Clinical Nutrition ESPEN 70 (2025) 129–137

Contents lists available at ScienceDirect

Clinical Nutrition ESPEN

journal homepage: http://www.clinicalnutritionespen.com

Original article

Investigation into the prevalence of malnutrition, sarcopenia and frailty in very old hospitalised patients and relationship with clinical outcomes

Adrian Slee [a,*], Manuela Sumar Vignau [a], Paul Bassett [b], Xinrui Jin [c,d], Junyi Guo [e], David Smithard [f,g]

[a] Division of Medicine, Faculty of Medical Sciences, University College London (UCL), London, UK
[b] Statsconsultancy Ltd, Amersham, Bucks, UK
[c] Medical Data Analytics Center, Department of Medicine and Therapeutics, The Chinese University of Hong Kong, Hong Kong, China
[d] State Key Laboratory of Digestive Disease, Institute of Digestive Disease, The Chinese University of Hong Kong, Hong Kong, China
[e] Appetite & Obesity Research Group, School of Psychology, Faculty of Medicine and Health, The University of Leeds, Leeds, UK
[f] Queen Elizabeth Hospital, Lewisham and Greenwich NHS Trust, Stadium Road, Woolwich, London, UK
[g] Centre for Exercise Activity and Rehabilitation, University of Greenwich, Avery Hill Campus, Eltham, London, UK

ARTICLE INFO

Article history:
Received 8 February 2025
Accepted 31 August 2025

Keywords:
Malnutrition
Sarcopenia
Frailty
Very old age

SUMMARY

Background and aims: Malnutrition, sarcopenia and frailty represent common conditions in the geriatric population that have a detrimental impact on quality of life and clinical outcomes. These syndromes also display resembling clinical features and may often co-exist, aggravating adverse health outcomes. This study aimed to investigate the prevalence and co-occurrence of the conditions in a very old aged cohort of hospital patients, and the associations with clinical outcomes.

Methods: A registered clinical audit was performed in a Hospital setting and data collected from older patients aged >85 years of age, between 2019 and 2024. Malnutrition risk was assessed using the nutritional screening tool (NST), geriatric nutritional risk index (GNRI) and global leadership initiative malnutrition (GLIM) criteria. Sarcopenia screening was evaluated with the SARC-F (Strength, Assistance in walking, Rising from a chair, Climbing stairs, and Falls) questionnaire and frailty using the clinical frailty scale (CFS). The prevalence and concurrence of the conditions was calculated, alongside the analysis of in-hospital mortality risk and routine blood biomarkers (albumin, C-reactive protein, urea, creatinine and haemaglobin).

Results: 768 audits were included for analysis and the median age was 89 years (87–92). Malnutrition was detected in 28.4 %, 32.8 % and 41.2 % of patients by NST, GNRI and GLIM respectively, while the prevalence of sarcopenia was 68.3 % and 73.2 % for frailty. Between 20.8 % and 29.2 % of patients presented all three conditions concomitantly, while 79.2 %–85.1 % had at least one. Cox regression analysis between geriatric syndromes and the risk of in-hospital death showed that high malnutrition risk by NST (adjusted HR = 1.78, p = 0.03), as well as the presence of sarcopenia by SARC-F (adjusted HR = 2.60, p = 0.001) and severe frailty (adjusted HR = 4.89, p < 0.001), were all significantly associated with an increased risk of mortality. Likewise, biomarker levels differed depending on the presence of conditions, with reduced albumin showing most significant associations with heightened risk/presence of malnutrition, sarcopenia and frailty.

Conclusion: The study showed a high prevalence and overlap between the explored conditions in this large, very old aged cohort, with nearly a third of patients presenting all three simultaneously, which may present significant health burden. Further research is needed to optimise the screening and assessment of conditions and establishing most accurate tools and techniques, to enhance clinical practical and potentially better guide interventions potentially affecting clinical outcomes.

* Corresponding author.
E-mail address: a.slee@ucl.ac.uk (A. Slee).

https://doi.org/10.1016/j.clnesp.2025.08.036

1. Introduction

The ageing process brings an accumulation of conditions that actively contribute to health deterioration. Amongst the geriatric conditions that affect older patients, malnutrition, sarcopenia and frailty stand as central players. These syndromes have a multifactorial aetiology in the older population, partly stemming from a complex network of age-related transformations, including altered energy metabolism [1], and reduced appetite — a phenomenon known as the 'anorexia of ageing' [2]. Malnutrition is one of the most serious health problems in older individuals [3] as it is associated with treatment complications [4], longer hospital stays [5] and may lead to the loss of muscle mass [6], which can correspondingly promote the pathogenesis of sarcopenia [7,8].

Sarcopenia is a muscle disease characterised by a progressive decline in muscle mass, quality and strength [9]. It may develop due to age-related alterations in muscle metabolism and function, inadequate dietary energy and protein intake, physical inactivity, and is also particularly precipitated by the presence of inflammation, e.g. from the presence of disease conditions [10]. This disease is highly prevalent amongst older adult patients [11], and may lead to an impaired ability to complete daily living activities [12], and is associated with greater hospital costs [13], and higher mortality rates [14]. Frailty, as the product of cumulative multiple physiological system declines, heightens vulnerability against adverse outcomes [15,16], and has been associated with higher hospital admissions and increased length of inpatient stay, collectively amplifying healthcare costs in the united kingdom (UK) [17]. Moreover, frailty can reduce quality of life [18] and decrease activity levels, which in turn, can aggravate the development of sarcopenia and malnutrition [19]. As a consequence, malnutrition, sarcopenia, and frailty can tightly coexist in a self-perpetuating cycle as first discussed by Fried and colleagues [15] where one can swiftly induce or amplify the severity of the others. Such interplay nurtures the prospect that in clinical practice older patients may concurrently experience multiple, if not all, of these syndromes [20]. Due to the independent undesirable outcomes associated to each condition, when they are to co-occur, they are expected to intensify ill health, potentially worsen outcomes, and yield cumulative healthcare costs. Consequently, a clustering of these conditions embodies a great healthcare challenge, making timely identification a crucial step required for initiating treatment and reducing undesirable health advancements [21]. However, each screening method uses different criteria — such as weight loss, appetite loss/anorexia, and blood biomarkers (e.g. plasma albumin) — to identify these conditions, resulting in varied prevalence estimates and ongoing debate over the optimal approach for patient assessment. Currently, in the UK, the Malnutrition Universal Screening Tool (MUST) is the most widely used tool to identify malnutrition [22], however, The Global Leadership Initiative on Malnutrition (GLIM) criteria has a higher diagnostic accuracy and is deemed as a gold standard for distinguishing malnutrition in clinical practice [23]. Several screening methods are available for sarcopenia and frailty. The SARC-F [9] is commonly used to screen for sarcopenia, while the Rockwood Clinical Frailty Scale (CFS) [24] is the recommended tool for assessing frailty in the UK.

Research assessing the prevalence and concomitance of malnutrition, sarcopenia and frailty has predominantly been conducted in community-dwelling older adults [24,25] and nursing home residents [26], while limited studies have been in the hospital setting [27]. Therefore, this investigation aims to evaluate the prevalence of malnutrition, sarcopenia, and frailty in a large group of hospitalised very old patients, using different diagnostic tools. Ultimately, insights from this study may clarify the genuine prevalence and overlap of these three conditions, guiding resource allocations and improving coordinated clinical screening practices across the UK.

