Chandra, 2021). These cumulative physiological changes substantially increase the risk of falls among older adults.

Falls in older adults are a major global public health concern, as they are frequently associated with severe injuries, functional decline, and reduced quality of life. Approximately 30% of adults over the age of 65 experience at least one fall per year (Ganz & Latham, 2020), which translates into 17 million individuals living with fall-related disabilities annually (Montero-Odasso et al., 2022). Falls most commonly occur at home (Yosef, Pasco, Tembo, Williams, & Holloway-Kew, 2024), and are significantly more prevalent among women than men (Elias Filho et al., 2019). Given the profound personal and societal consequences of falls, the identification and mitigation of risk factors are essential in fall prevention strategies.

Multiple risk factors contribute to falls, which can be classified based on their origin into intrinsic (biological) and extrinsic (environmental) factors. Among the intrinsic factors, physical fitness is particularly relevant, with muscle strength emerging as a critical determinants in fall prevention (Simpkins & Yang, 2022). In this context, handgrip strength (HGS) is widely recognized as a reliable indicator of overall muscular function and has been increasingly studied as a biomarker of healthy aging (Dos Santos et al., 2024). Evidence suggests that reduced HGS is associated with an increased risk of falls, making it a valuable tool in fall risk assessment and intervention planning.

Despite the growing evidence supporting the role of HGS, fall efficacy, and balance confidence in fall risk, few studies have examined these variables together as combined predictors in community-dwelling older adults. Furthermore, there is limited data specific to older adults actively engaged in structured exercise programs, which may influence both physical and psychological fall-related outcomes.

Beyond the physical repercussions of falls, psychological factors play a significant role in exacerbating mobility limitations in older adults. Fear of falling (FoF) is a well-documented psychological consequence that can have a profound impact on an individual’s confidence, activity levels, and overall quality of life, irrespective of prior fall experiences (Schoene et al., 2019). FoF can diminish older adults’ confidence leading to further balance, muscle strength, and overall quality of life (Alhwoaimel, Alshehri, Alhowimel, Alenazi, & Alqahtani, 2024). It is conceptually grounded in Bandura’s self-efficacy theory (Bandura & Wessels, 1994) which posits that self-perceived efficacy influences an individual's ability to perform daily tasks without fear of falling. Standardized instruments such as the Falls Efficacy Scale-International (FES-I) (Yardley et al., 2005) and the Activities-specific Balance Confidence Scale by Powell & Myers (Powell & Myers, 1995) have been developed to assess fall-related efficacy, providing valuable insights into psychological determinants of fall risk.

Importantly, balance confidence has been identified as an independent predictor of falls in community-dwelling older adults, regardless of physical function and other covariates, emphasizing its role in fall risk assessment and targeted interventions (Tsang, Leung, & Kwok, 2022). Research suggests that more than 70% of falls could be anticipated and potentially prevented through early identification of risk factors and timely intervention strategies (Nascimento, 2018). As such, integrating clinical assessments—including physical function tests and validated questionnaires—is strongly recommended for better understanding the risk factors associated with falls and how to prevent them more effectively.

Given the simplicity, low cost, and clinical applicability of the selected measures, their integration into primary care and community health settings may enhance early detection and intervention efforts aimed at reducing fall risk. Community-dwelling older adults, particularly those engaged in regular physical activity, may present distinct risk profiles compared to sedentary counterparts, warranting tailored assessment strategies. By simultaneously evaluating a physical (HGS) and two psychological constructs (fall efficacy and balance confidence), this study adopts a multidimensional approach that reflects the complex nature of fall risk in older populations.

In this context, the present study aims to explore how HGS, fall efficacy, and balance confidence can serve as predictors of fall risk in older adults. These three measures were selected due to their ease of application in clinical settings and their potential for replication in community-based environments.**Materials and Methods**

This is a cross-sectional study, conducted as part of the Stay Up - Falls Prevention Project, which evaluates variables related to fall risk in older adults. The study received ethical approval from the Ethics Committee of the Piaget Institute (nº P02-S40-11/01/2023). All participants provided **written informed consent** before enrollment. The study ensures **data anonymity** and follows the **ethical principles outlined in the Declaration of Helsinki**, the Belmont Report and the Ethics Standards in Research in Sport and Exercise SciencesIn compliance with the data protection guidelines established by the Ethics Committee, all data will be stored in paper format during the research period (five years). After this period, the paper records will be destroyed, and only the electronic database will be retained for potential use in future research.

