

The Mediating Role of Daily Living Autonomy in the Relationship Between Physical-Functional Fitness and Fear of Falling in Older Adults

Dina Mamede-Pereira

University of Coimbra

Timoteo Salvador Lucas Daca

Pedagogical University

Edson Gaspar Eduardo

University of Coimbra

Eduardo Carballeira

University of La Laguna

Francisco Rodrigues

`franciscobrodrigues@ipcb.pt`

Polytechnic Institute of Castelo Branco

Susana Isabel Vicente Ramos

University of Coimbra

Ana Maria Teixeira

University of Coimbra

Guilherme Eustáquio Furtado

Polytechnic Institute of Coimbra

Research Article

Keywords: Accidental Falls, Older Adults, Physical Functional Performance, Biosocial data

Posted Date: February 24th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-8620123/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Falls and Fear of Falling (FOF) are major public health concerns among older adults, impacting mobility, autonomy, and quality of life. This study aimed to investigate the multidimensional correlates of FOF, including clinical, cognitive, physical-functional, and functional autonomy factors, and to examine the mediating role of Instrumental Activities of Daily Living (IADL) in the relationship between physical function and FOF. A total of 278 older adults (mean age 81.9 ± 7.9 years) were assessed for sociodemographic, clinical, cognitive, nutritional, and physical-functional variables. Participants with higher FOF demonstrated greater comorbidity burden, higher depressive symptom scores, lower physical performance in most functional tests, and reduced IADL compared to those with lower FOF. Bivariate analyses showed moderate positive correlations of FOF with comorbidity burden ($r = 0.323$) and depressive symptoms ($r = 0.343$), and negative correlations with physical performance measures. Hierarchical regression revealed that IADL accounted for the largest incremental variance in FOF ($\Delta R^2 = 0.114$), highlighting its central role. Mediation analysis confirmed that IADL fully mediated the relationship between physical function and FOF (ACME = -5.46 , $p = 0.005$), suggesting that the impact of physical function on FOF operates primarily through functional autonomy. These findings emphasize the importance of integrating functional autonomy, physical performance, and clinical factors in fall prevention strategies. A multidimensional, biosocial approach may improve the identification of high-risk individuals and guide targeted interventions to enhance safety, independence, and quality of life among older adults.

1. Introduction

Falls among older adults remain a major public health concern, with profound implications for both healthcare systems and individual quality of life (Pereira et al., 2020). According to the World Health Organization, falls are a leading cause of injury-related morbidity and mortality among older adults, highlighting the urgent need for effective preventive strategies. Despite technological advancements, gaps persist in implementing solutions that are well-aligned with the needs, capabilities, and environmental contexts of older adults (Montero-Odasso et al. 2022).

Fear of Falling (FOF), defined as a persistent concern about falling (Tinetti et al. 1990), is a multifactorial phenomenon encompassing emotional, cognitive, and behavioral components, and can occur even in the absence of previous falls (Martínez-Arnau et al. 2021). FOF is associated not only with restricted mobility and reduced participation in daily activities but also with poorer physical performance, depressive symptoms, and functional decline (Mackay et al. 2021).

Recent evidence from our study confirms that older adults with higher FOF exhibit greater comorbidity burden, higher depressive symptom scores, and lower physical-functional performance across multiple domains, including lower and upper limb strength, aerobic capacity, and mobility (Choi et al. 2017; Jian-Yu et al. 2020). In contrast, cognitive performance and nutritional status showed weaker associations with FOF, while sociodemographic and anthropometric characteristics were largely unrelated (Martínez-

Arnau et al. 2021; Shirooka et al. 2016). These findings reinforce the multifactorial nature of FOF and its link to functional decline rather than merely demographic or anthropometric profiles.

From a biological perspective, impairments in strength, balance, gait, and aerobic capacity have been associated with higher levels of FOF, reinforcing a cycle of physical deconditioning and perceived vulnerability (W.-N. W. ; Huang et al. 2022). Psychologically, depressive symptomatology and reduced self-efficacy contribute to heightened fear and avoidance behaviors, further exacerbating functional decline (White et al. 2009). However, growing evidence suggests that functional autonomy, particularly the ability to perform instrumental activities of daily living (IADL), may represent a critical integrative dimension linking physical capacity, cognitive processing, emotional regulation, and environmental demands (Kekäläinen et al. 2023).

Functional autonomy reflects an individual's ability to perform complex daily tasks that require the integration of physical, cognitive, and social capacities, such as managing finances, shopping, or using transportation (Liao et al. 2015). Reduced IADL performance has been linked to greater FOF, suggesting that physical and cognitive limitations may increase perceived vulnerability through their impact on real-world functionality (Kim and Lee 2025a).

Recent studies also highlight the contribution of depressive symptoms and comorbidity burden to FOF (Berk et al. 2023), as well as the moderating role of physical function across multiple domains, including lower and upper limb strength, aerobic capacity, and mobility (W.-N. N. W. Huang et al. 2022). Moreover, regression analyses in older populations suggest that functional autonomy may mediate the relationship between physical performance and FOF, indicating that the effect of physical impairments on fear is largely explained by the individual's capacity to carry out complex daily activities (Rodrigues et al. 2025; Tabacchi et al. 2025).

Specifically, this study aims to: (1) examine the biosocial correlates of FOF in older adults, (2) quantify the contribution of physical, cognitive, and clinical factors to FOF, and (3) explore the mediating role of functional autonomy in the relationship between physical function and FOF. We hypothesize that a multidimensional, biosocial approach will provide more accurate and actionable insights into fall risk, facilitating targeted interventions and better outcomes for this vulnerable population.

2. Materials and Methods

2.1 Study design

This research was structured as a cross-sectional study focused on older adults residing in CHS, which offer both residential and healthcare services to seniors who need different levels of care and assistance (Teixeira et al. 2016). The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) (von Elm et al. 2008).

