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# Are multimorbidity patterns associated with fear of falling in community-dwelling older adults?

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## Abstract

**Background:** Multimorbidity is defined as the co-occurrence of multiple chronic or acute diseases and medical conditions in the same individual and can be grouped into different patterns based on the type of disease. These patterns are associated with poorer quality of life and premature death. It is believed that these patterns entail functional limitations, which may contribute to the fear of falling; however, this association remains unknown. Identifying this possible association is fundamental for developing individual and collective care approaches aimed at preventing the different patterns of chronic diseases in older adults in order to decrease the fear of falling. The objective of this study was to investigate the association between multimorbidity patterns and fear of falling in older adults.

**Methods:** This was a cross-sectional study including 308 older adults. The exposure variables were the presence of three multimorbidity patterns (cardiopulmonary, musculoskeletal, and vascular-metabolic) and pattern association assessed by self-report of two or more similar coexisting chronic diseases. The outcome was fear of falling assessed by the Brazilian version of Falls Efficacy Scale-International (cut-off point  $\geq 23$  points). Multivariable logistic regression was used to analyze the association between variables.

**Results:** Older adults with cardiopulmonary, musculoskeletal, vascular-metabolic patterns and pattern association had 3.49 (95%CI 1.13; 10.78), 2.03 (95%CI 1.13; 3.64), 2.14 (95%CI 1.20; 3.82), and 4.84 (95%CI 2.19; 10.68), respectively, greater chances of presenting fear of falling when compared to older adults without the patterns.

**Conclusions:** The presence of multimorbidity patterns is associated with higher chances of reporting fear of falling. It is emphasized that the introduction of public health programs aimed at preventing multimorbidity patterns is essential to reduce possible adverse health outcomes, including fear of falling and its negative consequences for older adult health.

**Keywords:** Accidental Falls, Aged, Fear of Falling, Independent Living, Risk Factors

## Background

Falls are the leading cause of death in older adults, representing a serious public health problem [1, 2]. The occurrence of falls in older adults negatively influences their quality of life, leading to disabilities in activities of daily living [3], predisposes them to develop anxiety and depression [4], reduces body balance [5], and contributes

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to developing fear of falling [6]. Fear of falling can be defined as an exacerbated concern about falling during daily activities [7], which shows high prevalence among community-dwelling older adults, being observed in 41.7% of Spanish older adults [8], 75.6% of Korean older adults [9], and 48.4% of Brazilian older adults [10].

Fear of falling is related to adverse health events such as increased depressive symptoms [11], reduction in physical activity [5], functional decline [12], and increased risk of falls [13]. Several conditions can predispose a person to fear of falling, among which are female sex [14, 15], a negative health self-perception [16, 17], environmental factors such as residing near garbage accumulation and/or open sewers and high crime rates [10], the presence of cognitive decline [4, 7], and multimorbidity [8, 15].

Multimorbidity can be defined as the coexistence of two or more chronic or acute diseases of multifactorial nature, limited to different physiological systems and associated with negative health outcomes, increased disability and decreased quality of life [18]. In this context, the influence of different patterns of diseases related to multimorbidity on negative outcomes in older adults has been investigated, which are usually classified into cardiopulmonary, musculoskeletal, and vascular-metabolic patterns [19]. Evidence shows that older adults with multimorbidity patterns have a greater chance of functional disability [20, 21], dementia [22], institutionalization [23], and mortality [24].

It is noteworthy that although no studies have been found so far that relate the different multimorbidity patterns with fear of falling in older adults, there are studies that have demonstrated the association of isolated diseases with this outcome [25–30]. According to these studies, fear of falling is associated with heart disease [25, 30] (cardiopulmonary pattern), joint diseases [29, 31] (musculoskeletal pattern), and obesity, diabetes mellitus, and systemic arterial hypertension [26–28] (vascular-metabolic pattern). However, there is no evidence whether the concomitant presence of diseases that have clinical and physiological manifestations in the same body system also negatively interferes with fear of falling.

Thus, considering all the negative repercussions of the fear of falling together with the high prevalence of chronic diseases in older adults, it is essential to study the different multimorbidity involvement patterns and their relationship with the fear of falling. It is believed that these results can help in screening and early identification of older adults who fit into multimorbidity patterns with greater associations with fear of falling, providing a choice of better strategies to prevent and cope with fear of falling in older adults. Thus, the present study aimed to investigate the association between multimorbidity

patterns and fear of falling in community-dwelling older adults.

