STUDY OF ASSOCIATED FACTORS WITH RISK OF FALL IN FRAIL OLDER PATIENTS

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The frailty syndrome and fall risk go hand in hand in the ageing process, significantly affecting the quality of life in elderly patients. The purpose of this study was to explore factors related to fall risk in older patients with frailty syndrome. A cross-sectional study of older frail patients was conducted, at the National Geriatric Hospital. All patients were diagnosed as having frailty by using Freid's criteria. Factors associated with fall risk of older frail patients are age (greater or equal to 80 years old) (OR = 2.315), polypharmacy (OR = 2.784), depression (OR = 3.718), IADLs dependence (OR = 4.589), risk of malnutrition (OR = 2.089), lower limb strength (OR = 2.807) and cognitive impairment (OR = 4.559). An effective multidisciplinary strategy to prevent and reduce fall risks for older people having frailty is necessary, including intervention on polypharmacy, depression, dependences, malnutrition, low physical performance and cognitive impairments.

Keywords: Fall, risk of fall, frailty.

I. INTRODUCTION

Normal gait relies on coordination of neural components like the basal ganglia-brainstem system, regulated muscle tone, and sensory input (vision, hearing, proprioception). In older adults, gait function declines with age, compounded by medical issues and increased medication use. Aging typically leads to a wider gait, slower speed, shorter steps, and reduced lower limb strength. Falls often result from the interplay of these long-term factors with short-term environmental triggers, such as drug reactions, acute illness, or tripping on uneven surfaces.

Key risk factors for falls, ranked by evidence strength, include a history of falls, balance impairment, reduced muscle strength, vision problems, polypharmacy (over four medications) or psychoactive drugs, gait issues, depression, dizziness or orthostasis, functional limitations, age over 80, female gender, incontinence, cognitive difficulties, frailty, arthritis, diabetes, and pain.[1,2] Falls result from a complicated combination of risk factors.[3] The key risk factors encompass a wide range of health variables that have an impact on well-being, either directly or indirectly. These are divided into four categories: biological, behavioral, environmental, and socioeconomic influences.[4] As exposure to risk factors grows, so does the risk of falling and getting harmed.

Patients with frailty face higher risk of falling compared to individuals who are healthy.[1,5] The aim of this study was to explore factors related to fall risk in older patients with frailty syndrome. The results will give the basic knowledge to develop more effective and preventative strategies tailored to reduce fall risks for older people.

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II. MATERIALS AND METHODS

1. Subjects

Inclusion criteria

Older adults aged 60 and above diagnosed with frailty, examined and treated at the National Geriatric Hospital.

Exclusion criteria

- Unable to perform interviews.

- Were in an emergency situation (respiratory failure, acute myocardial infarction, acute stroke, liver failure, kidney failure, severe heart failure...).

- Did not agree to participate in the study (did not agree to perform clinical and paraclinical examinations, and motor tests).

2. Methods

Study design: A cross-sectional study was conducted at National Geriatric Hospital from 06/2023 – 10/2024.

Variables

Frailty

Frailty is evaluated according to the modified Fried criteria, which includes 5 criteria[6]:

- Weight loss (in the past 12 months).

+ Self-reported loss of 4.5kg.

+ Documented weight loss of ≥ 5% of total body weight.

- Gait speed (walking 4.5 metres): Slowness is determined by the time a patient takes to walk 15ft (4.5m). Maximum time allotments are defined by sex and height. Time values slower than expected meet the criteria for frailty.

Table 1. Cut-off point for the walking speed test by height

Male		Female	
Height	**Gait speed**	**Height**	**Gait speed**
≤ 173 cm	≥ 7 seconds	≤ 159 cm	≥ 7 seconds
> 173 cm	≥ 6 seconds	> 159 cm	≥ 6 seconds

- Grip strength (measure with a dynamometer): A dynamometer is frequently used to measure grip strength. The minimal grip strength values depending on BMI and sex are compared with the best of the three assessments. Frailty is defined as a value below the minimum threshold.

