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ORIGINAL ARTICLE

Relationship between malnutrition and different fall risk assessment tools in a geriatric in-patient unit

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Abstract

Background Despite decades of research evaluating different predictive strategies to identify persons at risk for falls, nutritional issues have received little attention. Malnutrition leads to weight loss associated with muscle weakness and consequently increases the risk of falls.

Aims The current study assessed the association between nutritional state and fall risk scores in a geriatric in-patient unit in Ain Shams University Hospital, Cairo, Egypt.

Methods A cross-sectional study was conducted to assess the nutritional state of 190 older inpatients using a short form of the Mini-Nutritional Assessment (MNA-SF), and the risk of falls was assessed using the Morse Fall Scale (MFS), Johns Hopkins fall risk assessment tool (JH-FRAT), Schmid Fall Risk Assessment Tool (Schmid-FRAT), Hendrich II Fall Risk Model (HII-FRM) and Functional Assessment Instrument (FAI). The generalised linear models (GLM) and odds ratio (OR) were calculated to test the nutritional status as a risk factor for falls.

Results Malnutrition was significantly associated with high fall risk as assessed by MFS and HII-FRM (OR = 2.833, 95% CI 1.358–5.913, $P = 0.006$; OR = 3.477, 95% CI 1.822–6.636, $P < 0.001$), with the highest OR for JH-FRAT (OR = 5.455, 95% CI 1.548–19.214, $P = 0.008$). After adjusting for age, the adjusted Charlson Comorbidity Index (ACCI), number of fall risk-increasing drugs (FRIDs), risk of malnutrition or malnourished were significantly associated with high fall risk as assessed by MFS (OR = 2.761, 95% CI 1.306–5.836, $P = 0.008$), JH-FRAT (OR = 4.938, 95% CI 1.368–17.828, $P = 0.015$), and HII-FRM (OR = 3.486, 95% CI 1.783–6.815, $P < 0.001$).

Conclusions This study demonstrated a significant association between malnutrition and fall risk assessment scores, especially JH-FRAT, in hospitalised older patients.

Keywords Malnutrition · Nutritional state · Fall risk assessment tools · Hospitalised older patients

Introduction

According to the 2017 "National Reporting and Learning System" published by the National Health Service in the United Kingdom, approximately 250,000 falls occurred in 2015/16 in hospital settings [1]. Falls are associated with a death rate of 17.8 per 100,000 persons [2]. In the older population, accidental falls are the main causes of both fatal and nonfatal injuries [3].

Due to the significant impact of falls, the Joint Commission requires hospitals to evaluate a patient's fall risk upon admission and with any change in the patient's condition. Risk assessment is the cornerstone of any fall prevention programme and involves scoring each person with various scales to identify those who are at a high risk of falling [4]. Despite decades of research evaluating many different predictive strategies to identify persons at fall risk, nutritional issues have received little attention [5].

In a mini-review published by Vance et al. [6] in 2016 to assess the relationship between nutritional status and falls, the data were contradictory. Strong positive evidence was found between poor nutritional status and falls in most of the community-based studies, but not in those cases where only 2 out of 11 studies were conducted in hospital settings [7, 8],

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and no significant association was found between nutritional status and falls in hospital settings.

A recent meta-analysis performed by Naseri et al. in 2018 found weak evidence for the role of nutritional support in reducing falls among older adults discharged from hospitals [9].

Recently, the US Preventive Services Task Force Recommendation Statement reported weak evidence for the role of nutrition in preventing falls among community-dwelling older patients [10]. Therefore, the current work aimed to assess the association between nutritional status and fall risk scores among in-patient hospital settings.

Methods

Study design/settings

A cross-sectional study was conducted among the older patients, aged ≥ 60 years. Both males and females were admitted to the geriatric in-patient department over a period of 6 months from March to September 2018. The patients were excluded if they refused to participate or had entral or intravenous feeding.

Data collection

The data were collected from each participant or next of kin during the first 48 h of admission, including the following:

(a) Demographic data and medical history, such as age, gender, health behaviours such as smoking, alcohol consumption or addiction, previous falls in the past 6 months, and comorbidities, which were confirmed by medical records. Pre-admission drug history was reported, including fall risk-increasing drugs (FRIDs) [11].

