Original article

ASPEN-AND-ESPEN: A postacute-care comparison of the basic definition of malnutrition from the American Society of Parenteral and Enteral Nutrition and Academy of Nutrition and Dietetics with the European Society for Clinical Nutrition and Metabolism definition

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SUMMARY

Background: The aim of this study was to assess the prevalence of malnutrition by applying the ASPEN/AND definition and the ESPEN consensus definition in a postacute-care population, and secondly, to determine the metrological properties of the set of six clinical characteristics that constitute the ASPEN/AND basic diagnosis, compared to the ESPEN consensus, based mostly on objective anthropometric measurements.

Methods: Prospective study of 84 consecutive deconditioned older inpatients (85.4 ± 6.2; 59.5% women) admitted for rehabilitation in postacute care. ASPEN/AND diagnosis of malnutrition was considered in presence of at least two of the following: low energy intake, fluid accumulation, diminished handgrip strength, and loss of weight, muscle mass, or subcutaneous fat. Sensitivity, specificity, positive and negative predictive values, accuracy, likelihood ratios, and kappa statistics were calculated for ASPEN/AND criteria and compared with ESPEN consensus.

Results: The prevalence of malnutrition by ASPEN/AND criteria was 63.1% and by ESPEN consensus, 20.2%; both diagnoses were associated with significantly longer length of stay, but the ESPEN definition was significantly associated with poorer functional outcomes after the rehabilitation program. Compared to ESPEN consensus, ASPEN/AND diagnosis showed fair validity (sensitivity = 94.1%; specificity = 44.8%); kappa statistic was 2.217.

Conclusions: Applying the ASPEN/AND definition obtained a higher prevalence of malnutrition in a postacute-care population than was identified by the ESPEN definition. ASPEN/AND criteria had fair validity and agreement compared with the ESPEN definition. A simple, evidence-based, unified malnutrition definition might improve geriatric care.

1. Introduction

Malnutrition is a highly prevalent condition related to adverse clinical outcomes in hospitalized older patients, such as longer length of stay, mortality [1], and higher costs [2]. Malnutrition is bidirectionally linked to mobility and disability [3], and therefore, to poor functional outcomes in rehabilitation programs [3–5]. Early identification and management of malnutrition can counteract this negative influence, leading to better functional prognosis and shorter length of stay [5].

In the absence of a standardized diagnostic method, clinicians have been assessing malnutrition with several tools [6,7]. The largest parenteral and enteral societies have proposed diagnostic criteria, but a unified consensus suitable to all populations and settings worldwide is still a challenge for the scientific community [8–11]. The ASPEN/AND definition and ESPEN criteria are among the most widely extended approaches. In 2012, ASPEN/AND proposed a set of six clinical criteria: reduced energy intake, unintentional weight loss, loss of subcutaneous fat, loss of muscle mass, fluid accumulation, and reduced grip strength [11]. More recently, ESPEN launched a new consensus statement for patients at risk of malnutrition, which combines weight loss with either age-related body mass index (BMI) or fat-free mass index (FFMI) as a second alternative to low BMI (<18.5 kg/m^2) [8]. This consensus was further completed with the ESPEN guidelines on definitions and terminology of clinical nutrition [12].

Given that knowledge of the potential relationships between these two definitions might provide an evidence-based approach to key components of malnutrition, the aim of this study was to assess the prevalence of malnutrition in postacute patients, applying both ASPEN/AND and ESPEN definitions; and secondly, to determine the metrological properties of the ASPEN/AND basic diagnosis in comparison with the ESPEN consensus.

2. Methods

Prospective cohort study, reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement [13]. The study was conducted in a postacute care unit focused on comprehensive geriatric assessment and rehabilitation [14] in a university hospital in Barcelona (Catalonia, Spain) in a six-month period June–December 2016.

Participating patients were aged ≥ 70 years with functional impairment due to a non-disabling medical disease, admitted to postacute care for rehabilitation. Patients whose cognitive status (Mini-Mental Status Examination $< 21/30$) and/or general condition prevented completion of the diagnostic tests and/or active physical rehabilitation program were excluded.

The main outcome variable was malnutrition according to both the ASPEN/AND and ESPEN malnutrition criteria. **ASPEN/AND diagnosis of malnutrition** considers the presence of at least two of the following factors: low energy intake, fluid accumulation, diminished hand grip strength, and loss of weight, muscle mass or subcutaneous fat; distinguishes between severe and non-severe malnutrition; these characteristics vary according to care settings for acute or chronic illness and social or environmental circumstances [11]. **Food intake** was estimated by plate waste (%) during hospital stay and categorized as "yes" when food intake was <75% of estimated energy requirement for >7 days, and "no" otherwise. **Unintentional weight loss** was obtained by patient and caregiver anamnesis and medical records documenting weight loss of at least 5% in the previous month (during the acute illness). **Muscle mass** and **fat mass** in kg were estimated by bioimpedance (Bodystat 1500, Bodystat Ltd., Isle of Man British Isles) as previously described [14–16] and compared with those of the European reference

population [17]. **Water content**, expressed in liters (L), was also measured by bioimpedance analysis and compared with values of same-aged healthy controls. **Handgrip strength**, expressed in Kg and as a percentage of the reference population values [18], was measured by a hand-held dynamometer (JAMAR, Nottinghamshire, UK) [19]. For purpose of analysis, the highest value of three reproducible isometric contractions of finger flexor muscles (<10% variability between values) was used. Values of body composition and muscle strength less than 80% of the reference data, adjusted for sex and age, were considered decreased.