## Methods

### Study design

This was a cross-sectional study with a probabilistic sample, carried out with older adults (60 years or older) of both sexes, registered in the health information system of Primary Care in the municipality of Balneário Arroio do Silva, Santa Catarina State, Brazil.

### Population and sample

The sample size calculation took into account the total older adult population registered in the municipality's Health System ( $n=2,833$ ). The unknown prevalence for the outcomes of 50%, confidence level of 95%, and sampling error of six percentage points were considered for the sample calculation, thus estimating the need for 302 volunteers for the study. Foreseeing possible sample losses, 540 older adult subjects were eligible to compose the sample.

The study inclusion criteria were men and women aged 60 years or older living in the urban area of the municipality of Balneário Arroio do Silva, Santa Catarina State, Brazil. Older adults bedridden, dependent, or unable to answer the questionnaires, those living in long-term care institutions, and those who had changed their residential address were excluded. Older adults who were not located at their homes after three attempts made on different days and times were considered losses, while those who refused to participate in the study were considered refusals.

The older adult participants received guidance on the research objectives and signed an informed consent form. This study was approved by the Ethics Committee on Human Research of the Universidade Federal de Santa Catarina (CAAE no.87776318.3.0000.0121).

### Data collection procedure

Data collection was conducted between the months of September 2018 and September 2019. The selected older adults were initially contacted by phone and invited to participate in the study, and then visits to their homes were scheduled. All interviewers were previously trained to standardize the evaluation methods of the objective measures to be performed.

### Outcome variable

Fear of falling was assessed by the Falls Efficacy Scale-International-Brazil (FES-I-Brazil) [32], which was previously translated and adapted by Camargos et al. (2010) for use in Brazilian older adults. This scale evaluates the concern about suffering falls when

performing 16 daily life tasks including simple activities such as dressing, undressing, and bathing, to more complex activities such as walking on uneven surfaces, going up or down stairs, and walking on slippery surfaces. The evaluated older adults were asked about their concerns on the possibility of falling when performing 16 activities. For each task, the score ranges from 1 to 4, and the total scale score can vary from 16 to 64 points [33]. The cut-off point established to discriminate high fear of falling in older adults in Brazil is a score equal to or greater than 23 [33]. This scale is a valid instrument to assess fear of falling in older adults with and without cognitive decline [34].

**Exposure variables**

The independent variables were the presence of three multimorbidity patterns considering the self-reported occurrence of two or more diseases with similar clinical characteristics [35, 36]. The participants were asked the following question: "A doctor or health professional has already said that you have/had the following diseases: chronic bronchitis or asthma, cardiac diseases, and tuberculosis (cardiopulmonary pattern) [36, 37]; arthritis or rheumatism, chronic back problems, and osteoporosis (musculoskeletal pattern) [36, 38]; systemic arterial hypertension, diabetes mellitus, stroke, cancer, and chronic renal failure (vascular-metabolic pattern)?" [35, 39]. The pattern association (i.e. having two or three patterns) was also analyzed in this study [40–42].

**Adjustment variables**

The following adjustment variables were used for this analysis: sex (female, male) [43]; age group (60–69 years, 70–79 years, ≥ 80 years); cognitive impairment assessed by the Mini-Mental State Examination (MMSE), translated and validated for Brazilian population [44]. The cut-off points for the classification of cognitive decline were proposed by Brucki et al. (2003) [45]: 20 points for illiterates; 25 points for people with 1 to 4 years of schooling; 26.5 points for those with 5 to 8 years of schooling; 28 points for those with 9 to 11 years of schooling, and 29 points for those with more than 11 years of schooling [8]; and sedentary behavior [ $<248.57$  min (low),  $\geq 248.57$  min (high) in sitting, lying down or reclining position] [46], as evaluated by the long version of the International Physical Activity Questionnaire (IPAQ), previously validated for the Brazilian population [47].

**Statistical analysis**

The data were independently tabulated by two researchers in the Microsoft Excel software program (2019), and were subsequently entered into the SPSS

database (IBM®, Chicago, IL, USA), version 23.0. The significance level adopted was 5%. Descriptive analyses were performed using absolute values and proportions (%). Crude and adjusted logistic regression analyses were performed to investigate the association between different multimorbidity patterns and fear of falling, estimating the odds ratio (OR) and their respective 95% confidence intervals (95%CI).