2. Methods

2.1. Participants and study design

This is a retrospective study that utilises data obtained from the geriatric unit of The Queen Elizabeth Hospital, London (UK). Audits were collected by a healthcare professional between January 2019 and February 2024, resulting in 768 records of patients aged 85 years or older. The study was conducted in accordance with NHS-registered clinical guidelines and protocols.

Patients presented with diverse admission diagnoses. The audits contained documented data about comorbidities, medication usage, age, sex, ethnicity, body mass index (BMI), blood science, length of stay (days) and mortality. Patients underwent geriatric assessments within the first 24 h of admission, which included anthropometric assessment height (actual and estimated from ulna length) and body weight (seated or lying weighing scales), routine blood sampling, malnutrition risk evaluation using a nutritional screening tool (NST), the estimation or screening of sarcopenia risk with the SARC-F and the assessment of frailty according to the CFS. Malnutrition risk was additionally examined in a retrospective manner using the Geriatric Nutritional Risk Index (GNRI) and the Global Leadership Initiative on Malnutrition (GLIM).

2.2. Assessment of nutritional risk by NST, GNRI and GLIM

Nutritional status was evaluated in three distinct forms; firstly, patients were screened using the NST [28]. This tool categorises malnutrition risk based on scores that range from 0 to 17 (Appendix 1), and patients were grouped into three main categories: scores from 0 to 1 indicate low risk, a score of 2 represents medium risk, and scores of 3 or more correspond to a high malnutrition risk.

Secondly, the GNRI was also utilised (Appendix 2). This is a validated tool particularly designed to be used in clinical settings amongst older patients [29]. Individuals were categorized based on their calculated scores as follows: low or no risk of malnutrition ($\geq$92), moderate risk (<92–82), and severe risk (<82).

Lastly, nutritional status was defined by the GLIM criteria [30], which diagnoses malnutrition when at least one etiologic and one phenotypic criteria are present. Due to limited data, BMI was the only phenotypic criterion available for consideration and inflammation was used for the aetiological category. Additionally, malnutrition was further stratified as moderate when BMI <22 kg/m^2, or severe when BMI <20 kg/m^2 [30].

2.3. Screening of sarcopenia risk by SARC-F

The SARC-F is a validated questionnaire (Appendix 4) readily used in the community and healthcare settings to screen for sarcopenia risk [9]. It contains five major components evaluating function: Strength, Assistance with walking, Rise from a chair, Climb stairs, and Falls. Each category is scored from 0 to 2, with an overall score $\geq$4 reflecting sarcopenia risk [31].

2.4. Assessment of frailty by CFS

The CFS is a 9-point ordinal scale developed by Rockwood et al., commonly employed in clinical settings that requires clinical judgment from the assessor to assign the grade of frailty

[16,32,33]. Patients were grouped based on their scores as follows: 1 to 4 indicate no frailty, 5 and 6 reflect mild to moderate frailty and ≥7 denotes severe frailty [16,33].

2.5. Blood science

Routine blood tests were collected for analysis, adhering to standard hospital patient care protocols. The analysed biomarkers included sodium, albumin, haemoglobin, C-reactive protein (CRP), and CRP-to-albumin ratio (CRP/albumin).

2.6. Statistical analysis

The information of the collected audits was initially transferred to Microsoft Excel, and the statistical analyses were posteriorly executed using STATA 17 MP software, and analysed by external consultant statistician, Mr Paul Bassett.

The characteristics of the study cohort were summarised by the mean with standard deviation (SD) for normally distributed continuous variables, and by median with interquartile range (IQR) for non-normally distributed variables. The number and percentage in each category were used to summarise categorical variables. The prevalence of each condition was measured, whilst cross-tabulations were constructed to ascertain the coexistence of the syndromes, and the Chi-squared test was used to examine the significance of the associations.

Associations between malnutrition, sarcopenia and frailty and patient survival times were examined. As only a minority (around 10 % patients) stayed in hospital for longer than 30-days, patient survival up to 30-days only was examined. Survival rates from the time of admission were quantified by Kaplan–Meier methods. The assumption was made that patients discharged from hospital before 30-days were still alive at the 30-day point. Cox regression was used to examine associations between malnutrition, sarcopenia and frailty with survival times. Each factor was considered a separate analysis. Two analyses were performed for each variable. Firstly, an unadjusted comparison was made, following by adjustments for pre-specified risk factors collected in the study, including age, sex, number of comorbidities and number of medications.

Additional analyses used the Kruskal–Wallis and Mann–Whitney tests to compare the biomarker variables between different condition categories.

A p-value of <0.05 was considered statistically significant.

3. Results

3.1. Characteristics of patient cohort

A total of 768 patient audits from the geriatric ward were included for analysis. The median age of patients was 89 years [IQR: 87–92] and females represented 63 % of the cohort. Detailed patient characteristics are presented in Table 1.

Table 1
Participants characteristics and variables.

Characteristic	Number of records	Mean ± SD/Median [IQR]/Percentage (%)
Sex	730	
Female	460	63.0
Male	270	37.0
Age (years)	725	89 [87–92]
Ethnicity		
White	690	96.0
Asian	16	2.2
Black	10	1.4
Mixed	3	0.4
Weight (kg)	667	61 [51–72.6]
Height (m)	667	1.62 [1.60–1.70]
BMI (kg/m^2)	600	23.5 ± 5.4
Number of Comorbidities	738	3 [2–3]
Number of Medications	643	6.2 ± 3.2
Blood Science		
Sodium (mmol/L)	740	137 [134–141]
Albumin (g/L)	625	36 [33–40]
Haemoglobin (g/L)	709	122 [107–133]
CRP (mg/L)	664	32 [8–89]
CRP/Albumin	561	9.0 [2.2–25.7]
Malnutrition		
NST	610	0 [0–3]
GLIM	553	1 [1–2]
GNRI	475	98.0 ± 13.4
Sarcopenia (SARC-F)	710	6 [2–10]
Frailty (CFS)	751	6 [4–7]

Normally distributed data is expressed as mean ± standard deviation and for non-normally distributed variables as median [inter-quartile range]. Frequencies are presented as the percentage of patients.

3.2. Prevalence of malnutrition, sarcopenia and frailty

Fig. 1 illustrates the prevalence of malnutrition according to the different assessment methods. Amongst the 610 patients with an available NST in their records, 437 (71.6 %) were identified as low risk for malnutrition, 18 (3.0 %) as medium risk and 155 (25.4 %) as high risk. When the two latter categories are grouped, malnutrition prevalence amounts to 173 (28.4 %). For the subsequently estimated GNRI, a total of 475 patients had sufficient data for its calculation, which resulted in 319 (67.2 %) being classified as no or low risk, 105 (22.1 %) categorised as moderate risk and 51 (11 %) patients at major risk. A total malnutrition risk prevalence of 156 (32.8 %) is reached when moderate and major risk patients are grouped together. Similarly, of the 553 patients evaluated based on the GLIM criteria, 325 (58.8 %) had a normal nutritional status, while 228 (41.2 %) were considered malnourished. Further stratification led to 91 (16.5 %) patients categorized with moderate malnutrition and 137 (24.8 %) with severe malnutrition.