**Participants**

Participants were recruited from a community exercise program organized by a municipal council near the Lisbon region, Portugal. To be eligible for the study, participants had to be 55 years or older, physically active in the community, and attend the community exercise program at least twice a week. Additionally, they needed to be able to move independently without assistance. Individuals with contraindications for physical exercise or those unable to perform the physical tests on the evaluation day were excluded.

**Instruments and Variables**

Anthropometric and demographic data including weight, height, sex, age, number of comorbidities, and number of medications were collected. Height was measured using a 337 x 2165 x 590 mm dry stadiometer (GmBH & Co, Hamburg, Germany), while weight was assessed with a SECA 761 anthropometric scale (Bacelar & Irmão Lda, Portugal).

**Assessment of falls**

Participants' fall history was assessed according to the American Geriatrics Society & British Geriatrics Society (2011) by answering the following questions: (1) In the past 12 months, how many times have you fallen?; (2) If yes, the interview continued with the following question: Have you required medical attention?; (3) Have you had any difficulty walking or balancing as a result?

**Grip Strength**

The HGS was assessed using a manual dynamometer. This equipment provides reliable and accurate data (*Rho = ,8764 p < .001*), Godoy et al. (2004).The protocol involved taking the best result from three attempts on the dominant hand after adjusting the dynamometer to the participant's hand size. The test was conducted in a standing position, with the arm in a neutral rotation position, and the elbow fully extended (Reijnierse et al., 2017). Participants were instructed to squeeze the manual dynamometer to 100% of their maximum force for 3 seconds, enough time to collect data on the dynamometer.

**Balance Confidence**

Balance confidence was assessed by the Activities-specific Balance Confidence (ABC) Scale. This scale was designed to evaluate balance in a range of daily living activities (ADLs), which include various challenges. It was administered through a personal interview aimed at characterizing the individual's confidence in performing 16 Activities of daily living (ADL). For each ADL, confidence was measured by selecting a percentage value on the scale, ranging from 0% (no confidence) to 100% (complete confidence), yielding a total score between 0 (minimum) and 1600 (maximum). This total score was then divided by 16 to obtain the final score for each individual. A score greater than 80% indicates a high level of physical functioning; a score between 50-80% indicates moderate physical activity; and a score below 50% suggests low physical activity levels and a high risk of falling (Powell & Myers, 1995). The Portuguese version was validated by Branco et al. 2010 (Branco, 2010).

**Fall Efficacy**

The Fall Efficacy Scale-International (FES-I) was used to assess an individual's concern about the possibility of falling during 16 daily activities. For each activity, participants were asked to rate their level of concern using a scale that ranges from 1 (not concerned at all) to 4 (very concerned). The total score can range from 16 to 64, with a higher score indicating greater concern about falling. Scores above 40 indicate a high level of concern about falling, while scores below 20 suggest low concern, and scores between 20 and 40 reflect varying levels of fear or confidence. For analysis in this study, the mean value of the scale was used. This scale is commonly used to identify individuals at risk of falling and guide interventions aimed at improving balance and confidence (Yardley et al., 2005). The Portuguese version of the FES-I was validated by Marques-Vieira et al (2018) (Marques-Vieira, Sousa, Sousa, & Berenguer, 2018).

**Statistical Analysis**

The data was analyzed using IBM SPSS Statistics software version 28.0.1.0 (IBM, 2023). According to the central limit theorem (N=280), it was assumed that the distribution of the variables resembled a normal distribution. The data is presented as mean ± standard deviation and, where applicable, minimum and maximum values.