**Results**

A total of 308 community-dwelling older adults ( $69.67 \pm 6.99$  years) participated in the study. The sample was predominantly composed of women (57.8%), aged 60–69 years (54.7%), without cognitive impairment (80.0%), and with low sedentary behavior

**Table 1** Sociodemographic and lifestyle characteristics and multimorbidity patterns of community-dwelling older adults according to fear of falling (n = 308)

Variables	Total N (%)	Fear of falling	
		Low fear of falling N (%)	High fear of falling N (%)
Sex			
Female	178 (57.8)	73 (45.9)	102 (72.9)
Male	130 (42.2)	86 (54.1)	38 (27.1)
Age group (years)			
60–69	168 (54.7)	93 (58.9)	71 (50.7)
70–79	109 (35.5)	57 (36.1)	49 (35.0)
≥ 80	30 (9.8)	8 (5.1)	20 (6.7)
Cognitive impairment			
No	212 (80.0)	116 (80.0)	90 (80.4)
Yes	53 (20.0)	29 (20.0)	22 (19.6)
Sedentary behavior			
Low (< 248.57 min)	180 (58.4)	105 (66.0)	70 (50.0)
High (≥ 248.57 min)	128 (41.6)	54 (34.0)	70 (50.0)
Cardiopulmonary pattern			
Without pattern	288 (93.5)	154 (96.9)	126 (90.0)
With pattern	20 (6.5)	5 (3.1)	14 (10.0)
Musculoskeletal pattern			
Without pattern	200 (64.9)	121 (76.1)	72 (51.4)
With pattern	108 (35.1)	38 (23.9)	68 (48.6)
Vascular-metabolic pattern			
Without pattern	215 (70.0)	124 (78.0)	84 (60.4)
With pattern	92 (30.0)	35 (22.0)	55 (39.6)
Pattern association			
Without pattern	137 (44.6)	93 (58.5)	41 (29.5)
1 pattern	126 (41.0)	54 (34.0)	66 (47.5)
2 or 3 patterns	44 (14.3)	12 (7.5)	32 (23.0)

Legend: N: number; min: minutes.

(58.4%). The sample characterization is described in Table 1. The overall prevalence of fear of falling in the sample was 46.8%, with higher proportions among women (72.9%), aged 60–69 years (50.7%), without cognitive impairment (80.4%), and similar between low and high sedentary behavior groups (50.0%).

As for the multimorbidity patterns, 6.5% had the cardiopulmonary pattern, 35.1% the musculoskeletal pattern, 30.0% the vascular-metabolic pattern and 14.3% of the participants had more than one pattern at the same time.

The association between multimorbidity patterns and fear of falling is presented in Table 2. The adjusted logistic regression analysis showed that older adults with cardiopulmonary, musculoskeletal, vascular-metabolic patterns and pattern association had 3.49 (95%CI 1.13; 10.78), 2.03 (95%CI 1.13; 3.64), 2.14 (95%CI 1.20; 3.82), and 4.84 (95%CI 2.19; 10.68), respectively, greater chances of presenting fear of falling when compared to older adults without the patterns.

## Discussion

This study showed that older adults with multimorbidity patterns were more likely to be afraid of falling when compared to those who did not have the same patterns, even after adjusting for sociodemographic and behavioral variables. It is noteworthy that the chances of presenting fear of falling were 3.5 times higher for older adults with

cardiopulmonary diseases when compared to those who did not have the same involvement pattern.

Regarding the multimorbidity patterns, 6.5% of the older adults in this study presented a cardiopulmonary pattern, corroborating the findings of the National Health Survey conducted in Brazil in 2013, in which low prevalence was observed for this multimorbidity pattern (2.3%; 95%CI 2.0; 2.6) [35]. High prevalence rates of the cardiopulmonary pattern are observed in high population countries such as China (45.1%) and India (61.5%) due to the increase in chronic diseases such as COPD that occur due to high smoking and pollution rates [41]. A previous study has shown that older adults with COPD have a greater fear of falling (FES-I score > 25) than older adults without this condition (FES-I score < 20) [48]. This association can be explained by the fact that COPD patients have lower quadriceps femoris muscle strength, reduced physical activity, and balance deficits [48]. It is noteworthy that the cardiopulmonary pattern increased the chances of an older adult having fear of falling by 3.49 (95%CI 1.13; 10.78) in our study, corroborating other findings that demonstrated an association between diseases of the same pattern [25, 30]. Heart disease increased the chances of the older adults have fear of falling by 25% [25], which was associated with low confidence to perform physical activities and restricted activities of daily living and social activities; factors known to increase the fear of falling [30]. In addition, some conditions such as heart failure lead to reduced cardiac output and oxygen uptake in the muscle, which decreases aerobic capacity, leading the older adult to tire more easily and restrict their physical activities, thus increasing the fear of falling [49].