(b) Age-adjusted Charlson comorbidity index (ACCI): The comorbidity data were scored according to the ACCI [12].

(c) Mini-mental state examination (MMSE) Arabic version [13]: A score of 24 or less was used as a cut-off point for cognitive impairment [14].

(d) Premorbid physical function assessment questionnaires were assessed using (1) the Katz index of independence in activities of daily living (ADL), which includes bathing, dressing, toileting, transferring, continence, and feeding [15], and (2) the instrumental activities of daily living (IADLs) [16], which includes using the telephone, shopping, food preparation, housekeeping, laundry, mode of transportation, responsibility for one's own medications, and ability to handle finances.

(e) Nutritional assessment using the Arabic version of the short form of the Mini-nutritional Assessment (SF-MNA) tool as a valid method for assessing nutrition in hospitalised elderly patients. This assessment has three categories according to the nutritional state: normal (12–14 points), at risk of malnutrition (8–11 points), and malnutrition (0–7 points) [17].

(f) Fall risk assessment tools (Table 1)

1. Morse Fall Scale (MFS) [18]: It is one of the most widely used metrics in fall risk assessment, is a relatively simple instrument to administer and has been proven to be effective in gauging fall risk in different settings, especially in hospital settings [4]. The MFS is composed of six items (history of falling, secondary diagnosis, ambulatory aid, IV/heparin lock, gait, and mental state) and is scored as no risk (0–24), low risk (25–50) or high risk of falls (≥ 51).
2. Johns Hopkins Fall Risk Assessment Tool (JH-FRAT): It is a simple tool with established high validity, similar to MFS [19], especially in terms of content validity [20, 21]. This tool consists of seven points: age, fall history, bowel and urinary incontinence, medications, patient care equipment (IV infusion, chest tube, indwelling catheter, etc.), mobility and cognition. The patient has a moderate risk of falling if he scores 6–13 and a high risk of falling if he scores 14 or more.
3. Schmid Fall Risk Assessment Tool (Schmid-FRAT) [22]: It is composed of five items, mobility, mentation, elimination, prior fall history, and current medications. If the total score is ≥ 3, the patient is at risk of falling.
4. Hendrich II Fall Risk Model (HII-FRM) [23]: It consists of eight risk factors of falls, including confusion, depression, altered elimination, dizziness, gender, antiepileptics, benzodiazepines, and the Get-up-and-Go test. The patient is considered at high risk of falling if the total score is greater than or equal to 5. Both the Schmid-FRAT and HII-FRM are among the most commonly used tools in hospitalised older patients [24].

(g) Functional assessment instrument (FAI): Time of sit-to-stand (TSS) once was applied. A performance cut-off point of ≥ 2 s to stand up once is associated with significant fall risk [25].

Ethical statement

This study was conducted according to the guidelines established in the Declaration of Helsinki and was approved by the local ethical committee. Informed oral consent was