The **ESPEN basic diagnosis** required identification by any validated screening tool of patients at nutritional risk; scores ≤ 11 in the Mini-Nutritional Assessment Short Form (MNA-SF) were used in this study [20]. The two alternative ways to diagnose malnutrition proposed by the ESPEN criteria are **BMI** < 18.5 kg/m^2 (alternative 1) and unintentional weight loss (>10% indefinite of time, or >5% in the last three months) combined with age-related BMI (BMI < 20 kg/m^2 in <70 years, or <22 kg/m^2 in ≥ 70 years) or FFMI (<17 kg/m^2 in men and <15 kg/m^2 in women). FFMI was obtained by dividing the fat-free mass (kg) by the square of the height.

Other outcome variables were the indexes that determine the overall value of a diagnostic method: sensitivity, specificity, positive predictive value, negative and negative predictive values, positive likelihood ratio, and accuracy index. The cut-off points for validity were sensitivity or specificity <50% (poor validity); sensitivity or specificity <80% but both values >50% (fair validity); and sensitivity and specificity >80% (good validity) [7,21]. Concordance between the ESPEN consensus and ASPEN/AND basic diagnosis was determined with kappa (k) statistics: $k < 0$ (no agreement), 0–0.2 (poor agreement), 0.21–0.4 (fair agreement), 0.41–0.6 (moderate agreement), 0.61–0.8 (substantial agreement), and 0.81–1 (almost perfect agreement) [21,22].

Demographic and clinical characteristics included age, sex, Charlson comorbidity index, cognitive (Short Portable Mental Status Questionnaire), functional status by instrumental (Lawton index) and basic (Barthel index) activities of daily living. Changes in the functional status during hospitalization were assessed with the rehabilitation impact indexes: rehabilitation efficiency index [REI = (Barthel index at discharge−Barthel index at admission)/ (length of hospital stay)], and the relative functional gain [RFG = (Barthel index at discharge − Barthel index at admission)/ (Barthel index premorbid − Barthel index at admission) $\times$ 100] [4,23]. A 10-ml venous blood sample was collected from all patients under standardized conditions between 7 and 9 am, at rest and following an overnight fast to determine total proteins, serum albumin, and cholesterol levels.

National and international research ethics guidelines [24], including the Deontological Code of Ethics, Declaration of Helsinki, and Spain's confidentiality law concerning personal data were followed. Understandable oral and written information was provided to family members and patients, and informed consent to participate was signed by all participants. The institution's Clinical Ethics Committee approved the informed consent process used and the study.

2.1. Statistical analysis

Descriptive analysis of the sample used means with standard deviations for quantitative continuous variables, and percentages and frequency distributions for categorical variables. Sensitivity, specificity, positive and negative predictive values, positive likelihood ratio, and accuracy index were described in percentages. In the case of quantitative variables, the assumption of normality was analyzed through normal probability graphs and using the Kolmogorov–Smirnov test corrected by the Lilliefors test.

Contingency tables were used to calculate the reliability indexes of ASPEN/AND basic diagnosis compared with ESPEN malnutrition basic diagnosis. Each 2 × 2 contingency table contains two rows (positive or negative) for each diagnostic method. Univariate analysis was performed using Chi-square test for categorical variables; in the Student *t*-test for independent samples, mean differences with 95% confidence intervals (95% CI) were used for continuous variables. p value < 0.05 was considered statistically significant. Analysis was performed using IBM SPSS Statistics 22 (IBM Corporation, SPSS, INC., Chicago, IL, USA).

3. Results

Among 84 patients (aged 85.4 ± 6.2; 59.5% women) who fulfilled inclusion criteria, all of them were identified as being "at risk" of malnutrition (MNA-SF scores ≤11). Table 1 shows the general and geriatric assessment results in the whole sample, and in malnourished and non-malnourished patients according to both ESPEN and ASPEN/AND definitions. Patients without malnutrition presented shorter length of stay in postacute care, independently of the criteria used for the diagnosis: mean differences 5.1 (95% CI 0.7–9.5) by ESPEN and 3.1 (95% CI 0.5–5.7) by ASPEN/AND. Patients identified as malnourished by both ESPEN approaches had worse functional status after the rehabilitation process: mean differences of Barthel index at discharge and relative functional gain were 15.5 (95% CI 1.6–29.5), and 29.5 (95% CI 8.4–50.6), respectively. No statistical differences between the definitions were observed in total proteins and serum albumin levels between patients with or without malnutrition.