About 35.0% of the older adults in the current sample presented a musculoskeletal pattern; a lower prevalence compared with the findings of the study by Salazar et al. [50], in which the musculoskeletal pattern was present in 66% of Spanish adults. This difference in prevalence between studies may be because Salazar et al. [50] included individuals over 18 years in their sample and the determination of the prevalence of musculoskeletal conditions was not performed only for the older adult population. Moreover, older adults with a musculoskeletal pattern had 2.03 (95%CI 1.13; 3.64) higher chances of presenting fear of falling in the present study. This is due to the fact that this pattern is strongly related to rheumatic and joint diseases, which may increase the risk of older adults developing fear of falling [29, 35]. In addition, other studies show that musculoskeletal conditions such as pain and osteoporosis increase the chances of older adults presenting fear of falling by 1.76 (95%CI 1.02; 3.04) [51] and 2.04 (95%CI

**Table 2** Crude and adjusted logistic regression analyses between multimorbidity patterns and fear of falling in community-dwelling older adults

Variables	Fear of falling	
	Crude OR (95%CI)	Adjusted <sup>a</sup> OR (95%CI)
Cardiopulmonary pattern		
Without pattern	1.00	1.00
With pattern	3.24 (1.12; 9.37)	3.49 (1.13; 10.78)
Musculoskeletal pattern		
Without pattern	1.00	1.00
With pattern	2.70 (1.59; 4.61)	2.03 (1.13; 3.64)
Vascular-metabolic pattern		
Without pattern	1.00	1.00
With pattern	2.31 (1.34; 3.98)	2.14 (1.20; 3.82)
Pattern association		
Without pattern	1.00	1.00
1 pattern	2.85 (1.70; 4.78)	2.23 (1.29; 3.96)
2 or 3 patterns	6.13 (2.87; 13.12)	4.84 (2.19; 10.68)

<sup>a</sup>Adjusted for the variables sex, age group, cognitive impairment, and sedentary behavior. Legend: OR: odds ratio; 95%CI: 95% confidence interval

1.60; 2.60) [52], respectively. According to the literature, disorders such as pain or chronic conditions would exacerbate the disabling effect of fear of falling, as well as reduce healthy behaviors and patient compliance to treatment [53]. Recently, Meyer et al. [52] found that older adults with musculoskeletal disorders had greater joint instability, lower bone mass, frailty, and body balance deficits, all of which contributed to increased fear of falling.

Thirty percent of the older adults in the present sample presented a vascular-metabolic pattern, corroborating the findings in the study by Schmidt et al. [35], in which the prevalence for this pattern was 30.9% (95%CI 29.9; 31.9) for the Brazilian population. Furthermore, the vascular-metabolic pattern in the present study increased the chances of an older adult presenting fear of falling by 2.14 (95%CI 1.20; 3.82), also corroborating the findings which verified such association, but investigated diseases of this group separately [26, 27, 54, 55]. Neri et al. [56] demonstrated that obesity increased the chances of older adults having fear of falling by 30% ( $\pm 8.40$ ), which was associated with a higher risk of tripping, slipping, and falling among obese individuals, who prefer to remain at rest due to fear of falling [57]. In addition, obese individuals present lower balance due to anteriorization of the body mass center and altered sensory functions derived from the high body mass index, which increases postural oscillations, and consequently the fear of falling in this population [58].

Kelly et al. [26] investigated the association between diabetes mellitus and fear of falling, and found that diabetic individuals presented an 82.2% greater probability of fear of falling. This finding was associated with the fact that individuals with diabetes mellitus have worse gait performance, and therefore greater concern about falling [59]. Another important finding concerns reduced skin sensitivity in diabetics, which results in insecurity when performing activities of daily living and consequently greater fear of falling. Reduced skin sensitivity, especially in the plantar region, might lead to the balance deficit, which in turn, might affect older adults' confidence in stepping on uneven and/or sharp places and result in falls and fear of falling [26, 60]. In a study by Chang et al. [28], 50.0% of community-dwelling older adults with systemic arterial hypertension presented fear of falling, which was associated with low muscle strength, especially in the lower limbs (quadriceps femoris). In addition, older adults with systemic arterial hypertension were more likely to have mental disorders (anxiety and depression) that contribute to social restriction and physical limitation, which in turn favor the emergence of fear of falling [28].