In terms of sarcopenia, 710 patients had available SARC-F results, from which 225 (31.7 %) were non-sarcopenic and 485 (68.3 %) had sarcopenia. With respect to frailty, a total of 751 individuals were assessed with the CFS. From this group, 201 (26.8 %) were non-frail, 266 (35.4 %) had mild to moderate frailty and 284 (37.8 %) were severely frail. Once all frailty degrees are considered, the absolute number of frail patients amounts to 510 (73.2 %), representing the highest prevalence between the three geriatric syndromes. Fig. 2 depicts the combined malnutrition, sarcopenia, and frailty prevalence.

3.3. Co-existence of malnutrition, sarcopenia and frailty

The co-occurrence of malnutrition, sarcopenia and frailty is displayed in the Venn diagrams in Fig. 3 (A-C). According to NST (A), the following was exposed: malnutrition and sarcopenia were present in (128 (22.4 %) individuals, frailty and malnutrition overlapped in 133 (23.3 %) patients, and frailty and sarcopenia coexisted in 343 (60 %). A total of 119 (20.8 %) patients suffered from all three conditions, on the contrary 119 (20.8 %) were neither malnourished, sarcopenic, nor frail.

Under GNRI (B), a total of 120 (26.7 %) patients had both malnutrition and sarcopenia, 123 (27.4 %) had concomitant malnutrition and frailty, and 277 (61.9 %) presented with both sarcopenia and frailty. A simultaneous presence of malnutrition, sarcopenia and frailty occurred in 111 (24.8 %) patients, while 74 (16.5 %) had no conditions. Lastly, based on GLIM criteria (C), a

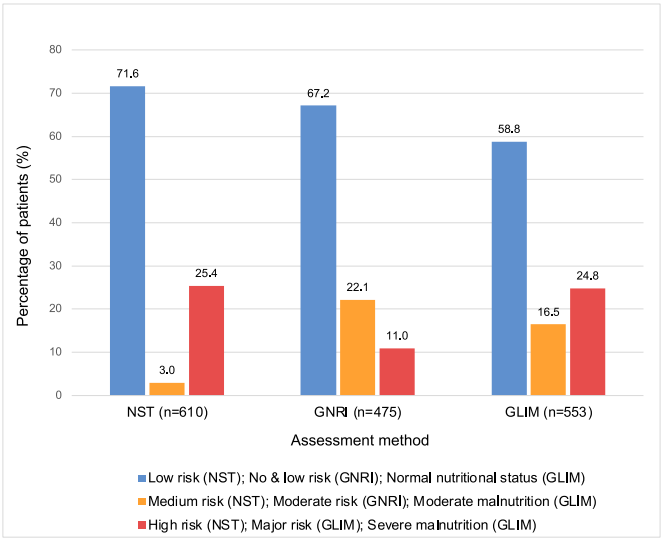

Fig. 1. Bar graph shows malnutrition prevalence (%) according to NST, GNRI and GLIM.

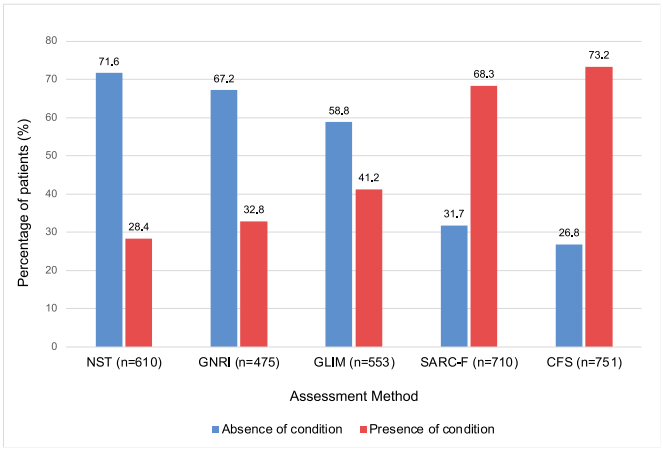

Fig. 2. Bar graph illustrates the percentage (%) of patients with malnutrition, frailty, and sarcopenia according to each assessment method. Presence of condition: NST (medium and high risk); GNRI (moderate and severe risk); GLIM (moderate and severe malnutrition) and CFS (mild to moderate frailty and severe frailty).

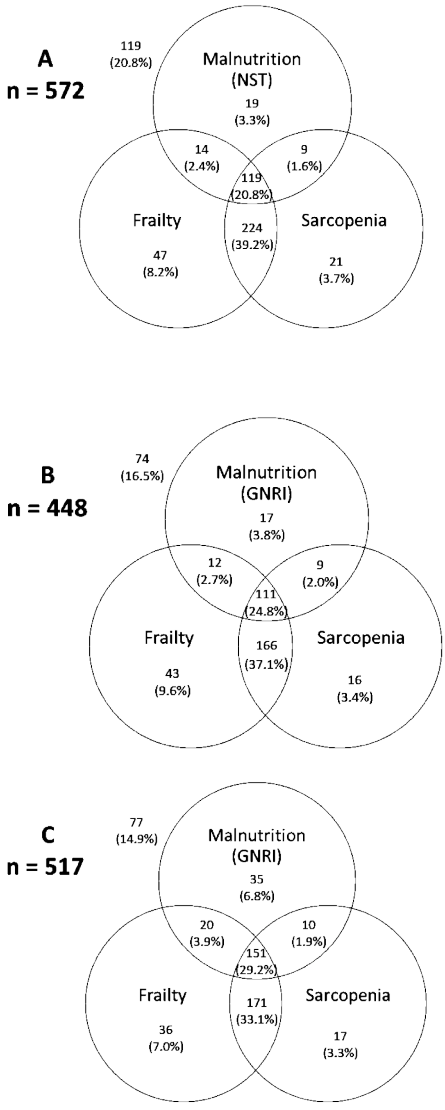

Fig. 3. The Venn diagrams present the co-prevalence's and overlaps between malnutrition, sarcopenia, and frailty. Sarcopenia by SARC-F, frailty by CFS, and malnutrition by: NST(**A**), GNRI (**B**) and GLIM (**C**). Data shown as number (%) of patients per subdivision.

total of 161 (31.1 %) patients were living with both malnutrition and sarcopenia, in 171 (33.1 %) malnutrition and frailty occurred concurrently, and 322 (62.3 %) patients had overlapping frailty and sarcopenia. Notably, 151 (29.2 %) had all the three conditions, whereas 77 (14.9 %) had neither present.

These finding accentuate a common clustering of malnutrition, sarcopenia, and frailty in medical inpatients, with a significant overlap established amongst the three conditions, ranging between 20.8 % and 29.2 %.

3.4. Interactions and associations between malnutrition, sarcopenia and frailty

The distribution of malnutrition and sarcopenia subject to the absence or presence of frailty is reported in Table 2. Concerning malnutrition, non-frail patients compared to patients with frailty had lower malnutrition risks as assessed using NST, GNRI, and GLIM criteria. Similarly, severe frailty was observed in only 2.2 % of non-sarcopenic patients, whereas 55.5 % of sarcopenic patients fell into the severe frailty category. These findings demonstrate that patients had a significantly greater prevalence of both malnutrition and sarcopenia when frailty was present, underscoring the strong interconnections between the explored conditions.