The “risk of falling” variable will be determined based on the answer to the 1st question of the guidelines proposed by the American Geriatrics Society & British Geriatrics Society (2011) and will be coded as 0 - Absence of falls and 1 - Presence of at least 1 fall in the last 12 months. Differences between the two groups for the variables included in the study were analyzed using Student's t-test. The association between the variables was analyzed using Spearman's correlation. Binary logistic regressions were carried out to verify the influence of grip strength, balance confidence and fall efficacy on the risk of falling. Statistical significance was set at 5% (α < 0.05).

**Results**

The characteristics of the sample are presented in Table 1. Significant differences between sexes were observed for weight (p<0.001) and height (p<0.001), as expected, as well as for the number of medications (p=0.047), with males consuming more medications than females.

Table 1- Sample Characteristics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables** | **Total**  **(n=280)** | **Male**  **(n=69)** | **Female**  **(n=211)** | **p-value** |
|  | **M(SD)** | **M(SD)** | **M(SD)** |  |
| **Age (years)** | 71.88 ± 5.35 | 73.07 ± 6.10 | 71.49 ± 5.04 | 0.055 |
| **Weight (kg)** | 68.56 ± 11.32 | 75.19 ± 10.84 | 66.40 ± 10.64 | <0.001 \* |
| **Height (m)** | 1.58 ± 7.54 | 1.67 ± 6.65 | 1.55 ± 5.69 | <0.001 \* |
| **BMI (kg/m2)** | 27.29 ± 4.02 | 27.21 ± 3.93 | 27.32 ± 4.06 | 0.084 |
| **Nº Medications** | 3.38 ± 2.66 | 3.93 ± 2.99 | 3.20 ± 2.53 | 0.047 \* |
| **Nº Comorbidities** | 2.45± 1.90 | 2.81 ± 2.56 | 2.33 ± 1.62 | 0.147 |

M- Mean; SD – standard deviation; BMI – Body mass index. \* Differences between sexes (p<0.05).

The table 2 presents the characteristics related to fall risk. Notably, females experienced more falls than males in the last 12 months.

Table 2- Characteristics of the fall risk

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Total**  **(N=280)** | **Male**  **(N=69)** | **Female**  **(N=211)** |
|  | **± SD Min-Max** | **± SD Min-Max** | **± SD Min-Max** |
| **Nº Falls in the last 12months** | 0.52±1.25 0-10 | 0.26±0.61 0-3 | 0.61±1.38 0-10 |
| **Falls in the last 12months F(%)**  Yes  No | 74 (26.4%)  206 (73.6%) | 13 (18.8%)  56 (81.2%) | 61 (28,9%)  150 (71.1%) |
| **Require Intervention F(%)**  Yes  No | 21(7.5%)  259 (92.5%) | 6 (8.7%)  63(91.3%) | 15 (7.1%)  196 (92.9%) |
| **Have balance/gait problems F(%)**  Yes  No | 116(41.4%)  164(58.6%) | 21 (30.4%)  48 (69.6%) | 95 (45%)  116 (55%) |

F (%)- Frequency (percentage)

The analysis of the table 3 reveals significant differences in HGS between males and females (p<0.001), with males demonstrating stronger grip strength. No significant differences were found between sexes for balance confidence (p=0.27) or fall efficacy (p=0.65).

Table 3. Descriptive analysis of grip strength, balance confidence and fall efficacy

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Variables** | **Total (N = 280)** | | **Male (N = 69)** | | **Female (N = 211)** | | **p** |
| **M (SD)** | **Min – Max** | **M (SD)** | **Min - Max** | **M (SD)** | **Min - Max** |  |
| **Grip Strenght** | 24.80±7.19 | 10.40-50.60 | 33.43±7.38 | 12.40-50.60 | 21.98±4.30 | 10.40-35.70 | <0,001\* |
| **Balance Confidence** | 85.00±13.54 | 17.5- 100,0 | 88,76±12,29 | 41,25- 100,0 | 82,99±14,65 | 17,50– 100,0 | 0,27 |
| **Fall Efficacy** | 1.41±0.40 | 1,00- 3,5 | 1,33±0,36 | 1,00- 3,3 | 1,42±0,36 | 1,00 – 3,4 | 0,65 |

\* Statistically significant differences between males and females.