Table 1 Fall risk assessment tools

Fall risk assessment tools		Points
Morse fall risk assessment		
History of falling	Immediate or within 3 months	25
Secondary diagnosis	More than one medical diagnosis is listed on the patient's chart	15
Ambulatory aid	Bed rest/nurse assist	0
	Crutches/cane/walker	15
	Furniture	30
IV/Heparin Lock		20
Gait/transferring	Normal/bedrest/immobile	0
	Weak	10
	Impaired	20
Mental status	Oriented to own ability	0
	Forgets limitations	15
John Hopkins hospital fall assessment tool		
Age (single-select)	60–69 years	1
	70–79 years	2
	≥ 80 years	3
Fall history (single-select)	One fall within 6 months before admission	5
Elimination, bowel and urine (single-select)	Incontinence	2
	Urgency or frequency	2
	Urgency/frequency and incontinence	4
Medications[a]: (single-select)	On 1 high fall risk drug	3
	On 2 or more high fall risk drugs	5
	Sedated procedure within past 24 h	7
Patient care equipment: Any equipment that tethers patient, e.g., IV infusion, chest tube, indwelling catheters, SCDs, etc.) (single-select)	One present	1
	Two present	2
	3 or more present	3
Mobility (multi-select, choose all that apply and add points together)	Requires assistance or supervision for mobility, transfer, or ambulation	2
	Unsteady gait visual or auditory impairment affecting mobility	2
Cognition (multi-select, choose all that apply and add points together)	Altered awareness of immediate physical environment	1
	Impulsive	2
	Lack of understanding of one's physical and cognitive limitations	4
Schmid fall risk assessment tool		
Mobility	Ambulates with no gait disturbance	0
	Ambulates or transfers with assistive devices	1
	Ambulates with unsteady gait and no assistance	1
	Unable to ambulate or transfer	0
Mentation	Alert, oriented × 3	0
	Periodic confusion	1
	Confusion at all times	1
	Comatose/unresponsive	0
Elimination	Independent in elimination	0
	Independent, with frequency or diarrhea	1
	Needs assistance with toileting	1
	Incontinence	1
Prior Fall History (within past 6 months)	Yes—before admission	1
	Yes—during this admission	2
	No/unknown	0
Current Medications	Yes—if the patient is on 1 or more of the following medications: anti convulsants/sedatives or psychotropics/hypnotics	1

Table 1 (continued)

Fall risk assessment tools		Points
Hendrich II fall risk model		
Confusion disorientation impulsivity 4	Male gender	1
Symptomatic depression 2	Any administered antiepileptics	2
Altered elimination 1	Any administered benzodiazepines	1
Dizziness vertigo 1		
Get Up & Go test able to rise in a single movement—no loss of balance with steps	Pushes up successful in one attempt	0
	Multiple attempts but successful	1
	Unable to rise without assistance during test	3

Morse fall risk assessment: no risk 0–24, low risk 25–50, high risk ≥ 51

John Hopkins hospital fall assessment tool: no risk < 6, low risk 6–13, high risk > 13

Schmid fall risk assessment tool: a score of 3 or more: patient is at risk for falls

Hendrich II fall risk model: a score of 5 or greater = high risk

[a]Includes PCA/opiates, anti-convulsants, anti-hypertensives, diuretics, hypnotics, laxatives, sedatives, and psychotropics

obtained from each patient and/or his next kin and was included in the study as most of the patients were illiterate and were accompanied by a nurse prior to enrolment. The consent procedure was approved by the local ethical committee of the faculty of medicine, Ain Shams University.

Statistical analysis

The data were collected, revised and entered using the Statistical Package for Social Science (IBM SPSS) version 16. The quantitative data are presented as the mean ± standard deviation or median, and the inter-quartile and qualitative data are presented as numbers and percentages. Comparisons between patients that were well-nourished, at risk of malnutrition, and malnourished were performed using the Chi square test for qualitative data and, when appropriate, ANOVA or the Kruskal–Wallis test for quantitative data.

The association between nutritional status (categorised as either not well-nourished or well-nourished) and high fall risk assessed through different tools was evaluated by means of generalised linear models (GLM).

The interaction between nutritional status and gender was tested in unadjusted regression models, followed by stratifying the data by gender with adjustment for ACCI, age and number of fall-risk-increasing drugs (FRIDs). A number of comorbidities and FRIDs are associated with an increased risk of falls in older people [26–29]. According to previous studies, increasing the number of comorbidities, especially with increasing age, significantly increases the fall risk [26], while FRIDs are associated with increased fall risk. These drugs include antihypertensive, psychotropic, and narcotic medications [30, 31]. Cognitive impairment as measured by MMSE scores was not included in the adjustment because mental status was included in the fall risk scores.

Results

The mean age of the patients in this study was 68.67 ± 7.33; 50.5% of the sample were female, and 14.7% had a history of previous falls. The prevalence of malnutrition was 18.4% ($n = 35$), and the risk of malnutrition was 37.4% ($n = 71$) (Table 2).