3.5. Mortality risk

The Cox regression analysis between geriatric syndromes and the risk of in-hospital death displayed in Table 3 uncovered that high malnutrition risk by NST (adjusted HR = 1.78, p = 0.03), as well as the presence of sarcopenia (adjusted HR = 2.60, p = 0.001) and severe frailty (adjusted HR = 4.89, p < 0.001) were all significantly associated with an increased risk of mortality, and thus shorter survival times (see significant results in Fig. 4). These relationships were present both before and after adjusting for other risk factors that may influence patient survival. There was also slight evidence that malnutrition, defined by GNRI, was also associated with survival times, but this result was only of borderline statistical significance. Malnutrition defined by GLIM did not demonstrate a significant association.

Table 2
Distribution of malnutrition and sarcopenia prevalence according to frailty status.

	Frailty (CFS)			
	No frailty n (%)	Mild & moderate frailty n (%)	Severe Frailty n (%)	p-value
Malnutrition (NST)				
Low risk	146 (82.0 %)	156 (73.6 %)	130 (61.3 %)	<0.001
Medium risk	4 (2.3 %)	6 (2.8 %)	8 (3.8 %)	
High risk	28 (15.7 %)	50 (23.6 %)	74 (34.9 %)	
Malnutrition (GNRI)				
No & low risk	99 (79.2 %)	129 (74.1 %)	90 (52.6 %)	<0.001
Moderate risk	20 (16.0 %)	33 (19.0 %)	48 (28.1 %)	
Major risk	6 (4.8 %)	12 (6.9 %)	33 (19.3 %)	
Malnutrition (GLIM)				
Normal Nutrition Status	103 (69.1 %)	125 (61.9 %)	93 (47.9 %)	<0.001
Moderate Malnutrition	25 (16.8 %)	33 (16.3 %)	32 (16.5 %)	
Severe Malnutrition	21 (14.1 %)	44 (21.8 %)	69 (35.6 %)	
Sarcopenia (SARC-F)				
No sarcopenia n (%)	151 (67.1 %)	69 (30.7 %)	5 (2.2 %)	<0.001
Sarcopenia present n (%)	36 (7.4 %)	180 (37.1 %)	269 (55.5 %)	

Data presented as number (%) of patients for each frailty subcategory. P-values were calculated using chi-square test.

Table 3
Cox regression analysis examining the associations between malnutrition, sarcopenia, and frailty and patient survival times.

Variable	Category	Unadjusted			Adjusted [b]	
		30 d surv [a]	HR (95 % CI)	P	HR (95 % CI)	P
Malnutrition	Low risk	88.9 %	1	**0.02**	1	**0.03**
(NST)	Med/High	81.1 %	1.74 (1.09, 2.78)		1.78 (1.07, 2.94)	
Malnutrition	No/low	88.3 %	1	0.05	1	0.05
(GNRI)	Mod. Risk	91.7 %	0.71 (0.33, 1.54)		0.72 (0.33, 1.56)	
	Major risk	76.1 %	2.13 (1.07, 4.21)		2.18 (1.04, 4.55)	
Malnutrition	Normal	87.5 %	1	0.74	1	0.27
(GLIM)	Mild/mod	90.5 %	0.77 (0.36, 1.66)		0.46 (0.18, 1.20)	
	Severe	89.5 %	0.84 (0.45, 1.59)		0.80 (0.40, 1.58)	
Sarcopenia	Absent	88.2 %	1	**0.008**	1	**0.001**
(SARC-F)	Present	79.2 %	1.86 (1.18, 2.93)		2.60 (1.51, 4.73)	
Frailty	No frailty	91.3 %	1	**<0.001**	1	**<0.001**
(CFS)	Mild/mod.	86.8 %	1.54 (0.84, 2.85)		2.02 (1.01, 4.07)	
	Severe	71.8 %	3.71 (2.13, 6.47)		4.89 (2.55, 9.35)	

HR = Hazard Ratio, CI = Confidence Interval. Significant values are in bold text
[a] 30-day survival based on Kaplan–Meier estimate.
[b] Adjusted for: age, sex, number of comorbidities, number of medications.

3.6. Blood science

Blood biomarkers presented significant variations based on malnutrition, sarcopenia, and frailty subgroups (Appendix 4). Individuals at low risk of malnutrition (NST and GNRI), normal nutritional status by GLIM, as well as non-sarcopenic and non-frail patients had considerably greater median albumin levels. Likewise, CRP and CRP/albumin levels were significantly lower in those at low malnutrition risk (NST and GNRI), and in patients with absent sarcopenia and frailty. Hence, patients with malnutrition, sarcopenia and frailty presented higher CRP and CRP/albumin levels, uncovering a potential association between inflammation and the manifestation of these geriatric syndromes. Nonetheless, malnutrition by GLIM did not exhibit a statistical difference in median values.

4. Discussion

The aim of this retrospective clinical audit was to investigate the prevalence and overlap of malnutrition, sarcopenia, and frailty in a large cohort of very old aged (>85 years) hospitalised patients. Correspondingly, the major outcome of this investigation was the noteworthy prevalence of malnutrition (28.3–41.2 %), and high prevalence of sarcopenia (68.3 %), and frailty (73.2 %) identified in the cohort. The most prevalent condition was frailty, with its occurrence closely aligning with the proportion of 79.6 % reported in unplanned hospital admissions amongst older individuals [34]). The current project also demonstrated that a concerningly high percentage of patients were affected by at least one of the three conditions, equivalent to 79.2 %–85.1 %. Likewise, many presented with coexisting syndromes (Fig. 3), with around 20.8 %–29 % of patients having all three concurrently. Another remark is that the presence of sarcopenia alone in isolation is a very small proportion, which is not surprising given the nature of the overlapping physical symptoms of advancing sarcopenia and physical frailty It was also suggested that when malnutrition and sarcopenia co-occur in older hospital patients, it is likely that frailty is also present as an underlying condition. Furthermore, the syndromes were found to affect the distribution of each other (Table 2).