2.2 Participants selection criteria

Participants were selected using a non-probability convenience sample based on the geographical area of Coimbra, Portugal, from May 2019 to April 2020. Specific inclusion criteria were applied: (1) women; (2) aged over 60 years; (3) living in SHC; (4) controlled clinical condition/drug therapy according to medical information; and (5) voluntary participation in the study. Exclusion criteria were also applied: (1) presence of any health condition (e.g., severe cardiomyopathy, hypertension, uncontrolled asthmatic bronchitis, musculoskeletal conditions) that might prevent testing, as determined by medical decision; (2) clinically diagnosed mental illness; and (3) morbid obesity (body mass index ≥ 40).

2.3 Ethical aspects

Consent forms were distributed and signed by the directors of the social and healthcare centers (SHC), all participants, and their legal representatives. This study received approval from the Ethical Committee of the Faculty of Sport Science and Physical Education at the University of Coimbra (Reference code CE/FCDEF-UC/002082018 and) and complied with the Portuguese Resolution (Art. 4th; Law no 12/2005, 1st series). Additionally, the study adhered to the research guidelines for human subjects set forth in the Helsinki Declaration (Shrestha and Dunn 2020).

2.4 Measures

All sample variables were recorded using specific alphanumeric codes and were analyzed by the same member of the research team. Data quality was assessed using internal consistency reliability scores.

2.4.1 Biosocial status

Sociodemographic information included chronological age (a continuous variable), and educational level (assessed as a continuous variable). These data were collected using a questionnaire.

2.4.2 Anthropometric indexes

Body mass (kg) was measured using a portable scale (Seca®, model 770, Germany) with a precision of 0.1 kilograms. Height (m) was measured using a portable stadiometer (Seca Body Meter®, model 208, Germany) with a precision of 0.1 centimeters. Body mass index (BMI; kg/m^2) was calculated using the formula $[\text{BMI} = \text{weight}/\text{height}^2]$.

2.4.3 Comorbidities and daily medication use

The Charlson Comorbidity Index (CCI) was used to assess the occurrence of comorbidities among the older participants. The CCI score can be combined and/or adjusted for age and gender to create a single continuous variable, based on 19 comorbid conditions (Roffman et al. 2016). To assess current medication use, participants were asked whether they take more or fewer than three prescription drugs per day (Roffman et al. 2016). Polypharmacy was reported according to the Portuguese Classification System of Human Medicine (Simões et al. 2019).

2.4.4 Mental health status

The Center for Epidemiologic Studies Depression Scale (CES-D) is a 20-item scale that rates how often participants experienced symptoms related to depression (e.g., poor appetite, loneliness, restless sleep) over the past week (Simões et al. 2019). The response options range from 0 to 3, with total scores ranging from 0 to 60, where lower scores indicate fewer depressive symptoms. A cut-off score of 16 is used to identify significant depressive symptoms (Simões et al. 2019). The MMSE is scored out of 30 points, with scores below 24 indicating potential cognitive impairment. It is a quick and practical tool, typically taking 5–10 minutes to administer, making it suitable for routine use in clinical settings (Morgado et al. 2010).

2.4.5 Nutritional status

The Mini Nutritional Assessment (MNA) was used to evaluate nutritional status in relation to health behaviour. It consists of 18 questions, with a maximum score of 30 points. The MNA classifies participants into three categories: well-nourished ($MNA \geq 24$ points), at risk of malnutrition ($17 \leq MNA < 24$ points), and malnourished ($MNA < 17$ points) (Poínhos et al. 2021).

2.4.6 Fear of falling (FOF)

The fear of falling questionnaire were applied. Participants rated their concerns about falling while performing 10 activities of daily living on a scale from 1 to 10 points. Scores on the FOF range from 10 to 100 points, with lower scores indicating higher self-efficacy and less FOF (Figueiredo and Santos 2017). For analysis, the modal value was used to create two subgroups: (1) High FOF, for those scoring > 40 points, and (2) Low FOF, for those scoring ≤ 40 points. The sample's cutoff score was determined by the median value due to the absence of a validated cutoff point for the Portuguese population (Marques-Vieira et al. 2018).

2.4.7 Physical-Functional Fitness screen

The Senior Fitness Test battery was used to assess Physical- Functional Fitness (PFF), including the following assessments: lower body strength, measured by the 30-Second Chair Stand Test (30s-CS); upper body strength, measured by the 30-Second Arm Curl Test (30s-AC); lower-body flexibility, measured by the Chair Sit-and-Reach Test (CSR); upper-body flexibility (shoulder girdle), measured by the Back Stretch Test (BST); agility and dynamic balance, measured by the 8-Foot Up-and-Go Test (8-FGT); and aerobic endurance, measured by the 2-Minute Step Test (2m-ST) (Rickly and Jones 2013). Additionally, the Tandem Stance Balance Test (TSB) assessed static balance, requiring the participant to maintain a standing position with eyes open and one foot in front of the other for up to 30 seconds, with scores of 10 seconds or less indicating very poor static balance (Langhammer and Stanghelle 2015). Each functional test was performed in three repetitions, and the best score was used for analysis.

2.4.8 Composite Physical Function Score

A composite physical function score was created to represent overall physical performance using multiple objective functional tests. The score was derived from the following measures: 8-FGT, CSR, 30s-CS, 30s-AC, 2m-ST, BST, and TSB (Langhammer and Stanghelle 2015; Rickly and Jones 2013). All

variables were standardized into z-scores to account for differences in scale and measurement units. For tests in which higher values indicate poorer performance, scores were reverse-coded prior to standardization so that higher z-scores consistently reflected better physical function. The composite score was calculated as the mean of the standardized values, with higher scores indicating better overall physical function.

2.4.9 Instrumental and Independent daily life activities

The Lawton of Independent daily life activities (IADL) scale measures a broader range of socio-biological functions, assessing the ability to perform more complex tasks necessary for independent living, such as using the telephone, shopping, food preparation, housekeeping, laundry, transportation, managing medications, and handling finances (Graf 2008). The IADL score ranges from 8 to 32 points, with higher scores indicating greater independence and lower scores indicating a higher level of dependency (Portela et al. 2020).

3. Statistical analysis

Continuous data were described using means and standard deviations. Comparisons of continuous variables between the two FOF subgroups were performed using either Student's *t* test or the Mann–Whitney *U* test, according to data distribution. Standardized differences between means were calculated using Cohen's *d* effect size (ES) and interpreted as follows: <0.20 (trivial), 0.20–0.59 (small), 0.60–1.19 (moderate), 1.20–1.99 (large), 2.00–3.99 (very large), and > 4.00 (extremely large) (Hopkins et al. 2009).