Table 2. Cut-off for grip strength based on BMI

Male		Female	
BMI (kg/m²)	**Grip strength (kg)**	**BMI (kg/m²)**	**Grip strength (kg)**
≤ 24	≤ 29	≤ 23	≤ 17
24.1 – 26.0	≤ 30	23.1 – 26.0	≤ 17.3
26.1 – 28.0	≤ 30	26.1 – 29.0	≤ 18
> 28	≤ 32	> 29	≤ 21

Physical exhaustion (Center for Epidemiological Studies Depression Scale): According to the Center for Epidemiological Studies Depression Scale, questions like "*I felt that everything I did was an effort in the past week*" and "*I could not get going in the past*

week" are used to gauge endurance.

- Low energy expenditure (per the Minnesota Leisure Time Physical Activity Questionnaire): Total kilocalories burned per week were calculated using the International Physical Activity Questionnaire (IPAQ). Participants who answered "*I rarely or never do any physical activity*" were considered Inactive.

Risks of fall

The FRI-21 is a questionnaire with 21 questions on risks factors for falls. The answer is ''Yes'' or "No''. Each item received a score of 1 (risk present) or 0 (risk absent), and the sum of all items ranged from 0 (low fall risk) to 21 (high fall risk), with higher scores indicating a higher fall risk. A cut-off point of ≥ 10 on the 21-item FRI-21 is useful for early detection of fall risk.[7]

Some factors related to risks of fall

Comorbidity: Using medical record, comorbidity was evaluated based on the Charlson Comorbidity Index (CCI). The severity of comorbidity was categorized: (1) no comorbidity, CCI score of 0; (2) mild, CCI scores of 1 - 2; (3) moderate, CCI scores of 3 - 4; (4) severe, CCI scores ≥ 5.[8]

Polypharmacy: A list of prescription drugs was collected from medical record. Polypharmacy was defined as the use of five or more drugs.

Depression: The Geriatric Depression Scale (GDS-15) includes 15 yes/no questions. The GDS-15 has a maximum score 15. A score greater than 5 suggests depression.[9]

Physical activities: will be evaluated by the International Physical Activity Questionnaire (IPAQ) and categorized into Low, Moderate and High.[10]

Functional ability was evaluated by the Lawton IADL scale (Instruments Activities Daily Living. A summary score ranges from 0 (dependence) to 8 (independence).

Sleep quality was assessed by using Pittsburgh Sleep Quality Index (PSQI).[11] The PSQI contains 19 self-rated questionnaires combining to 7 components, each ranging from 0 - 3 points. The scores range from 0 to 21 and a score > 5 was considered as poor sleep.

Nutritional status was evaluated by the short form of Mini Nutritional Assessment (MNA-SF) which consists of 6 questions.[12] The maximum score was 14. A score below 8: malnutrition, 8 - 11: malnutrition risk, and 12 - 14: normal nutritional status.

Lower limb strength: The Five Times Sit-to-Stand (5CST) test was used to measure functional strength in the lower limbs, and assess transitional movements, balance, and fall risk in older adults. A completion time of ≥ 12 seconds serves as a critical threshold to define lower limb impairment. [13]

Mental status: The Mini Mental State Examination (MMSE) was used to assess mental status.[14] Five areas of cognitive function were evaluated: orientation, registration, attention and calculation, recall, and language. The maximum score is 30. A score of 23 or lower is indicative of cognitive impairment.

Data analysis

Inferential statistics were applied to perform correlations between groups by univariable and multivariable regression (variables with $p < 0.2$ from the univariate logistic regression model were selected into the multivariate regression model). Statistical significance was accepted at the 95% confidence level ($p < 0.05$).

3. Research ethics

The research will respect the confidentiality and anonymity of all subjects. All participants provided with sufficient information about the research subject and are informed about the contents of the research. The research causes

no significant harm or threat to participants, physically and emotionally. The research is independent and impartial.

III. RESULTS

A total of 308 outpatients was recruited in the study, 14.6% experienced at least one fall in the past 12 months. Regarding fall risk, 56.5% of patients were classified as high risk. The average score on the 21-item Fall Risk Index (FRI-21) was 9.85 ± 3.83, indicating a moderate overall fall risk among the participants.