Overall, these findings reveal the genuine intertwined relationship between malnutrition, sarcopenia, and frailty; reflecting that older inpatients frequently suffer simultaneously from one or multiple geriatric syndromes. Indeed, a systematic review and meta-analysis previously estimated that nearly half of older hospitalised patients suffered from at least two of these three debilitating conditions [20]. Such findings are alarming since the manifestation of one condition can provoke the onset of another and, as a consequence, health complications could dramatically escalate. A study already reported higher mortality risks,

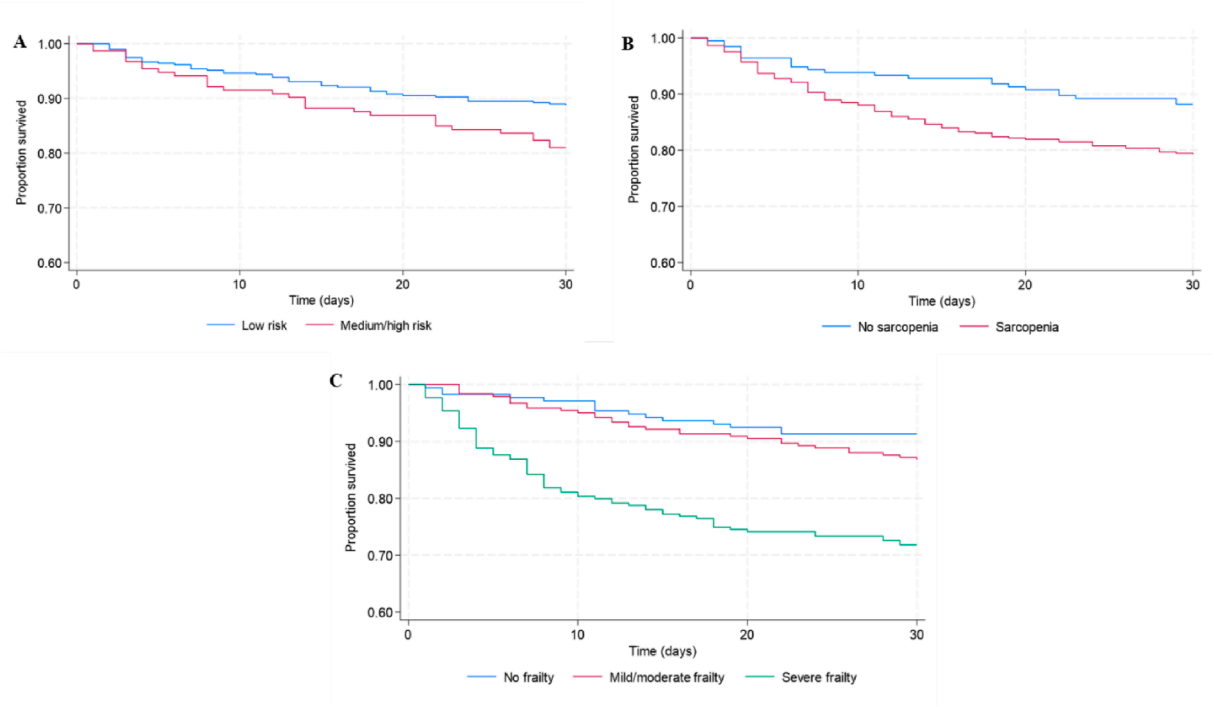

Fig. 4. Kaplan–Meier survival plots for (A) malnutrition risk by NST, (B) sarcopenia risk by SARC-F and (C) frailty by CFS.

approximately four-fold higher, in cirrhotic patients aged 57 or older with simultaneous malnutrition, sarcopenia, and frailty [35]. Therefore, the implementation of comprehensive and standardized screening strategies both at admission time and throughout the hospital stay is crucial to improve health outcomes [20].

Furthermore, the development and progression of frailty is a dynamic process, with evidence pointing towards the capacity of reaching reversibility [36,37], which emphasizes the growing importance of early detection to constrain its evolution. Identifying these conditions is also vital to determine the course of nutritional and physical activity/rehabilitation interventions reported to foster positive anabolic responses in malnourished frail patients [38]. These anabolic responses, may sometimes translate into improving muscle strength and function, potentially curbing the advancement of physical impairments, and ultimately, improving patients' quality of life. Thus, timely recognition of each geriatric condition stands as the crucial first step to reduce poor health in clinical practice and could be achieved by optimising the existent comprehensive geriatric assessments (CGA).

However, the identification of these conditions is highly reliable on the assessment tool employed. For instance, the proportion of people identified at low risk of malnutrition or normal nutritional status by NST was 71.6 %, compared to 67.2 % by GNRI and 58.8 % by GLIM (Fig. 2). A resembling variability was found between the MUST and the mini nutritional assessment short-form (MNA-SF) in a study involving care home residents, with considerably lower rates of malnutrition reported by the former [39]. This ambivalence in the results highlights important inconsistencies in the predictive ability of certain tools, and possibly UK screening practices using the MUST could be misinterpreting the precise extent of malnutrition prevalence.

Therefore, when aiming to improve clinical management such variability between methods has to be considered, given that underreporting malnutrition has a myriad of negative health repercussions, whereas early identification is associated to better nutritional care [40]. It is imperative to employ sensitive instruments to effectively recognise high-risk geriatric patients, and the MNA-SF, validated to assess nutritional status in older adults (aged >65), is a suitable approach for the geriatric population. Another key assessment method is GLIM, recently formulated by a group of experts [30] and potentially deemed as the gold standard to identify malnutrition in clinical practice [23]. Interestingly, GLIM was capable of recognising malnutrition in older hospital patients that had been previously disguised by the nutritional risk screening 2002 (NRS-2002) [41]. Additional evidence of its applicability in this population surfaces from a prospective analysis in which malnutrition defined by GLIM was a predictor of sarcopenia, frailty, and mortality over a 14-year follow-up period [42]. Therefore, GLIM, by accounting for criteria like muscle mass loss, which strongly links to sarcopenia and frailty, offers a comprehensive and wider view of health status.

Mortality risk examinations in the current study (Table 3) revealed that malnutrition risk was associated with survival times when defined by NST screening (Fig. 4 A). On the contrary, malnutrition risk as defined by GNRI and GLIM were not strongly related with mortality risk. This irregularity may have been a result of applying GLIM retrospectively and constrained by the available information in the audits (e.g. full availability of blood markers and lack of body composition/muscle assessment), rather than on-site, and not being able to perform a full malnutrition assessment. Alternatively, there is potential that due to the differing questions in the NST (appendix 1), for example, including questions on whether a patient is being tube fed, has presence of pressure ulcers and reduced food intake over period, whether this provides additional important information linking to severity of condition, and hence mortality risk. Sarcopenia risk by SARC-F screening and frailty by CFS were both associated with a higher risk of death. Notably, comparable observations have been described between greater SARCF-F scores [43], as well as higher CFS scores [44] and increased risk of mortality (Fig. 4 B + C).

According to the blood biomarkers analyses, the value of biomarkers significantly differed in relation to malnutrition, sarcopenia, and frailty status (Appendix 4), which was particularly true

for albumin, CRP, and CRP/albumin. Albumin has importance and relevance, and is a core component of the GNRI calculation, and data from this study showed inferior levels associated with increased risk of malnutrition, sarcopenia and frailty. Previous studies have highlighted albumin including one that involved 1389 hospitalised individuals at malnutrition risk, in which patients with lower albumin levels presented higher mortality rates than those with normal concentrations [45]. Another investigation further underscored the prognostic value of albumin by recognising a potential relationship between albumin levels and MNA-SF scores [46]. Additionally, a prior investigation identified that CRP/albumin is associated to reduced energy intake and serves as a protein-energy malnutrition indicator in hospitalised frail older adults [47]. Such findings mirror those from this study, as CRP/albumin levels were higher in patients at risk of malnutrition (GNRI and NST), sarcopenic and frail individuals.

Lastly, these insights jointly shed light on the potential usage of blood biomarkers as simple obtainable indicators of geriatric conditions, as well as predictors of clinical outcomes. Therefore, the development of innovative assessment methods that incorporate blood science parameters like CRP/albumin represents a promising avenue of research.