Among the included patients, 14.7%, 11.1%, 6.8%, 36.8%, and 98.5% were classified as high-risk groups according to the MFS, JH-FRAT, Schmid-FRAT, and HII-FRM and impaired TSS once consecutively (Table 2). Based on the results of the SF-MNA scale, the prevalence of at risk of malnutrition and malnutrition was 37.4% ($N = 71$) and 18.4% ($N = 35$), respectively. However, there were no significant differences between the males and females with respect to at risk of malnutrition or malnutrition ($P = 0.75$). By comparing the nutritional status between patients, the malnourished patients had significantly worse MMSE, ADLs, IADLs scores and fall number ($P = 0.023, < 0.001, 0.001, 0.028$) and had higher MFS, JH-FRAT, Schmid-FRAT, and HII-FRM scores than did patients who were at risk or had normal nutritional scores ($P = 0.001, < 0.001, < 0.001, < 0.001$, respectively). However, there was no statistically significant difference in the prevalence of impaired TSS by nutritional status ($P = 0.144$) (Table 2).

In the adjusted model for ACCI, patients who were not well-nourished were significantly associated with a high fall risk as assessed by MFS (OR = 2.795, 95% CI 1.337–5.841, $P = 0.006$), JH-FRAT (OR = 5.261, 95% CI 1.486–18.625, $P = 0.010$), and HII-FRM (OR = 3.412, 95% CI 1.782–6.533, $P < 0.001$) with the highest OR also for JH-FRAT (Table 3).

After further adjusting for age, ACCI, and number of FRIDs, the 'not well-nourished' patients were significantly associated with high fall risk as assessed by MFS (OR = 2.761, 95% CI 1.306–5.836, $P = 0.008$), JH-FRAT

Table 2 General description of patients' characteristics

Variables	Total (*n*)%	Nutritional status			*P* value
		Malnourished (*n* = 35)	At risk (*n* = 71)	Normal (*n* = 84)	
Age (mean ± SD)	68.67 ± 7.33	71.69 ± 8.51	67.86 ± 7.10	68.11 ± 6.75	0.025
Gender					
Females	96 (50.5%)	16 (45.7%)	38 (53.5%)	42 (50%)	0.75
Males	94 (49.5%)	19 (54.3%)	33 (46.5%)	42 (50%)	
Marital status					
Single	3 (1.6%)	1 (2.9%)	1 (1.4%)	1 (1.2%)	
Married	115 (60.5%)	21 (60%)	42 (59.2%)	52 (61.9%)	0.96
Widow	69 (36.3%)	13 (37.1%)	27 (38.0%)	29 (34.5%)	
Divorced	3 (1.6%)	0 (0%)	1 (1.4%)	2 (2.4%)	
Smoking					
Smoker	29 (15.3%)	6 (17.1%)	9 (12.7%)	14 (16.7%)	0.59
Ex-smoker	48 (25.3%)	12 (34.3%)	17 (23.9%)	19 (22.6%)	
Non-smoker	113 (59.5%)	17 (48.6%)	45 (63.4%)	51 (60.7%)	
LOS median (IQR)	11 (7–17.25)	14 (8–21)	11 (7–20)	10 (7–16)	0.095
ACCI (Mean ± SD)	5.98 ± 1.77	6.57 ± 2.24	5.95 ± 1.62	5.76 ± 1.66	0.075
Previous falls	28 (14.7)	10 (28.6%)	10 (14.1%)	8 (9.5%)	0.028
ADL median (IQR)	5 (1–6)	1 (0–6)	5 (1–6)	6 (4–6)	< 0.001
IADL median (IQR)	6 (2–8)	2 (0–8)	7 (2–8)	6 (4–8)	0.001
MMSE (mean ± SD)	24.25 ± 4.29	22.24 ± 6.86	24.19 ± 4.01	24.91 ± 3.26	0.023
MFS median (IQR)	35 (15–45)	40 (30–55)	35 (15–45)	35 (15–40)	0.002
Low risk	60 (31.6%)	3 (8.6%)	26 (36.5%)	31 (37.3%)	
Moderate risk	101 (53.2%)	22 (62.9%)	34 (47.9%)	45 (54.25%)	0.001*
High risk	28 (14.7%)	10 (28.6%)	11 (15.5%)	7 (8.4%)	
JH-FRAT median (IQR)	8.42 ± 4.25	11 (9–15)	7 (5–10)	7 (5–9)	< 0.001*
Low risk	47 (24.7%)	2 (5.7%)	20 (28.2%)	25 (30.15)	
Moderate risk	121 (63.7%)	20(57.1%)	46(64.8%)	55(66.3%)	< 0.001
High risk	21 (11.1%)	13 (37.15)	5 (7.0%)	3 (3.6%)	
Schmid-FRAT median (IQR)	1 (0–2)	2 (1–2)	1 (0–1)	1 (0–1)	< 0.001
Score ≥ 3	13 (6.8%)	6 (17.1%)	2 (2.8%)	5 (6.0%)	0.024*
Score < 3	176 (92.6%)	29 (82.9%)	69 (97.2%)	78 (94.0%)	
HII-FRM median (IQR)	3 (2–5)	6 (4–9)	4 (2–6)	3 (2–4)	< 0.001
Score ≥ 5	70 (36.8%)	23 (65.7%)	29 (40.8%)	18 (21.7%)	< 0.001*
Score < 5	119 (62.6%)	12 (34.3%)	42 (59.2%)	65 (78.3%)	
Impaired TSS once	170 (98.5%)	31 (88.6%)	60 (84.5%)	79 (94.0%)	0.144