Pearson's or Spearman's correlation coefficients were computed, as appropriate, to examine bivariate associations between fear of falling and biosocial variables. To identify independent predictors of fear of falling and to examine the incremental contribution of different domains, a hierarchical linear regression analysis was conducted. Variables were entered in blocks according to theoretical relevance: anthropometric variables were entered in the first block, clinical and cognitive variables in the second block, physical-functional performance measures in the third block, and IADL in the final block. Changes in explained variance (ΔR^2) were evaluated at each step to assess the unique contribution of each domain.

A mediation analysis was subsequently conducted to examine whether functional autonomy of IADL mediated the association between physical function composite score and FOF. The analysis was performed using a regression-based approach with bootstrapping (5,000 resamples) to estimate indirect effects and their 95% confidence intervals. All statistical analyses were performed using R version 3.3.1 and IBM SPSS Statistics version 24.0

4. Results

Table 1 shows the characterization of total sample and comparison of biosocial variables between participants with higher and lower FOF. The sociodemographic and anthropometric variables did not

show significant statistical differences ($p > 0.05$). In terms of Clinical health status, participants with higher FOF scored significantly higher on the Charlson Comorbidity Index ($p = 0.05$) and the Depression scale (CES-D; $p = 0.01$).

Still and Table 1, cognitive performance assessed using the MMSE was also significantly different between groups, with higher scores in participants with higher FOF ($p = 0.05$). For physical-functional fitness indicators, participants with higher FOF performed worse in all tests, except for chair seated and reach and back starch test. Lastly, participants with higher FOF scored significantly higher on the Lawton of IADL scale ($p < 0.001$).

Table 1

– Participants characterization and Comparison of biosocial outcomes between Older Adults with Higher and Lower Fear of Falling

Biosocial variables	Total sample (n = 278)		Higher Fear of falling (n = 126)		Lower Fear of falling (n = 152)		p-value
Sociodemographic	M	SD	M	SD	M	SD	
Chronological age (years)	81.9	7.9	82.6	7.3	81.5	8.29	0.45
Education (years)	3.6	2.7	3.5	2.8	3.7	3.05	0.66
Anthropometric							
Weight (kg)	65.4	12.6	66.4	14.1	64.8	11.61	0.52
Height (m)	1.5	0.0	1.5	0.0	1.5	0.08	0.17
Body mass index (kg/m ²)	28.4	5.0	29.3	5.8	27.9	4.48	0.16
General Health Status							
Medication use per day (unit)	3.1	1.4	3.0	1.3	3.1	1.5	0.91
Charlson Comorbidity Index (0–10 points)	7.4	1.8	8.8	1.5	7.2	1.9	0.05
Depression of CES-D (0–60 points)	21.9	8.0	24.8	8.5	20.0	7.1	0.01
Mini-nutritional assessment (0–30 points)	24.3	2.3	23.5	2.5	24.8	2.1	0.12
Cognition profile of MMSE (0–24 points)	19.64	5.49	20.30	5.19	18.60	5.83	0.05
Physical-Functional evaluations							
8-foot-up and go test (seconds)	16.6	10.8	13.5	6.4	18.9	12.5	< 0.001
Chair Seated and Reach (centimeters)	34.8	14.5	34.4	17.7	35.1	12.2	0.68
Back Stretch Test (centimeters)	48.3	22.2	44.8	17.6	50.2	24.5	0.16
Notes: Depending on the data assumptions, the Student's or Mann-Whitney-U test was used to compare Fear of Falling Subgroups; M = mean; SD = standard deviation; ES = Effect size; CES-D = Center for Epidemiologic Studies for Depression.							

Biosocial variables	Total sample (n = 278)		Higher Fear of falling (n = 126)		Lower Fear of falling (n = 152)		p-value
30-seconds Chair Seated (per time)	8.5	3.5	7.5	3.8	9.1	3.25	0.05
30-second arm curl (per time)	10.7	4.3	9.4	3.6	11.6	4.5	0.04
2-minute step test (per time)	34.7	15.4	31.2	15.1	36.9	15.4	0.05
Tandem Stance Balance (seconds)	4.1	7.1	2.5	4.7	5.1	8.18	0.03
Lawton Instrumental of ADL	20.08	5.72	22.67	4.48	18.43	5.84	0.00
Notes: Depending on the data assumptions, the Student's or Mann-Whitney-U test was used to compare Fear of Falling Subgroups; M = mean; SD = standard deviation; ES = Effect size; CES-D = Center for Epidemiologic Studies for Depression.							

Bivariate correlation analyses revealed that fear of falling (FOF) was significantly associated with several biopsychosocial and functional variables. Higher levels of fear of falling were moderately correlated with a greater comorbidity burden (ICC; $r = 0.323$) and higher depressive symptoms (CES-D; $r = 0.343$). A strong positive correlation was observed between fear of falling and instrumental activities of daily living (IADL; $r = 0.430$), indicating that lower functional autonomy was associated with greater fear of falling.

In contrast, fear of falling showed significant negative correlations with multiple indicators of physical function, including the 30-second chair stand (30s-CS; $r = -0.331$), 30-second arm curl (30s-AC; $r = -0.252$), 2-minute step test (2m-ST; $r = -0.212$), and Timed Up & Go (TUG; $r = -0.208$), suggesting that poorer physical performance was associated with higher fear of falling. Weaker negative associations were also observed with flexibility (CSR; $r = -0.095$) and nutritional status (MNA; $r = -0.171$). No significant correlations were found between fear of falling and age, education, anthropometric measures (weight, height, BMI), medication use, or global cognitive status (MMSE).

A hierarchical linear regression analysis was performed to examine the contribution of multidimensional factors to FOF. In the first block, anthropometric variables explained a negligible proportion of variance in FOF ($R^2 = 0.005$). The inclusion of clinical and cognitive variables in the second block resulted in a statistically significant increase in explained variance ($\Delta R^2 = 0.085$, $p < 0.05$), raising the total explained variance to 9.0%.