5. Limitations

While the present audit holds significant value for clinical practice, it is not without its limitations. Firstly, the cohort mostly comprised very old patients of white ethnicity, which is not entirely representative of the entire UK population (across all age ranges) and reduces the generalisability of the results. Likewise, the retrospective nature of the study coupled with the lack of a follow-up period made it impossible to evaluate changes in patients' health over time, or to track readmission and post-discharge mortality rates.

Another noteworthy limitation is that only certain criteria were considered for malnutrition evaluation according to GLIM. This potentially diminished the efficacy to recognise patients with malnutrition, since this method was designed to assess all five etiological and phenotypical criteria for a definitive exclusion or diagnosis of malnutrition (30). Similarly, the screening of sarcopenia was performed using the SARC-F questionnaire alone, and objective muscle strength/physical function tests and additional body composition techniques would offer robust insights on true sarcopenia diagnosis. The dual-energy X-ray absorptiometry (DXA) is considered the gold-standard technique for body composition assessments in clinical settings and is the best approach to characterise sarcopenia [48,49]. Nonetheless, due to practical and cost constraints, techniques such as adjusted (adjusted for BMI and presence of edema) calf circumference assessment might help detect reduced muscle mass in routine clinical practice [50]. Consequently, to clearly elucidate the prevalence and relationship between malnutrition, sarcopenia and frailty, future investigations should use the complete GLIM criteria. In addition, integrating both muscle function and muscle mass assessments would not only provide a more precise sarcopenia diagnosis but would facilitate the accurate identification of patients living with sarcopenic obesity; a condition in which muscle loss tends to remain undetected for longer, and patients have hidden muscle wasting not detected by conventional nutrition screening [51].

6. Conclusion

This real world clinical audit addresses an important research gap by providing critical insights on the overlapping widespread prevalence of malnutrition, sarcopenia and frailty in a large group of very old (>85 years) medical inpatients. Future studies are essential to corroborate the interplay in this vulnerable patient population, with an importance directed at evaluating nutritional risk screening tool accuracy in line with gold standard assessment. Additionally, the utility of blood biomarkers as predictors of adverse clinical outcomes symbolises a valuable research path. Nevertheless, as the population increasingly ages, the undisputable key to enhancing health trajectory lies in optimising CGA by incorporating meticulous evaluations and regular re-assessments for each debilitating condition: malnutrition, sarcopenia, and frailty.

Author contributions

AS and DS conceived and planned the study. DS collected hospital patient audit data. XJ and JG performed preliminary analyses. MSV performed analysis and wrote the initial manuscript draft. PB provided additional external expert statistical support with data analysis and key aspects of the Results section. AS and DS finalised work and all authors contributed to the final draft submission.

Declaration of competing interest

There were no conflicts of interest for any of the authors.

Acknowledgements and Funding Statement

There was no funding for this project.

Appendices

Appendix 1. Nutritional Screening Tool.

Instructions: Complete this form within 24 h of hospital admission.

Date and time of assessment		
Usual weight (kg):	Re-admission	Previous Week's score:
Height (m)	of re-	Weight (kg):
(can be estimated using ulna length)	assessment score	
	Weight (kg):	
Is the patient on the tube feed (NG/PEG/jejunostomy) or parenteral nutrition?		
NO	0	
YES	3	
Is the Body Mass Index (BMI) in the pale blue category (<18.5 kg/m^2) (BMI calculation)		
NO	0	
(BMI = ….) YES	3	
Does patient have a grade 3–4 pressure sore?		
NO	0	
YES	3	
Has the patient unintentionally been eating less in the last 6 months or since the last assessment?		
NO	0	
YES	2	
Nil by mouth (NBM) for ≥5 days	3	
TOTAL SCORE		
Date patient referred to dietitian		
Nurse's name and signature		

ACTION PLAN.

Score 0 = Re-assess and weigh patients throughout hospital stay
Score 2 =
- Start on food chart
- Encourage milky drinks and high protein/high calorie foods
- Consider using the Red Tray
- Repeat screening weekly and monitor

Score 3 or over =
- Actions as for Score 2 above
- Refer to dietitian within 24 h using the electronic referral system
- Please give nutrition screening score and state reason for referral
- Discuss with multi-disciplinary team (MDT)

March 2014 Nutrition Screening Tool. Produced by the Department of Nutrition & Dietetics, Lewisham and Greenwich NHS Trust. Adapted with permission form original by Dr Liz Weekes, Research Dietitian, Guy's and St Thomas Foundation Trust.

Appendix 2. Equations employed to predict malnutrition risk with the GNRI [29].

WLo for men: H - 100 - [(H 150)/4]
WLo for women: H - 100 - [(H 150)/2.5]
GNRI: [1.489 × albumin (g/L)] + [41.7 × (weight/WLo)]

WLo = Ideal body weight calculated from the Lorentz equations; **H** = height.

Appendix 3. SARC-F questionnaire utilised to screen for sarcopenia [31].

Component	Question	Scoring
Strength	How much difficulty do you have in lifting and carrying 10 pounds?	None = 0 Some = 1 A lot or unable = 2
Assistance in walking	How much difficulty do you have walking across a room?	None = 0 Some = 1 A lot, use aids, or unable = 2
Rise from a chair	How much difficulty do you have transferring from a chair or bed?	None = 0 Some = 1 A lot or unable without help = 2
Climb stairs	How much difficulty do you have climbing a flight of 10 stairs?	None = 0 Some = 1 A lot or unable = 2
Falls	How many times have you fallen in the past year?	None = 0 1–3 falls = 1 4 or more falls = 2

Appendix 4. Inflammatory and Nutritional Biomarkers According to the status of Malnutrition, Sarcopenia and Frailty.

	Sodium (mmol/)	Albumin (g/L)	Haemoglobin (g/L)	CRP (mg/L)
Malnutrition (NST)				
Low risk	137 [134–140]	37 [34–40]	121 [107–133]	26 [7–79]
Medium risk	138 [133–141]	36 [32–39]	123 [114–136]	81 [16–137]
High risk	137 [133–140]	35 [31–39]	120 [106–129]	41 [15–123]
p-value	0.790	<0.001	0.300	0.004
Malnutrition (GNRI)				
No & low risk	137 [134–141]	38 [35–41]	123 [112–134]	21 [6–68]
Moderate risk	137 [133–141]	33 [31–36]	111 [100–128]	34 [11–73]
Major risk	138 [132–140]	29 [26–33]	112 (101–125]	108 [41–201]
p-value	0.610	<0.001	<0.001	<0.001
Malnutrition (GLIM)				
Normal Nutrition Status	137 [134–140]	37 [34–41]	123 [110–135]	29 [7–82]
Moderate Malnutrition	137 [134–140]	36 [31–38]	114 [101–128]	39 [10–84]
Severe Malnutrition	138 [134–141]	35 [33–39]	120 [106–130]	29 [8–86]
p-value	0.842	0.004*	0.006*	0.720
Sarcopenia (SARCF)				
No sarcopenia	137 [134–140]	38 [35–41]	122 [109–136]	20 [4–72]
Sarcopenia present	138 [134–141]	35 [32–39]	121 [107–133]	40 [12–99]
p-value	0.264	<0.001*	0.450	<0.001*
Frailty (CFS)				
No frailty	137 [134–141]	38 [34–41]	122 [111–136]	20.5 [5–70]
Mild & moderate frailty	137 [134–140]	37 [34–40]	123 [106–135]	29 [6–81]
Severe frailty	138 [133–141]	35 [32–38]	119 [105–131]	42 [14–116]
p-value	0.420	<0.001*	0.085	<0.001