ACCI age adjusted charlson co-morbidity index, *ADL* activity of daily living, *MFS* Morse fall scale, *HII-FRM* Hendrich II fall risk model, *IADL* instrumental activity of daily living, *JH-FRAT* John Hopkins fall risk assessment tool, *LOS* length of stay, *MMSE* Mini-Mental State Examination, *MNA* Mini-Nutritional Assessment, *Schmid- FRAT* Schmid fall risk assessment tool, *TSS* time of sit to stand

**P* value was calculated using linear by linear association for ordinal data

(OR = 4.938, 95% CI 1.368–17.828, $P = 0.015$), and HII-FRM (OR = 3.486, 95% CI 1.783–6.815, P value < 0.001) (Table 3).

The result was the same when the adjustment was performed with (Table 3) or without age (data are not shown). The adjusted models did not differ substantially from the unadjusted ones.

Schmid-FRAT was not significantly associated with nutritional status in the adjusted and unadjusted models.

Similarly, TSS once was not associated with either the 'not well-nourished' patients ($P = 0.067$) or any of the fall risk scores (data are not shown).

Moreover, by testing the interaction between nutritional status and gender in the unadjusted model, the association between nutritional status and fall risk could be modified by gender using MFS ($P = 0.047$) and HII-FRM ($P = 0.001$) but not JH-FRAT and Schmid-FRAT ($P = 0.208$ and 0.490, respectively) (data not shown).

Table 3 Association between nutritional status and high fall risk groups, unadjusted and adjusted models

		B	*P*	OR	95% CI for OR	
					Lower	Upper
Unadjusted model						
High risk MFS	Not well nourished	1.041	0.006	2.83	1.36	5.91
High risk JH-FRAT	Not well nourished	1.70	0.008*	5.46	1.55	19.21
At risk Schmid FRAT	Not well nourished	0.396	0.455	1.49	0.53	4.20
High risk HII-FRM	Not well nourished	1.246	< 0.001*	3.48	1.822	6.64
Adjusted for ACCI						
High risk MFS	Not well nourished	1.028	0.006	2.80	1.34	5.84
High risk JHFRAT	Not well nourished	1.660	0.010	5.26	1.49	18.63
At risk Schmid FRAT	Not well nourished	0.381	0.473	1.46	.52	4.15
High risk HII-FRM	Not well nourished	1.227	< 0.001*	3.41	1.78	6.53
Adjusted for age, ACCI, and number of FRIDs drugs						
High risk MFS	Not well nourished	1.016	0.008	2.76	1.31	5.84
High risk JHFRAT	Not well nourished	1.597	0.015	4.94	1.37	17.83
At risk SchmidFRAT	Not well nourished	0.351	0.519	1.42	.49	4.12
High risk HII-FRM	Not well nourished	1.249	< 0.001*	3.49	1.78	6.82