The addition of physical-functional performance variables in the third block further improved the model ($\Delta R^2 = 0.068$, $p < 0.05$), with the cumulative explained variance reaching 15.8%. Despite these improvements, most physical performance measures did not retain independent significance in the fully

adjusted model. The IADL were entered in a separate final block, as they represent a higher-order functional construct that integrates physical capacity, cognitive demands, and environmental interaction, and are conceptually distinct from isolated physical performance measures. The inclusion of IADL resulted in the largest incremental increase in explained variance ($\Delta R^2 = 0.114$, $p < 0.001$), increasing the total explained variance to 27.2% (adjusted $R^2 = 0.181$).

Table 2
Hierarchical Linear Regression Models Predicting Fear of Falling

Model	Variables Entered	R ²	Adjusted R ²	ΔR^2
Block 1	Anthropometry variables	0.005	-0.021	—
Block 2	+ Cognitive, nutritional, comorbidities and medication use profile	0.090	0.032	0.085
Block 3	+ Physical-functional fitness tests	0.158	0.062	0.068
Block 4	+ Instrumental activities of daily life screen	0.272	0.181	0.114
Notes: Fear of Falling was treated as a continuous dependent variable. Variables were entered hierarchically according to theoretical relevance; ΔR^2 represents the change in explained variance at each step.				

Based on hierarchical linear regression results, a mediation analysis was conducted to examine whether IADL mediated the association between physical function and FOF. Path *a* represents the effect of the composite physical function score on IADL, path *b* represents the effect of IADL on FOF controlling for physical function, path *c* represents the total effect of physical function on FOF, and path *c'* represents the direct effect after accounting for IADL. The indirect effect ($a \times b$) reflects the extent to which physical function influences FOF via IADL. All coefficients are adjusted for age, cognitive, nutritional, and comorbidity and medication use.

The results indicate a significant indirect effect of physical function on FOF through IADL (ACME = - 5.46, $p = 0.005$), suggesting that better physical function is associated with lower fear of falling via greater functional autonomy. The direct effect of physical function on fear of falling was not significant after accounting for IADL (ADE = 0.12, $p = 0.978$), indicating that the relationship between physical function and fear of falling is largely explained by functional autonomy. Although the total effect was not statistically significant, the presence of a significant indirect pathway supports a full mediation pattern, consistent with contemporary mediation theory, which does not require a significant total effect when indirect effects are present.

Table 3
Mediation analysis using a composite physical function score, IADL and FOF variables

Effect	Estimate (B)	95% CI	p-value
Indirect effect (ACME)	-5.46	[-10.39, -1.59]	0.005
Direct effect (ADE)	0.12	[-7.41, 7.77]	0.978
Total effect	-5.35	[-13.35, 2.80]	0.197
Proportion mediated	0.86	[-6.12, 8.20]	0.198
Notes: ACME = Average Causal Mediation Effect. Confidence intervals were estimated using non-parametric bootstrapping with 5,000 resamples.			

Discussion

This study provides a comprehensive analysis of the multidimensional factors associated with FOF in older adults, integrating clinical, cognitive, physical-functional, and functional autonomy variables. Our results indicate that participants with higher FOF exhibit significantly greater comorbidity burden and depressive symptoms, along with lower physical-functional performance across several domains, including lower and upper limb strength, aerobic capacity, and mobility. In contrast, sociodemographic and anthropometric characteristics did not differ significantly between groups, highlighting that FOF is more closely linked to functional and clinical factors than to age, education, or body composition.

The observed differences between older adults with higher versus lower Fear of Falling (FOF) highlight how clinical and psychological factors distinguish individuals at greater risk. Participants with higher FOF not only exhibited a greater comorbidity burden and more depressive symptoms, but also performed worse across several physical-functional measures.

These results are consistent with recent evidence showing that multimorbidity and functional limitations are significant predictors of FOF, with physical dependence and reduced activity levels contributing to fear and avoidance behaviors in older adults (e.g., multimorbidity increasing both falls and FOF risk through functional impairment pathways) (Canevar et al. 2022). Such findings underscore the need for integrated clinical assessments that include psychological and functional dimensions, rather than solely demographic or anthropometric characteristics, to identify those at higher risk of fear-related activity restriction and functional decline (Si et al. 2025).

The results of bivariate correlation analyses further supported these findings, demonstrating moderate positive associations of FOF with comorbidity burden and depressive symptoms, and negative associations with physical performance measures (Mei et al. 2025). Notably, functional autonomy, assessed through IADL, showed the strongest correlation with FOF, emphasizing its central role in the fear-related experience of older adults. These results align with previous studies showing that limitations in complex daily tasks significantly contribute to reduced confidence and heightened FOF (Badrasawi et al. 2022; M. E. A. Pereira et al. 2024). Large community studies have documented that depressive

symptoms, functional independence, and physical performance collectively shape the FOF profile, contributing to both avoidance behavior and reduced engagement in daily activities among older adults (Si et al. 2025; Yang et al. 2025). This pattern suggests that interventions targeting depressive symptoms and physical capacity may have synergistic benefits for reducing FOF and improving overall function

The hierarchical regression analyses revealed that anthropometric variables alone explained a negligible portion of FOF variance, whereas clinical, cognitive, and physical-functional variables collectively increased the explained variance to 15.8%. Importantly, adding IADL as a higher-order functional construct produced the largest incremental gain, raising total explained variance to 27.2%. This finding underscores the pivotal role of functional autonomy in determining FOF, indicating that interventions aiming to reduce fear should focus not only on physical performance but also on maintaining or enhancing independence in daily activities (Brustio et al. 2018a; Sapmaz and Mujdeci 2021).

This mirrors recent findings in the literature where integrated models that combine physical, psychological, and functional measures account for a greater proportion of variance in FOF than isolated predictors (M. E. A. Pereira et al. 2024). Higher-order functional constructs like IADL capture the interaction between physical capacity, cognitive demands, and daily task performance, making them particularly salient in explaining fear-related outcomes (Kim and Lee 2025b). These results support the concept that FOF is not an isolated psychological state but a dynamic outcome of interconnected physiological and functional domains, necessitating comprehensive assessment strategies in clinical practice (Fang et al. 2024).