	Urea (mmol/L)	Creatinine (mmol/L)	CRP/ Albumin	Urea/ Creatinine
Malnutrition (NST)				
Low risk	8.3 [6.2–12.4]	100 [75–131]	8 [2–22]	84 [68–109]
Medium risk	9.7 [6.1–17.6]	101 [84–142]	27 [6–43]	105 [73–127]
High risk	9.1 [6.8–13.2]	93 [72–119]	12 [4–36]	1001 [72–126]
p-value	0.31	0.210	0.002	0.002
Malnutrition (GNRI)				
No & low risk	8.8 [6.2–12.8]	102 [77–134]	6 [2–18]	86 [69–109]
Moderate risk	8.3 [6.5–14]	88 [69–123]	10 [3.2–23]	97 [73–130]
Major risk	8.8 [5.9–12.7]	97 [70–123]	37 [15–73]	88 [69–125]
p-value	0.851	0.02	<0.001	0.060
Malnutrition (GLIM)				
Normal Nutrition Status	8.9 [6.2–12.9]	102 [78–136]	8 [2–23]	86 [68–112]
Moderate Malnutrition	8.3 [6.3–12.8]	100 [67–130)]	14 23–23]	88 [67–114]
Severe Malnutrition	8.6 [6.6–13.2]	88 [71–117]	8 [2–30]	97 [77–125]
p-value	0.830	0.008	0.410	0.023
Sarcopenia (SARCF)				
No sarcopenia	8.9 [6.3–12.5]	102 [82–131]	5 [1–19]	86 [70–108]
Sarcopenia present	9.1 [6.4–14.3]	99 [73–138]	11 [3.4–29]	90 [69–125]
p-value	0.207	0.320	<0.001	0.052
Frailty (CFS)				
No frailty	8.6 [6.3–12.1]	100 [84–133]	6 [1–19]	82 [68–101]
Mild & moderate frailty	8.9 [6.4–13.6]	100 [73–135]	9 [2–23]	90 [70–116]
Severe frailty	9.2 [6.6–14.3]	98 [73–138]	13 [4–38]	92 [70–124]
p-value	0.192	0.222	<0.001	0.003

Data expressed as median [IQR]. P-values were determined with Kruskal Wallis test for non-binary data and Mann–Whitney test for binary categorical data.

References

[1] Roberts SB, Rosenberg I. Nutrition and aging: changes in the regulation of energy metabolism with aging. Physiol Rev 2006;86(2):651–67.
[2] Landi F, Calvani R, Tosato M, Martone AM, Ortolani E, Savera G, et al. Anorexia of aging: risk factors, consequences, and potential treatments. Nutrients 2016;8(2):69.
[3] Dent E, Hoogendijk EO, Visvanathan R, Wright ORL. Malnutrition screening and assessment in hospitalised older people: a review. J Nutr Health Aging 2019;23(5):431–41.
[4] Norman K, Pichard C, Lochs H, Pirlich. Prognostic impact of disease-related malnutrition. Clin Nutr 2008;27(1):5–15.
[5] Pirlich M, Schütz T, Norman K, Gastell S, LÜbke HJ, Bischoff SC, et al. The German hospital malnutrition study. Clin Nutr 2006;25(4):563–72.