Table 3. Association between some socio-demographic factors and fall risk among older frailty patients

Variables	High fall risk (n = 174)	Univariate	Multivariate
		OR (95% CI)	AOR (95% CI)
Gender (vs. Male)			
Female	130 (58.6%)	1.349 (0.818 – 2.224)	
Age (vs. 60 – 69)			
70 – 79	68 (51.1%)	1.592 (0.851 – 2.978)	
≥ 80	83 (70.9%)	3.715 (1.919 – 7.190) *	2.315 (0.985 – 5.441) *
BMI (vs. Normal)			
Underweight	28 (63.6%)	1.275 (0.633 – 2.567)	
Overweight	65 (52.4%)	0.802 (0.493 – 1.305)	
Alcohol consumption (vs. No alcohol consumption)			
Yes	32 (50%)	0.718 (0.414 – 1.248)	

Table 3 shows the outcomes of the multiple logistic regression analysis. According to the data, individuals over 80 years of age were 2.315 times more likely to fall (95% CI: 0.985 – 5.441) than those between the ages of 60 and 69.

Table 4. Association between some geriatric factors and high risk of fall among older frailty patients

Variables	High fall risk (n = 174)	Univariate	Multivariate
		OR (95% CI)	AOR (95% CI)
Comorbidity (vs. No comorbidity)			
Mild	89 (57.4%)	1.637 (0.905 – 2.963)	
Moderate	44 (60.3%)	1.842 (0.928 – 3.657)	
Severe	13 (72.2%)	3.157 (1.003 – 9.934) *	1.161 (0.255 – 5.286)
Polypharmacy (vs. No polypharmacy)			
Yes	79 (50%)	1.727 (1.095 – 2.724) *	*2.784 (1.399 – 5.540)* *

Variables	High fall risk (n = 174)	Univariate	Multivariate
		OR (95% CI)	AOR (95% CI)
Depression (vs. No depression)			
Depression	61 (77.2%)	3.479 (1.936 – 6.251) *	*3.718 (1.655 – 8.353)* *
Physical activities (vs. Moderate)			
Low	142 (65.4%)	3.432 (2.052 – 5.740) *	1.770 (0.908 – 3.452)
Functional ability (vs. Normal IADL ability)			
IADL dependence	145 (71.1%)	6.356 (3.761 – 10.741) *	*4.589 (2.398 – 8.782)* *
Sleep quality (vs. Good sleep)			
Poor sleep	124 (60.8%)	1.674 (1.040 – 2.696) *	1.306 (0.696 – 2.449)
Nutritional status (vs. No malnutrition)			
Malnutrition	21 (61.8%)	2.126 (0.982 – 4.603)	
Risk of malnutrition	96 (67.6%)	2.746 (1.679 – 4.492) *	*2.089 (1.116 – 3.910)* *
Lower limb strength (vs. Normal lower limb strength)			
Impair	163 (59.5%)	3.070 (1.439 – 6.552) *	*2.807 (1.040 – 7.574)* *
Cognitive function (vs. Normal cognitive)			
Cognitive impairment	53 (88.3%)	7.947 (3.477 – 18.163) *	*4.559 (1.669 – 12.456)* *

Patients with polypharmacy had a 2.784 times higher risk of falling (95% CI: 1.399 – 5.540) compared to those without polypharmacy. Depression also significantly increased fall risk, with affected patients having a 3.718 times higher likelihood of falling (95% CI: 1.655 – 8.353). Patients with IADL dependence showed a 4.589-fold increase in fall risk (95% CI: 2.398 – 8.782) compared to those with normal functionality. Additionally, patients having a risk of malnutrition had a 2.089 times higher risk of falls (95% CI: 1.116 – 3.910) than well-nourished individuals. Elderly individuals with reduced lower limb strength were 2.807 times more likely to experience falls (95% CI: 1.040 – 7.574) than those with normal strength, and patients with cognitive impairment were 4.559 times more likely to fall (95% CI: 1.669 – 12.456) than those with normal cognitive function.

IV. DISCUSSION

The data from this study indicate that individuals over the age of 80 were 2.315 times more likely to experience a fall compared to those in the 60-69 age group (95% CI: 0.985 – 5.441). This finding underscores the growing risk of falls with increasing age, particularly among individuals with frailty, suggesting that older adults are more vulnerable to falling as they age. Supporting this finding, a study by Dias AL et al. (2023) also reported that adults over the age of 70 had nearly double the likelihood of experiencing a fall compared to younger individuals, with an odds ratio of 1.99 (95% CI: 1.12 – 6.13; $p < 0.00$).[1] This further reinforces the association between advanced age and an elevated risk of falls. The results from both studies highlight the critical role age plays in increasing fall risk, particularly in frail

older adults, emphasizing the need for targeted interventions and fall prevention strategies in this high-risk population.