The correlations presented in table 4 show significant relationships between the variables. Specifically, falls are positively correlated with fall efficacy and negatively correlated with balance confidence and HGS. Notably, fall efficacy is strongly negatively correlated with balance confidence and grip strength, while balance confidence is positively correlated with HGS. All significant correlations are at the 0.01 level.

Table 4. Spearman's Correlation Coefficients Matrix between the Variables

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Fall in the last 12 month** | **Fall Eficacy** | **Balance Confidence** | **Grip Strenght** |
| **Fall in the last 12 month** | 1 | 0.222\*\* | -0.276\*\* | -0.157\*\* |
| **Fall Efficacy** | 0.222\*\* | 1 | -0.645\*\* | -0.261\*\* |
| **Balance Confidence** | -0.276\*\* | -0.645\*\* | 1 | 0.304\*\* |
| **Grip Strenght** | -0.157\*\* | -0.261\*\* | 0.304\*\* | 1 |

\*\*Spearman's correlation coefficients significant at the 1% level (p<0.01).

Grip strength does not significantly predict the outcome in either males or females. However, both fall efficacy and balance confidence are significant predictors, with higher fall efficacy increasing the likelihood of the outcome, while higher balance confidence decreases it.

Table 5. Logistic Regression Analysis of Predictors of Fall Risk.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | ß | **Sig** | **OR** | **CI** | | **p-value** |
|  |  |  |  | **Inf.** | **Sup.** |  |
| **Grip Strenght (female)** | -0.05 | 0.13 | 0.94 | 0.88 | 1.01 | 0.436 |
| **Constant** | 0.30 |  |  |  |  |  |
| **Grip Strenght (male)** | -0.03 | 0.438 | 0.96 | 0.89 | 1.05 | 0.125 |
| **Constant** | -0,38 |  |  |  |  |  |
| **Fall Efficacy** | 1.21 | <0.001 | 3.37 | 1.70 | 6.67 | <0.001 |
| **Constant** | -2.77 |  |  |  |  |  |
| **Balance Confidence** | -0.05 | <0.001 | 0.95 | 0.93 | 0.071 | <0.001 |
| **Constant** | 3.130 |  |  |  |  |  |

Legend: OR = Odds Ratio, CI = Confidence Interval, Sig = Significance, β = Regression Coefficient.

**Discussion**

This study aimed to understand how HGS, fall efficacy, and balance confidence could help predict fall risk in physically active older adults living in the community and regularly participating in structured exercise programs. Although HGS showed a positive correlation with balance confidence, it did not independently predict fall risk. In contrast, both fall efficacy and balance confidence were significantly associated with previous falls, highlighting the critical role of psychological factors in fall risk assessment, even in physically active older adults.

These findings reinforce what numerous studies have already emphasized: psychological factors play a decisive role in fall risk. For instance, a recent study by Prieto-Contreras et al. (2023) found that a score of 20 or higher on the FES-I scale was a strong indicator of fall risk in pre-frail older adults, with a specificity above 70%. Our data support these results as well, participants with higher concern about falling (or lower perceived efficacy) were more likely to report a fall in the previous year.

Another noteworthy aspect was balance confidence, assessed using the ABC Scale, which also proved to be a significant predictor. This aligns with the findings reported by Tsang et al. (2022), who identified low confidence as an independent risk factor for falls, even when controlling for physical variables. This is especially relevant, as it shows that older adults' perception of their abilities directly influences motor behavior, task safety, and ultimately, fall risk.

Although HGS is widely recognized as a functional marker and a proxy of healthy aging, it was not statistically associated with fall risk in our sample. This lack of a direct effect may be explained by the specific characteristics of our sample, all participants were physically active and engaged in regular exercise programs. As suggested by Rodrigues et al. (2023), muscular strength alone may not be enough to predict falls unless it is accompanied by agility and functional confidence. In their path model, strength influenced fall risk indirectly through agility and fear of falling. This suggests that more than strength in isolation, it is how it is applied in dynamic tasks, alongside perceived safety, that truly matters.