[6] Pierik VD, Meskers CGM, Van Ancum JM, Numans ST, Verlaan S, Scheerman K, et al. High risk of malnutrition is associated with low muscle mass in older hospitalized patients - a prospective cohort study. BMC Geriatr 2017;17(1):118.
[7] Morley JE. Anorexia of ageing: a key component in the pathogenesis of both sarcopenia and cachexia. J Cachexia, Sarcopenia Muscle 2017;8(4):523–6.
[8] Tsutsumimoto K, Doi T, Nakakubo S, Kim M, Kurita S, Ishii H, et al. Association between anorexia of ageing and sarcopenia among Japanese older adults. J Cachexia, Sarcopenia Muscle 2020;11(5):1250–7.
[9] Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, BruyÉre O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing 2019;48(1):16–31.
[10] Dalle S, Rossmeislova L, Koppo K. The role of inflammation in age-related sarcopenia. Front Physiol 2017;8.
[11] Bertschi D, Kiss CM, Beerli N, Kressig RW. Sarcopenia in hospitalized geriatric patients: insights into prevalence and associated parameters using new EWGSOP2 guidelines. Eur J Clin Nutr 2021 Apr;75(4):653–60.
[12] Malmstrom TK, Miller DK, Simonsick EM, Ferrucci L, Morley J. SARC-F: a symptom score to predict persons with sarcopenia at risk for poor functional outcomes. J Cachexia, Sarcopenia Muscle 2016;7(1):28–36.
[13] Antunes AC, Araújo DA, Veríssimo MT, Amaral TF. Sarcopenia and hospitalisation costs in older adults: a cross-sectional study. Nutr Diet 2017;74(1):46–50.
[14] Bachettini NP, Bielemann RM, Barbosa-Silva TG, Menezes AMB, Tomasi E, Gonzalez MC. Sarcopenia as a mortality predictor in community-dwelling older adults: a comparison of the diagnostic criteria of the European Working Group on Sarcopenia in Older People. Eur J Clin Nutr 2020 Apr;74(4):573–80.
[15] Fried LP, Tangen CM, Walston J, Newman AB, Hirsch C, Gottdiener J, et al. Cardiovascular Health Study Collaborative Research Group. Frailty in older adults: evidence for a phenotype. J Gerontol A Biol Sci Med Sci 2001 Mar;56(3):M146–56.
[16] Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet 2013;381(9868):752–62.
[17] Han L, Clegg A, Doran T, Fraser L. The impact of frailty on healthcare resource use: a longitudinal analysis using the Clinical Practice Research Datalink in England. Age Ageing 2019;48(5):665–71.
[18] Crocker TF, Brown L, Clegg A, Farley K, Frankin M, Simpkins S, et al. Quality of life is substantially worse for community-dwelling older people living with frailty: systematic review and meta-analysis. Qual Life Res 2019;28(8):2041–56.
[19] Clegg A, Young J. The frailty syndrome. Clin Med 2011;11(1):72–5.
[20] Ligthart-Melis GC, Luiking YC, Kakourou A, Cederholm T, Maier A, de van der Schueren MAE. Frailty, sarcopenia, and malnutrition frequently (Co-)occur in hospitalized older adults: a systematic review and meta-analysis. J Am Med Dir Assoc 2020;21(9):1216–28.
[21] Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. Educational and Clinical Practice Committee, European Society of Parenteral and Enteral Nutrition (ESPEN). ESPEN guidelines for nutrition screening 2002. Clin Nutr 2003 Aug;22(4):415–21.
[22] Murphy J, Mayor A, Forde E. Identifying and treating older patients with malnutrition in primary care: the MUST screening tool. Br J Gen Pract 2018;68(672):344–5.
[23] Huo Z, Chong F, Yin L, Lu Z, Liu J, Xu H. Accuracy of the GLIM criteria for diagnosing malnutrition: A systematic review and meta-analysis. Clin Nutr 2022 Jun;41(6):1208–17.
[24] Sousa-Santos AR, Afonso C, Borges N, Santos A, Padrão P, Moreira PF, et al. Sarcopenia, physical frailty, undernutrition and obesity cooccurrence among Portuguese community-dwelling older adults: results from Nutrition UP 65 cross-sectional study. BMJ Open 2020 Jun 15;10(6):e033661.
[25] Almohaisen N, Gittins M, Todd C, Sremanakova J, Sowerbutts AM, Aldossari A, et al. Prevalence of Undernutrition, Frailty and Sarcopenia in Community-Dwelling People Aged 50 Years and Above: Systematic Review and Meta-Analysis. Nutrients 2022 Apr 7;14(8):1537.
[26] Faxén-Irving G, Luiking Y, Grönstedt H, Franzén E, Seiger Å, Vikström S, et al. Do Malnutrition, Sarcopenia and Frailty Overlap in Nursing-Home Residents? J Frailty Aging 2021;10(1):17–21.
[27] Smithard D, Hansjee D, Henry D, Mitchell L, Sabaharwal A, Salkeld J, et al. Inter-Relationships between Frailty, Sarcopenia, Undernutrition and Dysphagia in Older People Who Are Admitted to Acute Frailty and Medical Wards: Is There an Older Adult Quartet? Geriatrics (Basel) 2020 Jun 30;5(3):41.
[28] Weekes CE, Elia M, Emery PW. The development, validation and reliability of a nutrition screening tool based on the recommendations of the British Association for Parenteral and Enteral Nutrition (BAPEN). Clin Nutr 2004;23(5):1104–12.
[29] Bouillanne O, Morineau G, Dupont C, Coulombel I, Vincent JP, Nicolis I, et al. Geriatric Nutritional Risk Index: a new index for evaluating at-risk elderly medical patients. Am J Clin Nutr 2005 Oct;82(4):777–83.
[30] Cederholm T, Jensen GL, Correia MITD, Gonzalez MC, Fukushima R, Higashiguchi T, et al. GLIM criteria for the diagnosis of malnutrition – a consensus report from the global clinical nutrition community. Clin Nutr 2019;38(1):1–9.
[31] Malmstrom TK, Morley JE. SARC-F: a simple questionnaire to rapidly diagnose sarcopenia. J Am Med Dir Assoc 2013;14(8):531–2.
[32] Rockwood K. A global clinical measure of fitness and frailty in elderly people. Can Med Assoc J 2005;173(5):489–95.
[33] Mendiratta P, Schoo C, Latif R. Clinical frailty scale. 2024.
[34] Boucher EL, Gan JM, Rothwell PM, Shepperd S, Pendlebury ST. Prevalence and outcomes of frailty in unplanned hospital admissions: a systematic review and meta-analysis of hospital-wide and general (internal) medicine cohorts. eClinicalMedicine 2023;59:101947.
[35] Guo G, Wang H, Yang W, Li C, Zhao X, Fan X, et al. The relationship between sarcopenia, multidimensional frailty, and malnutrition cluster and long-term mortality in hospitalized patients with cirrhosis. Portal Hypertension & Cirrhosis 2023;2(2):51–60.
[36] Gill TM, Gahbauer EA, Allore HG, Han L. Transitions between frailty states among community-living older persons. Arch Intern Med 2006;166(4):418.
[37] Travers J, Romero-Ortuno R, Bailey J, Cooney MT. Delaying and reversing frailty: a systematic review of primary care interventions. Br J Gen Pract 2019;69(678):e61–9.
[38] Hébuterne X, Bermon S, Schneider SM. Ageing and muscle: the effects of malnutrition, re-nutrition, and physical exercise. Curr Opin Clin Nutr Metab Care 2001;4(4):295–300.
[39] Tu Y, Garden G, Wilkinson L, Slee A. The prevalence of malnutrition (MUST and MNA-SF), frailty and physical disability and relationship with mortality in older care home residents. Clini Nutri Open Sci 2023;51:98–108.
[40] Eglseer D, Halfens RJG, Lohrmann C. Is the presence of a validated malnutrition screening tool associated with better nutritional care in hospitalized patients? Nutrition 2017;37:104–11.
[41] Trollebø MA, Skeie E, Revheim I, Stangeland H, Erstein MH, Grønning MK, et al. Comparison of nutritional risk screening with NRS2002 and the GLIM diagnostic criteria for malnutrition in hospitalized patients. Sci Rep 2022;12(1):19743.
[42] Yeung SSY, Chan RSM, Kwok T, Lee JSW, Woo J. Malnutrition according to GLIM criteria and adverse outcomes in community-dwelling Chinese older adults: a prospective analysis. J Am Med Dir Assoc 2021;22(9):1953–1959.e4.
[43] Ueshima J, Maeda K, Ishida Y, Himizu A, Inoue T, Nonogaki T, et al. SARC-F predicts mortality risk of older adults during hospitalization. J Nutr Health Aging 2021;25(7):914–20.
[44] Pal LM, Manning L. Palliative care for frail older people. Clin Med 2014;14(3):292–5.
[45] Bretscher C, Boesiger F, Kaegi-Braun N, Hersberger L, Lobo DN, Evans DC, et al. Admission serum albumin concentrations and response to nutritional therapy in hospitalised patients at malnutrition risk: secondary analysis of a randomised clinical trial. eClinicalMedicine 2022;45:101301.
[46] Slee A, Birch D, Stokoe D. The relationship between malnutrition risk and clinical outcomes in a cohort of frail older hospital patients. Clin Nutri ESPEN 2016;15:57–62.
[47] Sanson G, Bertocchi L, Dal Bo E, Di Pasquale CL, Zanetti. Identifying reliable predictors of protein-energy malnutrition in hospitalized frail older adults: a prospective longitudinal study. Int J Nurs Stud 2018;82:40–8.
[48] Cruz-Jentoft AJ, Baeyens JP, Bauer JM, Boirie Y, Cederholm T. Landi Fet al. Sarcopenia: european consensus on definition and diagnosis. Age Ageing 2010;39(4):412–23.
[49] Guglielmi G, Ponti F, Agostini M, Amadori M, Battista G, Bazzocchi A, et al. The role of DXA in sarcopenia. Aging Clin Exp Res 2016;28(6):1047–60.
[50] Sousa IM, Burgel CF, Silva FM, Fayh APT. Prognostic value of isolated sarcopenia or malnutrition–sarcopenia syndrome for clinical outcomes in hospitalized patients. Nutrients 2022;14(11):2207.
[51] Donini LM, Busetto L, Bischoff SC, Cederholm T, Ballesteros-Pomar MD, Batsis JA, et al. Definition and diagnostic criteria for sarcopenic obesity: ESPEN and EASO consensus statement. Obes Facts 2022;15(3):321–35.