Mediation analysis provided further insight into the mechanisms linking physical function and FOF. The results indicate a significant indirect effect of physical function on FOF through IADL, whereas the direct effect was not significant. This pattern of full mediation suggests that the influence of physical function on fear is largely mediated by functional autonomy. In other words, physical impairments contribute to FOF primarily by reducing the ability to perform instrumental daily tasks, rather than through direct effects on fear itself.

For example, studies have demonstrated that mediators such as dual-task ability influence the effect of physical performance on daily functioning, underscoring that functional ability – rather than raw physical metrics alone – determines fear and avoidance tendencies (Brustio et al. 2018b). In another, the results clearly showed that subjective functional capacity mediated the association between FOF and health related quality of life (Gottschalk et al. 2020). This finding is consistent with contemporary models of FOF, which conceptualize it as an outcome influenced by the interaction of physical, cognitive, and functional capacities in real-life contexts (Mei et al. 2025).

Strengths and limitations

The strengths of this study include the multidimensional approach to assessing FOF, the integration of objective physical-functional measures, and the use of rigorous statistical analyses, including hierarchical regression and mediation modeling. These methods allowed us to identify not only the correlates of FOF but also the potential mechanisms through which physical impairments influence fear, providing clinically relevant insights for designing targeted interventions.

However, some limitations should be acknowledged. The cross-sectional design precludes causal inferences, and the generalizability of findings may be limited to similar populations of community-dwelling older adults. Additionally, some measures, such as cognitive performance, showed only weak associations with FOF, suggesting that other unmeasured factors—such as self-efficacy, balance confidence, or environmental hazards—may also contribute to fear of falling. Future longitudinal studies could clarify causal pathways and examine how interventions targeting functional autonomy may reduce FOF over time.

Practical applications

From a practical perspective, these findings have important implications for fall prevention programs. Interventions should not only aim to improve strength, balance, and mobility but also support the maintenance of functional independence in daily activities. Multidimensional assessment protocols incorporating physical, cognitive, and functional autonomy measures can help identify high-risk individuals and guide personalized interventions. Moreover, these results support the development of low-cost, accessible strategies in institutional and community settings, including structured exercise programs, occupational therapy, and assistive technologies that enhance independence in instrumental activities of daily living.

Conclusion

Fear of Falling in older adults is a multifactorial phenomenon strongly influenced by clinical status, depressive symptoms, physical-functional performance, and, most importantly, functional autonomy. Functional independence mediates the relationship between physical function and FOF, indicating that preserving autonomy in daily life is key to reducing fear. Multidimensional assessment and targeted interventions addressing both physical capacity and functional autonomy may enhance safety, mobility, and quality of life in older populations. These findings provide a basis for future research and practical applications in fall prevention strategies, emphasizing the centrality of functional autonomy in mitigating fear and promoting independence.

Declarations

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of University of Coimbra Ethics Committee under protocol number CE/FECDEFUC/0002013 and CE/FCDEF-UC/00112024.

Consent for Publication

Not applicable.

Competing Interests

The authors declare no competing interests.

Funding

There was no external funding for this study.

Author Contribution

AA contributed to the conceptualization, methodology, investigation, supervision, and writing of the original draft. BB contributed to the conceptualization, methodology, and writing – review and editing. CC was responsible for investigation, data curation, and formal analysis. DD and EE contributed to project administration and resource acquisition. FF contributed to statistical analysis, validation, and project administration. GG was responsible for formal analysis, data curation, and writing – review and editing. HH contributed to software development, visualization, and writing – review and editing. All authors reviewed and approved the final version of the manuscript.

Acknowledgments

Our research team expresses sincere gratitude to all the institutions that agreed to participate in our study. We would like to thank the EIT Health-supported Summer School “Mobility and Active Ageing,” held at the Faculty of Human Kinetics, University of Lisbon (2019), which emerged as the first-place winner in the Summer School competition, as well as the Polytechnic University of Coimbra - *Poliempreende* program for awarding our idea. The recognition and third-place award in the 20th edition of the regional competition of Coimbra (2023) were crucial in guiding the development of the project. The author, Guilherme Furtado, acknowledges the national funding from FCT - Foundation for Science and Technology, through the institutional scientific employment program (CEECINST/00077/2021).

Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

References

1. Badrasawi, M., Hamdan, M., Vanoh, D., Zidan, S., ALSaied, T., & Muhtaseb, T. B. (2022). Predictors of fear of falling among community-dwelling older adults: Cross-sectional study from Palestine. *PLOS ONE*, 17(11), e0276967. <https://doi.org/10.1371/JOURNAL.PONE.0276967>
2. Berk, M., Köhler-Forsberg, O., Turner, M., Penninx, B. W. J. H., Wrobel, A., Firth, J., et al. (2023). Comorbidity between major depressive disorder and physical diseases: a comprehensive review of epidemiology, mechanisms and management. *World Psychiatry*, 22(3), 366. <https://doi.org/10.1002/WPS.21110>
3. Brustio, P. R., Magistro, D., Zecca, M., Liubicich, M. E., & Rabaglietti, E. (2018a). Fear of falling and activities of daily living function: mediation effect of dual-task ability. *Aging & Mental Health*, 22(6), 856–861. <https://doi.org/10.1080/13607863.2017.1318257>
4. Brustio, P. R., Magistro, D., Zecca, M., Liubicich, M. E., & Rabaglietti, E. (2018b). Fear of falling and activities of daily living function: mediation effect of dual-task ability. *Aging & mental health*, 22(6), 856–861. <https://doi.org/10.1080/13607863.2017.1318257>
5. Canevar, J. B., de Souza Moreira, B., Danielewicz, A. L., & de Avelar, N. C. P. (2022). Are multimorbidity patterns associated with fear of falling in community-dwelling older adults? *BMC Geriatrics*, 22(1), 192. <https://doi.org/10.1186/S12877-022-02889-9>
6. Choi, K., Jeon, G. S., & Cho, S. (2017). Prospective Study on the Impact of Fear of Falling on Functional Decline among Community Dwelling Elderly Women. *International Journal of Environmental Research and Public Health*, 14(5), 469. <https://doi.org/10.3390/ijerph14050469>
7. Fang, W., Phung, H., Olley, R., & Lee, P. (2024). The Major Domains of Comprehensive Assessment Tools for Older Adults Requiring Home-Based Aged Care Services: A Systematic Review. *Healthcare (Switzerland)*, 12(23), 2468. <https://doi.org/10.3390/HEALTHCARE12232468/S1>
8. Figueiredo, D., & Santos, S. (2017). Cross-cultural validation of the Falls Efficacy Scale-International (FES-I) in Portuguese community-dwelling older adults. *Archives of Gerontology and Geriatrics*, 68, 168–173. <https://doi.org/10.1016/j.archger.2016.10.010>
9. Gottschalk, S., König, H. H., Schwenk, M., Jansen, C. P., Nerz, C., Becker, C., et al. (2020). Mediating factors on the association between fear of falling and health-related quality of life in community-dwelling German older people: a cross-sectional study. *BMC Geriatrics*, 20(1), 401. <https://doi.org/10.1186/S12877-020-01802-6>
10. Graf, C. (2008). The Lawton Instrumental Activities of Daily Living Scale. *AJN American Journal of Nursing*, 108(4), 52–62. <https://doi.org/10.1097/01.NAJ.0000314810.46029.74>

11. Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and science in sports and exercise*, 41(1), 3–13. <https://doi.org/10.1249/MSS.0b013e31818cb278>
12. Huang, W. N. N. W., Mao, H. F. F., Lee, H. M. M., & Chi, W. C. C. (2022). Association between Fear of Falling and Seven Performance-Based Physical Function Measures in Older Adults: A Cross-Sectional Study. *Healthcare (Switzerland)*, 10(6), 1139. <https://doi.org/10.3390/healthcare10061139>
13. Huang, W. N. W., Mao, H. F., ; Lee, H. M., ; Chi, W. C., Sala, A., Huang, W. N. W., et al. (2022). Association between Fear of Falling and Seven Performance-Based Physical Function Measures in Older Adults: A Cross-Sectional Study. *Healthcare*, 10(6), 1139. <https://doi.org/10.3390/HEALTHCARE10061139>
14. Jian-Yu, E., Mihailovic, A., Kuo, P. L., West, S. K., Friedman, D. S., Gitlin, L. N., et al. (2020). Characterizing the Impact of Fear of Falling on Activity and Falls in Older Adults with Glaucoma. *Journal of the American Geriatrics Society*, 68(8), 1847. <https://doi.org/10.1111/JGS.16516>
15. Kekäläinen, T., Luchetti, M., Sutin, A., & Terracciano, A. (2023). Functional Capacity and Difficulties in Activities of Daily Living From a Cross-National Perspective. *Journal of Aging and Health*, 35(5–6), 356–369. https://doi.org/10.1177/08982643221128929/SUPPL_FILE/SJ-PDF-1-JAH-10.1177_08982643221128929.PDF
16. Kim, J. H., & Lee, S. B. (2025a). Evaluation of Activities of Daily Living: Current Insights and Future Horizons. *Annals of Geriatric Medicine and Research*, 29(2), 143. <https://doi.org/10.4235/AGMR.24.0172>
17. Kim, J. H., & Lee, S. B. (2025b). Evaluation of Activities of Daily Living: Current Insights and Future Horizons. *Annals of Geriatric Medicine and Research*, 29(2), 143. <https://doi.org/10.4235/AGMR.24.0172>
18. Langhammer, B., & Stanghelle, J. K. (2015). The Senior Fitness Test. *Journal of Physiotherapy*, 61(3), 163. <https://doi.org/10.1016/j.jphys.2015.04.001>
19. Liao, Y., Shonkoff, E. T., & Dunton, G. F. (2015). The Acute Relationships Between Affect, Physical Feeling States, and Physical Activity in Daily Life: A Review of Current Evidence. *Frontiers in psychology*, 6, 1975. <https://doi.org/10.3389/fpsyg.2015.01975>
20. Mackay, S., Bs, K., Ebert, P., Harbidge, D. P., Pt, C., B. S., & Hogan, D. B. (2021). Fear of Falling in Older Adults: A Scoping Review of Recent Literature, 24(4).
21. Marques-Vieira, C. M. A., de Sousa, L. M. M., de Sousa, L. M. R., & Berenguer, S. M. A. C. (2018). Validation of the Falls Efficacy Scale – International in a sample of Portuguese elderly. *Revista Brasileira de Enfermagem*, 71(suppl 2), 747–754. <https://doi.org/10.1590/0034-7167-2017-0497>
22. Martínez-Arnau, F. M., Prieto-Contreras, L., & Pérez-Ros, P. (2021). Factors associated with fear of falling among frail older adults. *Geriatric Nursing*, 42(5), 1035–1041. <https://doi.org/10.1016/J.GERINURSE.2021.06.007>
23. Mei, D., Yang, Y., Meng, D., Hu, Y., & Wang, X. (2025). The Mediating Role of Activities of Daily Living in the Relationship Between Depressive Symptoms and Multidimensional Frailty in the Elderly with