The risk of falls among patients is influenced by a complex interplay of multiple geriatric factors, each contributing to an individual's overall vulnerability to falling. Individuals with polypharmacy were 2.784 times more likely to fall compared to those without polypharmacy (95% CI: 1.399 – 5.540). This finding underscores the potential dangers of polypharmacy often increases the likelihood of side effects that can impair balance, coordination, and cognitive function. Supporting these findings, a study by Dias AL et al. (2023) similarly demonstrated a strong association between polypharmacy and increased fall risk. Their research showed that adults who were taking five or more medications daily had a 2.23 times greater risk of falling.[1] The evidence from both studies strongly indicates that polypharmacy is a significant risk factor for falls. This is particularly concerning in the aging population, where multiple health conditions often require complex medication regimens. Reducing the number of medications prescribed, when possible, and monitoring for adverse effects may help mitigate this increased risk and enhance patient safety.

Depression was found to significantly increase the risk of falls, with patients who experienced depression having a 3.718 times higher likelihood of falling compared to those without depression. Similarly, research by Pu-Lin Yu et al. (2009) demonstrated comparable results, reporting that individuals with depression had a 4.27 times higher risk of falling than those without the condition.[2] While both studies highlight a clear relationship between depression and increased fall risk, the difference in the precise magnitude of this risk may stem from several factors, most notably the higher prevalence of falls observed in Yu et al.'s study, as well as their larger sample size. The larger sample size in Yu's study may have provided more statistical power, potentially leading to a more pronounced overall estimate of fall risk. Additionally, a higher prevalence of falls within their population might have influenced the risk estimates, as individuals in their study may have had more frequent fall-related events, further magnifying the impact of depression on fall risk.

Patients with IADLs dependence demonstrated a significantly higher risk of falling. Specifically, individuals with IADL dependence functionality were found to have a 4.589-fold increased risk of falling compared to those with normal IADL capabilities. This relationship between IADL dependence and fall risk has been further supported by the research of Luc TV et al. (2024), who investigated post-stroke patients and found that older adults with IADL impairments were significantly more likely to experience falls. In their study, older post-stroke patients with IADL impairment were significantly associated with an increased risk of falling (OR = 3.844).[15] This consistent association suggests that the ability to independently perform everyday tasks is closely tied to physical and cognitive health, both of which are critical to maintaining balance and preventing falls. The difference in fall risk estimates between these two studies can likely be attributed to the specific populations being studied. In my study, the focus was on frail patients, a group that is inherently at higher risk for falls due to factors such as muscle weakness, balance issues, and overall frailty.

Patients having a risk of malnutrition had a 2.089 times higher risk of falls than well-nourished individuals. Malnourished individuals are often weaker, more fatigued, and less able

to recover from physical stress, which can make them more susceptible to losing their balance or failing to react quickly enough to prevent a fall. However, this result contrasts with the findings of a study by Luc TV et al. (2024), which did not establish a clear relationship between malnutrition and fall risk. Their research did not find a significant association between malnutrition and increased likelihood of falls in the populations they studied, which raises questions about the consistency of this risk factor across different groups.[15] Given these contrasting results, further research is needed to better understand the relationship between malnutrition and fall risk.

Lower limb strength was another critical factor influencing fall risk. Elderly individuals with reduced lower limb strength were found to be 2.807 times more likely to experience a fall than those with normal lower limb strength (95% CI: 1.040 – 7.574). Lower limb strength is essential for maintaining balance, stability, and mobility, and its decline in older adults is a key contributor to falls. This finding highlights the need for targeted interventions such as strength training and physical therapy to preserve or improve lower limb strength in older populations, thereby reducing fall risk.