Reference categories were low risk MFS, JH-FRAT, and HII-FRM and no risk Schmid FRAT

ACCI age adjusted charlson co-morbidity index, *FRIDs* fall risk-increasing drugs, *HII-FRM* Hendrich II fall risk model, *JH-FRAT* John Hopkins fall risk assessment tool, *MFS* Morse fall scale, *Schmid-FRAT* Schmid fall risk assessment tool

Then, stratified analysis was performed to compare the fall risk by MFS and HII-FRM between the males and females based on their nutritional status in the adjusted regression models. The "not well-nourished" males had a significant association with fall risk based on MFS (OR = 5.39, 95% CI 1.34–21.67, $P = 0.018$) compared to the "not well-nourished" females ($P = 0.13$). However, when HII-FRM was used, both males and females had a significant association between being "not well-nourished" and having a high fall risk (OR = 4.17 and 4.37, 95% CI 1.35–12.83 and 1.45–13.14, $P = 0.013$ and 0.009, respectively) (Table 4).

Table 4 Association between nutritional status and falls as stratified by gender, in adjusted model for Age, ACCI, FRID number

	B	*P*	OR	95% Wald confidence interval for OR	
				Lower	Upper
High risk MFS					
Not well nourished					
Females	0.881	0.133	2.41	0.77	7.62
Males	1.684	0.018	5.39	1.34	21.67
High risk HII-FRM					
Not well nourished					
Females	1.475	0.009	4.37	1.45	13.14
Males	1.427	0.013	4.17	1.35	12.83

Reference group was patients with normal SF-MNA scores

ACCI age adjusted charlson co-morbidity index, *FRIDs* fall risk-increasing drugs, *HII-FRM* Hendrich II fall risk model, *MFS* Morse fall scale

Discussion

The current work showed that either being at risk of malnutrition or being malnourished is associated with an increased fall risk in older inpatients. This result was confirmed when evaluating fall risk with different fall risk assessment tools, as well as when adjusting the analysis for potential confounders.

These data agreed with two cohort studies performed by Chien and Guo and Tsai and Lai [32, 33], where the odds of falling were increased in patients at risk of malnutrition or malnourished in the community-dwelling older population. Neelemaat et al. [34] found that dietetic counselling in malnourished older patients decreased the incidence of falls during the next 3 months after discharge, similar to studies conducted in hospital settings.

Similarly, Johnson [35] reported that fallers had a poor nutritional status compared to non-fallers in a sample of frail older patients.

On the other hand, weak evidence was elicited by the US Preventive Services Task Force Recommendation Statement [10], which might be partially attributed to the study on nutritional support as a part of a multifactorial intervention. Additionally, a recent meta-analysis [9] showed weak evidence for the role of nutritional support in reducing falls among recently discharged older patients. However, in this meta-analysis, the nutritional data were based on a single study that assessed the impact of nutrition [31].

Furthermore, Bauer et al. [7] found no difference in the number of falls between malnourished and well-nourished hospitalised patients; however, nutritional status was associated with a history of falls prior to admission.

Similarly, Vivanti et al. [8] reported an insignificant association between malnutrition and falling during admission with long lengths of stay for fallers versus non-fallers; however, malnutrition was associated with decreased mobility.

A study by Oliver et al. [36] might explain the contradictory data between these findings, which assessed actual falls during hospitalisation and nutritional status, and those from nutritional studies on hospitalised subjects prior to falling or falling post-discharge. Oliver et al. declared that studies reporting falls in hospitals are potentially confounded by secular trends in fall rates that are influenced by changes in staff members, activity, or fall recording practice, which may exceed the purported fall prevention intervention [36]. Further evidence-based studies are needed to confirm the impact of different fall prevention interventions in hospitals [37].

In addition to the continuous challenge between encouraging patient mobility/independence and minimising the risks of patient falls among hospitalised subjects [1], the use of fall risk assessment tools rather than fall incidence in the current work is justified.