- Multimorbidity. *Clinical Interventions in Aging*, 20, 1109. <https://doi.org/10.2147/CIA.S518492>
24. Montero-Odasso, M., van der Velde, N., Martin, F. C., Petrovic, M., Tan, M. P., Ryg, J., et al. (2022). World guidelines for falls prevention and management for older adults: a global initiative. *Age and Ageing*, 51(9). <https://doi.org/10.1093/ageing/afac205>
 25. Morgado, J., Rocha, C. S., Maruta, C., Guerreiro, M., & Martins, I. P. (2010). Cut-off scores in MMSE: a moving target? *European Journal of Neurology*, 17(5), 692–695. <https://doi.org/10.1111/j.1468-1331.2009.02907.x>
 26. Pereira, C., Bravo, J., Raimundo, A., Tomas-Carus, P., Mendes, F., & Baptista, F. (2020). Risk for physical dependence in community-dwelling older adults: The role of fear of falling, falls and fall-related injuries. *International Journal of Older People Nursing*, 15(3). <https://doi.org/10.1111/opn.12310>
 27. Pereira, M. E. A., Santos, G. S., de Almeida, C. R., Nunes, K. C. S., Silva, M. C. M. da, José, H. (2024). Association between Falls, Fear of Falling and Depressive Symptoms in Community-Dwelling Older Adults. *Healthcare 2024, Vol. 12, Page 1638*, 12(16), 1638. <https://doi.org/10.3390/HEALTHCARE12161638>
 28. Poínhos, R., Oliveira, B. M. P. M., Sorokina, A., Franchini, B., Afonso, C., & de Almeida, M. D. V. (2021). An extended version of the MNA-SF increases sensitivity in identifying malnutrition among community living older adults. Results from the PRONUTRISENIOR project. *Clinical Nutrition ESPEN*, 46, 167–172. <https://doi.org/10.1016/j.clnesp.2021.10.018>
 29. Portela, D., Almada, M., Midão, L., & Costa, E. (2020). Instrumental Activities of Daily Living (iADL) Limitations in Europe: An Assessment of SHARE Data. *International Journal of Environmental Research and Public Health*, 17(20), 7387. <https://doi.org/10.3390/ijerph17207387>
 30. Rickly and Jones (2013). *Senior Fitness Test* (2 nd.).
 31. Rodrigues, R. N., Pereira, D. M. M., Brito-Costa, S., Souza-Gomes, A. F., Cezar, N. O., de Greve, C., J. M. D., et al. (2025). Balancing on the edge of age: neuroendocrine, mental health and functional fitness correlates of fear of falling in older women. *Clinics*, 80, 100792. <https://doi.org/10.1016/J.CLINSP.2025.100792>
 32. Roffman, C. E., Buchanan, J., & Allison, G. T. (2016). Charlson Comorbidities Index. *Journal of Physiotherapy*, 62(3), 171. <https://doi.org/10.1016/j.jphys.2016.05.008>
 33. Sapmaz, M., & Mujdeci, B. (2021). The effect of fear of falling on balance and dual task performance in the elderly. *Experimental Gerontology*, 147, 111250. <https://doi.org/10.1016/j.exger.2021.111250>
 34. Shirooka, H., Nishiguchi, S., Fukutani, N., Tashiro, Y., Nozaki, Y., Hirata, H., et al. (2016). Cognitive impairment is associated with the absence of fear of falling in community-dwelling frail older adults. *Geriatrics & Gerontology International*, 17(February). <https://doi.org/10.1111/ggi.12702>. n/a-n/a
 35. Shrestha, B., & Dunn, L. (2020). The Declaration of Helsinki on Medical Research involving Human Subjects: A Review of Seventh Revision. *Journal of Nepal Health Research Council*, 17(4), 548–552. <https://doi.org/10.33314/jnhrc.v17i4.1042>

36. Si, H., Yuan, Y., Shi, Z., Wang, Y., & He, P. (2025). Longitudinal trajectories of disability index and associated factors in Chinese older adults. *The Journal of Nutrition Health & Aging*, 29(5), 100530. <https://doi.org/10.1016/J.JNHA.2025.100530>
37. Simões, P. A., Santiago, L. M., Maurício, K., & Simões, J. A. (2019). Prevalence Of Potentially Inappropriate Medication In The Older Adult Population Within Primary Care In Portugal: A Nationwide Cross-Sectional Study. *Patient Preference and Adherence*, 131569–1576. <https://doi.org/10.2147/PPA.S219346>
38. Tabacchi, G., Navarra, G. A., Scardina, A., Thomas, E., D'Amico, A., Gene-Morales, J., et al. (2025). A multiple correspondence analysis of the fear of falling, sociodemographic, physical and mental health factors in older adults. *Scientific Reports* 2025, 15:1(1), 6341. <https://doi.org/10.1038/s41598-025-89702-w>. 15.
39. Teixeira, A. M., Ferreira, J. P., Hogervorst, E., Braga, M. F., Bandelow, S., Rama, L., et al. (2016). Study Protocol on Hormonal Mediation of Exercise on Cognition, Stress and Immunity (PRO-HMECSI): Effects of Different Exercise Programmes in Institutionalized Elders. *Frontiers in Public Health*, 4. <https://doi.org/10.3389/fpubh.2016.00133>
40. Tinetti, M. E., Richman, D., & Powell, L. (1990). Falls Efficacy as a Measure of Fear of Falling. *Journal of Gerontology*, 45(6), P239–P243. <https://doi.org/10.1093/geronj/45.6.P239>
41. von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2008). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Journal of Clinical Epidemiology*, 61(4), 344–349. <https://doi.org/10.1016/j.jclinepi.2007.11.008>
42. White, K., Kendrick, T., & Yardley, L. (2009). Change in self-esteem, self-efficacy and the mood dimensions of depression as potential mediators of the physical activity and depression relationship: Exploring the temporal relation of change. *Mental Health and Physical Activity*, 2(1), 44–52. <https://doi.org/10.1016/J.MHPA.2009.03.001>
43. Yang, J., Song, G., Zhang, M., Liu, H., & Hou, M. (2025). Changes in daily living dependency and incident depressive symptoms among older individuals: findings from four prospective cohort studies. *BMJ Mental Health*, 28(1), e301749. <https://doi.org/10.1136/BMJMENT-2025-301749>