Patients with cognitive impairment were found to be significantly more likely to experience a fall, higher risk of falling compared to individuals with normal cognitive function Interestingly, this finding is consistent with the results from a study by Xiaojing Guo et al. (2023), which also showed that individuals with cognitive frailty had a significantly higher risk of falling. In their study, cognitively frail participants were found to have a 3.02 times higher risk of falls (OR = 3.02, 95% CI: 2.11 – 4.32) compared to robust participants without any cognitive impairment.[16] The similarity in findings between the two studies further supports the notion that cognitive impairment is an independent risk factor for falls. Both studies emphasize that cognitive frailty can significantly increase fall risk, potentially due to the combined effects of diminished cognitive function and reduced physical capacity.

The study had some limitations. This was a cross-sectional study, therefore the results can not emphasized the causual relationship between fall and some associated factors. The study was conduted on a large number of study population in one central hospital. It should be careful to generalize the results to the community setting.

V. CONCLUSION

The fall risk among frailty patients may be linked to factors such as advance age, polypharmacy, depression, functional ability, nutritional status, lower limb strength, and cognitive function. Conduct regular assessments of fall risk in elderly individuals with frailty syndrome is necessary in clinical practice.

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REFERENCES

1. Dias ALP, Pereira FA, Barbosa CPdL, et al. Fall risk and the frailty syndrome in older adults. *Acta Paulista de Enfermagem.* 2023;36:eAPE006731.

2. Pu-Lin Y, Zhao-Hui Q, Jing S, et al. Prevalence and related factors of falls

among the elderly in an urban community of Beijing. *Biomedical environmental sciences.* 2009;22(3):179-187.

3. Bartosch PS, Kristensson J, McGuigan FE, et al. Frailty and prediction of recurrent falls over 10 years in a community cohort of 75-year-old women. *Aging clinical experimental research.* 2020;32:2241-2250.

4. Montero-Odasso M, Van Der Velde N, Martin FC, et al. World guidelines for falls prevention and management for older adults: a global initiative. *Age ageing.* 2022;51(9):afac205.

5. Pi H-Y, Hu M-M, Zhang J, et al. Circumstances of falls and fall-related injuries among frail elderly under home care in China. *International journal of nursing sciences.* 2015;2(3):237-242.

6. Fried LP, Tangen CM, Walston J, et al. Frailty in older adults: evidence for a phenotype. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences.* 2001;56(3):M146-M157.

7. Wada T, Ishimoto Y, Hirosaki M, et al. Twenty-one-item fall risk index predicts falls in elderly community-dwelling Japanese. *J Am Geriatr Soc*. 2009 Dec;57(12):2369-71 2009.

8. Charlson M, Szatrowski TP, Peterson J, et al. Validation of a combined comorbidity index. *Journal of clinical epidemiology.* 1994;47(11):1245-1251.

9. Greenberg SA. The geriatric depression scale (GDS). *Best Practices in Nursing Care to Older Adults.* 2012;4(1):1-2.

10. Tran DV, Lee AH, Au TB, et al. Reliability and validity of the International Physical Activity Questionnaire–Short Form for older adults in Vietnam. 2013;24(2):126-131.

11. Buysse DJ, Reynolds III CF, Monk TH, et al. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry research.* 1989;28(2):193-213.

12. Kaiser MJ, Bauer JM, Ramsch C, et al. Validation of the Mini Nutritional Assessment Short-Form (MNA®-SF): A practical tool for identification of nutritional status. *JNHA-The Journal of Nutrition, Health and Aging.* 2009;13(9):782.

13. Chen L-K, Woo J, Assantachai P, et al. Asian Working Group for Sarcopenia: 2019 Consensus Update on Sarcopenia Diagnosis and Treatment. *Journal of the American Medical Directors Association.* 2020;21(3):300-307. e302.

14. Cao Manh Long, Ho Thi Kim Thanh, Toan TK. Value of Mini-Mental State Examination (MMSE) in screening dementia for older adults in community. *Journal of medical research.* 2022;149(1):227-234.

15. Luc TV, Anh NT, Huong NTT. Factors related to risk of falls among older post-stroke patients. *Journal of medical research.* 2024;177(4E14):32-38.

16. Guo X, Pei J, Ma Y, et al. Cognitive frailty as a predictor of future falls in older adults: a systematic review and meta-analysis. *Journal of the American Medical Directors Association.* 2023;24(1):38-47.