Schmid-FRAT was not significantly associated with nutritional status in the adjusted and unadjusted models. This result may be attributed to the low prevalence (6.8%) in our sample.

The results of the MFS/JH-FRAT/Schmid-FRAT/HII-FRM tools showed statistically significant differences in fall risk between the normal, risk of malnutrition and malnutrition risk, but the prevalence of high fall risk was higher for HII-FRM than for other tools. In fact, most patients had impaired TSS scores (98.5%), which would justify the non-significant association with malnutrition or fall risk. Functional performance tools, such as TSS, were not recommended to be suitable for assessing fall risk in the hospital setting; however, these tools may be appropriate within outpatient settings [38].

The MFS/JH-FRAT/Schmid-FRAT/HII-FRM tools have overlapped items, such as mobility, mental status, past history of falls, elimination and medications. Additionally, the Get-up-and-Go test, which is included in HII-FRM as the main item, also overlaps with TSS once. This feature could explain the high prevalence but good discrimination of HII-FRM in the current study. According to Han et al., HII-FRM is used to test the balance function of fall and non-fall groups, and a significant difference indicates high sensibility and discrimination validity in fall risk assessment in the older people [39]. Therefore, HII-FRM has been the most effective tool for the assessment of falls in older patients.

With ageing, malnutrition and sarcopenia are commonly present together and are manifested clinically through a combination of decreased body weight, mainly skeletal muscle mass, and function. Moreover, malnutrition is one of the main pathophysiological causes of sarcopenia. Both malnutrition and sarcopenia result in numerous and significant negative outcomes on either the patients or the healthcare system and can decrease the quality of life and functional activities, impair balance [40], and increase the risk of falls and bone vulnerability, all of which will in turn increase healthcare costs, hospitalisation rates, morbidity and mortality [41, 42].

Many studies have concluded that hospitalised older patients with malnutrition and/or sarcopenia have low ADL scores, which agrees with the current findings, as malnourished subjects have significantly worse ADL scores than those of subjects who are well-nourished or at risk of malnutrition [43, 44].

In our study, the MMSE scores were low in malnourished individuals who were at risk and well-nourished. The relationship between nutrition and cognition is complex. Vitamin deficiencies, especially those in vitamin B6, B12 and folate, as a part of nutrition-related health problems that occur in malnutrition, may underlie cognitive impairment. [45, 46]. Hence, falls are found to decrease with vitamin D supplementation in those patients with a deficiency [47]. In addition, decreased food intake in cognitively impaired patients may lead to malnutrition [48]. Therefore, changes in nutrition status may play an important role in the deterioration of cognitive function in hospitalised and community-dwelling older populations [49, 50].

Moreover, falls are closely associated with cognitive impairment due to impaired motor function through neurological gait abnormalities [51–53], even in the presence of relatively intact motor function [54]. This problem could be related to certain domain affection [55], especially mental flexibility, as an important aspect of executive function [56] and slow reaction time [57].

Poor nutritional status in older individuals is a reflection of many underlying problems, such as sarcopenia, cognitive impairment and functional impairment, that interact together and significantly increase the risk of falls [41–44, 49, 50].

Strength and limitations

The main limitation of our study is the cross-sectional study design, which limits the implications of any causal reasoning between malnutrition and incident falls. The assessment of patients using multiple fall risk tools in view of their nutritional status can strengthen this work.

Conclusion

Using MFS, JH-FRAT, and HII-FRM with the highest OR for JH-FRAT, a poor nutritional status was found to be associated with a high fall risk in older inpatients. "Not well-nourished" males had a significant association with high fall risk based on the MFS, while both "not well-nourished" males and females had a significant association with high fall risk based on the HII-FRM.

Recommendation

Efforts should be made to improve nutritional status as a part of any fall prevention programme. Further nutritional intervention studies should be encouraged to decrease fall risk, especially in high-risk fallers.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Statement of human and animal rights: ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the Local Ethics Committee of Faculty of Medicine, Ain Shams University.

Informed consent Informed oral consent was obtained from all patients included in the study and/or their next of kin, as most of them were illiterate and were accompanied by a nurse prior to enrolment.

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