Figures

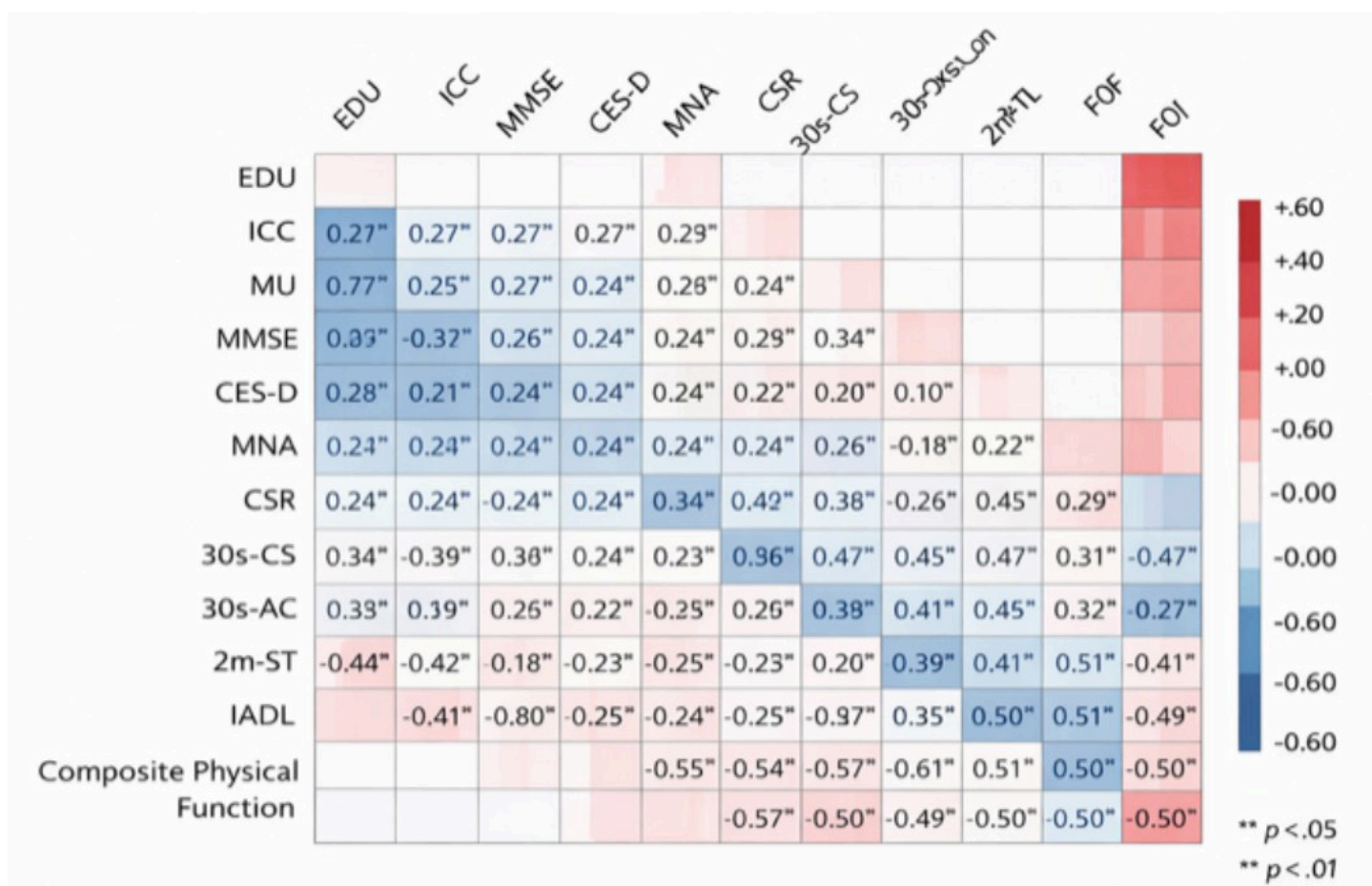


Figure 1

Horizontal bar chart showing Pearson correlation coefficients (r) between FOF and all variables. Positive correlations are shown in **blue**, negative correlations in **red**, and stronger correlations ($r \geq 0.30$) are highlighted in **green**. Numerical values of correlation coefficients are displayed adjacent to each bar for clarity. Abbreviations: EDU = Education; ICC = Comorbidity Index; MU = Medication Use; MMSE = Mini-Mental State Examination; CES-D = Depressive Symptoms; MNA = Mini Nutritional Assessment; CSR = Chair Sit-and-Reach; 30s-CS = 30-Second Chair Stand; 30s-AC = 30-Second Arm Curl; 2m-ST = 2-Minute Step Test; IADL = Instrumental Activities of Daily Living; TUG = Timed Up & Go Test.

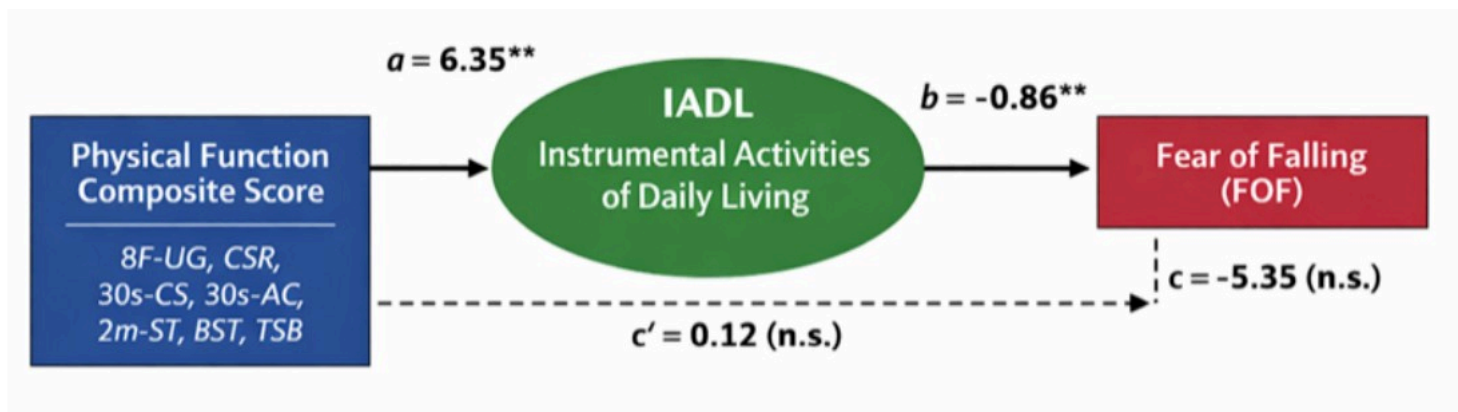


Figure 2

This figure illustrates the mediation model in which global physical function, operationalized as a composite z-score, influences FOF indirectly through functional autonomy. Indirect effects were estimated using non-parametric bootstrapping with 5.000 resamples.