It is noteworthy that the cardiopulmonary pattern was the most associated with fear of falling in this study when compared to the other patterns. This finding may be associated with the fact that cardiorespiratory conditioning can be reduced in older adults due to the senescence process and aggravated by the sedentary lifestyle adopted by many older adults [61]. Cardiorespiratory fitness, also affected by chronic conditions prevalent in older adults, such as COPD and chronic heart failure [62], is an important regulator of cerebral blood flow during physical activities [63]. Thus, when older adults who have cardiopulmonary diseases perform some functional activity such as walking, they may feel pre-syncope or be unable to perform such task due to extreme fatigue, consequently increasing the fear of falling, as highlighted in the study by McCarthy et al. [64].

Although the musculoskeletal and vascular-metabolic patterns have associations of lower magnitude with fear of falling than the cardiopulmonary pattern, these patterns present considerable odds ratios (around 2). In relation to the musculoskeletal pattern, its association with fear of falling may be due to muscle weakness, pain [65], and reduction in balance and proprioception [66]. Regarding the vascular-metabolic pattern, studies state that diseases related to this pattern are associated with the occurrence of falls and fear of falling due to different pathophysiological processes such as the increase in inflammatory biomarkers, which can trigger functional decline, reduced muscle strength, and gait changes, well-known factors that culminate in the fear of falling [67–69].

The association of two or three patterns increased the chances of the older adults reporting fear of falling. It is noteworthy that this finding corroborates previous studies [38, 70] and might be related to the fact that the presence of associated conditions in different systems can increase negative health self-perception, and culminate in frailty [71]. Frailty is considered a geriatric syndrome associated with several adverse health outcomes, including the fear of falling [72].

The originality is the greatest strength of the present study. To the best of our knowledge, this is the first study that proposed to examine the association of different multimorbidity patterns with the fear of falling in community-dwelling older adults. Thus, our results may help in proposing collective actions to prevent fear of falling directed to older adults with different multimorbidity patterns. For clinical practice, our findings can contribute to health professionals to carry out promotion and education actions on the multimorbidity patterns in a more specific way, aiming to

inform the older adults about the various negative health outcomes that fear of falling can cause.

One of the limitations of this study is the cross-sectional design, which is subject to reverse causality in the relationship between multimorbidity patterns and fear of falling. The fact that the sample, despite being probabilistic, was exclusively composed of older adult residents of the southernmost region of Santa Catarina State, Brazil, prevents extrapolating the results to populations of places with different sociodemographic and environmental characteristics. Finally, it is noteworthy that chronic diseases were collected through self-report, which may be subject to biases such as memory bias, thus preventing their clinical confirmation.

## Conclusion

Older adults with investigated multimorbidity patterns were more likely to have fear of falling compared to those who did not have the same patterns of diseases. It is noteworthy that public health programs aimed at preventing multimorbidity patterns are essential to reduce possible negative health outcomes related to fear of falling, especially falls that lead to functional limitations and increase the risk of death.

## Acknowledgments

The authors are grateful to the Municipal Health Secretariat and the professionals who work in the Basic Health Units of the municipality Balneário Arroio do Silva, Santa Catarina State, for assisting in conducting the project and facilitating contact with the sampled older adult population.

## Authors' contributions

JBC performed the data interpretation and major writing. BSM performed a critical review of the study. ALD performed data collection and interpretation and critical review of the study. NCPA performed the interpretation and collection of data and critical review of the study. All authors read and approved the final manuscript.

## Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Availability of data and materials

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

## Declarations

### Ethics approval and consent to participate

This study was approved by the Ethics Committee on Human Research of the Universidade Federal de Santa Catarina (CAAE nº87776318.3.0000.0121). Informed consent has been obtained from all participants. All procedures were performed in accordance with relevant guidelines. The older adult participants received guidance on the research objectives and signed a written informed consent form.

### Consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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Received: 14 October 2021 Accepted: 2 March 2022

Published online: 10 March 2022

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