The literature also shows that HGS is more consistently associated with fall risk in frailer populations (Pahm et al., 2023). In more active populations like ours, a "ceiling effect" may occur, where participants have sufficient strength levels, making it harder to detect significant differences. Moreover, studies such as Ha et al. (2021) highlight that in active older adults, other factors, such as polypharmacy, comorbidities, and psychological conditions, play a more prominent role in fall risk than muscular strength alone.

It is also important to remember that fall risk is multifactorial. From Tinetti et al.’s (1988) classical work to more recent systematic reviews like Gillespie et al. (2012), it has been established that falls result from a combination of physical, environmental, sensory, and psychological factors. Our findings support this notion, showing that even among active individuals, psychological variables are crucial to understanding fall risk.

In this sense, the use of simple tools like the FES-I and ABC Scale proves extremely useful. These are easy-to-administer, low-cost instruments that are sensitive to changes in psychological status. This is particularly relevant in community settings, where quick and effective assessments are essential to identify vulnerable individuals and direct them to appropriate interventions.

It is also worth emphasizing that the multidimensional approach suggested in this study aligns with international recommendations, such as those from the Cochrane Review (Gillespie et al., 2010), which emphasizes the effectiveness of multifactorial fall prevention strategies. The integration of physical strategies with psychological components, such as enhancing confidence, reducing fear, and promoting self-efficacy, may be the key to more effective and sustainable interventions.

From a practical perspective, our findings suggest that healthcare and exercise professionals should incorporate psychological assessments in fall risk screening protocols, even for older adults who appear robust. Strategies such as dual-task training, balance-challenging exercises in safe environments, and even behavioral psychology techniques may help boost confidence and reduce fall-related anxiety.

An interesting contribution of this study is its focus on a population that is often underrepresented in fall risk research, active older adults. Most research focuses on frail or institutionalized populations, but it is increasingly clear that even the most active are not immune to falls. As noted by Montero-Odasso et al. (2022), functional independence may mask latent vulnerabilities that only become apparent under more challenging circumstances.

Clinical implications

Strengths, limitations, future studies

Naturally, this study has limitations. Its cross-sectional design prevents us from establishing causal relationships, only associations can be inferred. Furthermore, using self-report to assess fall history may introduce recall bias or underreporting, especially in cases where no injury occurred. Another limitation is the exclusive inclusion of physically active individuals, with no control group, which limits generalizability to more sedentary or institutionalized populations.

Additionally, contextual factors such as home environment, lighting, footwear, or social support were not assessed but may interact with individual risk factors in determining fall risk, as highlighted by Ha et al. (2021).

Future research should aim to develop more comprehensive predictive models that integrate physical, psychological, and environmental variables, for example, through the use of motion sensor–based predictive algorithms. Another possibility is to explore interventions specifically focused on improving confidence and self-efficacy and assess whether these psychological changes translate into fewer falls in the medium term.

**Conclusion**

This study highlights the importance of adopting a multidimensional approach to fall risk assessment among community-dwelling older adults. While HGS has been widely regarded as a key indicator of physical health and aging, our findings suggest that, in physically active populations, it may not independently predict fall risk. In contrast, psychological variables, namely fall efficacy and balance confidence, demonstrated strong predictive value, reinforcing the critical role of self-perception and confidence in the context of fall prevention.

These results underscore the need to incorporate psychological assessments into standard fall risk screening protocols, particularly in settings involving active older adults who may not exhibit obvious physical limitations. Simple and validated tools such as the FES-I and ABC Scale are effective in identifying individuals at greater risk, even when physical strength is preserved.

Moreover, the findings support international recommendations that advocate for multifactorial fall prevention strategies, which combine physical, psychological, and behavioral components. By doing so, interventions can be better tailored to the specific profiles of older adults, increasing their effectiveness and promoting healthier, safer aging in the community.

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