The prevalence of malnutrition was 20.2%, according to ESPEN basic diagnosis, and 63.1% when ASPEN/AND diagnosis of malnutrition was applied, as shown in Table 2. Unintentional weight loss combined with low FFMI was the ESPEN diagnostic alternative that identified a higher number of malnourished patients (15/17); likewise, loss of handgrip strength was the ASPEN/AND component most frequently present in patients with malnutrition (52/53).

The distribution of patients according to ASPEN/AND and ESPEN criteria is depicted in Fig. 1. From a conceptual and clinical point of view, a comprehensive interpretation of malnutrition characteristics is translated into the "ship and sailboat analogy", where blocks represents all 84 patients at risk of malnutrition, the "sailboat" shape shows patients fulfilling ESPEN criteria and the larger "ship" encompasses patients fulfilling the less restrictive ASPEN/AND criteria.

Table 3 is a contingency table comparing the distribution of ASPEN/AND basic definition and ESPEN basic diagnosis. Metrological properties of the ASPEN basic definition of malnutrition compared with ESPEN basic diagnosis are summarized in Table 4. Sensitivity and specificity of ASPEN/AND basic diagnosis were 94.1% and 44.8%, respectively, indicating fair validity. The agreement between both definitions of malnutrition was fair (k = 0.217).

4. Discussion

This is the first study to simultaneously apply ASPEN/AND and ESPEN definitions of malnutrition in clinical practice, and may contribute to identify the core attributes of malnutrition. The prevalence of malnutrition identified by the ESPEN definition (20.2%) was much lower than that reported using the ASPEN/AND definition (63.2%). This low prevalence is in consonance with previously reported rates obtained by applying the ESPEN consensus definition: 6.7% in diabetic inpatients [1], 15.1% in acute geriatric wards [25], 21% in acute chronic obstructive pulmonary disease inpatients [26], and 20% in postacute care [15,16].

All malnutrition variables considered in ESPEN, except body mass index, are included in ASPEN/AND [27]. In addition to these variables, ASPEN/AND also considered fat mass, fluid retention, and muscle function (e.g. grip strength). The ESPEN approach includes a 2-step process in which patients are identified as being at risk of malnutrition and diagnostic criteria are applied. In contrast, patients who fulfilled 2 of 6 ASPEN/AND criteria for malnutrition are diagnosed directly, as there is no screening phase. Most of malnourished patients according to ESPEN had unintentional weight loss + low FFMI, whilst reduced handgrip strength was the most common component among patients diagnosed by ASPEN/AND.

Table 1
General characteristics of the study participants in the whole sample (n = 84), and in malnourished vs. non-malnourished patients according to ESPEN and ASPEN/AND definitions.

	Total sample (n = 84)	ESPEN malnutrition diagnosis			ASPEN/AND basic diagnosis		
		Malnourished (n = 17)	Non malnourished (n = 67)	p-value	Malnourished (n = 53)	Non malnourished (n = 31)	p-value
Age (years)	85.4 (±6.2)	84.4 (±7.2)	85.6 (±5.9)	0.482	85.7 (±6.4)	84.8 (±5.8)	0.511
Sex (female)	50 (59.5%)	11 (64.7%)	39 (58.2%)	0.626	34 (64.2%)	16 (51.6%)	0.259
Body mass index (kg/m^2)	24.7 (±3.4)	22 (±3.9)	25.4 (±2.9)	**0.003**	23.7 (±3.5)	26.3 (±2.5)	**<0.001**
Charlson comorbidity index	2.4 (±1.9)	2.4 (±2.3)	2.3 (±1.7)	0.869	2.2 (±1.7)	2.6 (±2.0)	0.312
Short portable mental status questionnaire	4.4 (±3.0)	4.5 (±3.0)	4.4 (±3.0)	0.864	4.7 (±3.0)	3.9 (±3.0)	0.205
Lawton index	2.4 (±2.5)	2.4 (±2.7)	2.3 (±2.5)	0.904	2.3 (±2.5)	2.5 (±2.5)	0.637
Barthel index:							
- Prior to admission	68.9 (±21.2)	67.8 (±23.7)	69.2 (±20.7)	0.805	68.3 (±20.9)	69.9 (±21.9)	0.735
- At admission	26.4 (±15.7)	21.9 (±14.1)	27.5 (±16.0)	0.191	24.9 (±15.9)	28.9 (±15.3)	0.256
- At discharge	50.8 (±26.4)	38.4 (±27.4)	54 (±25.3)	0.029	46.7 (±24.7)	57.6 (±28.1)	0.070
Relative functional gain (%)	57.5 (±40.6)	34.1 (±38.7)	63.5 (±39.1)	**0.007**	53.4 (±36.1)	64.4 (±46.9)	0.233
Rehabilitation efficiency index	2.04 (±2.03)	1.4 (±2.3)	2.2 (±1.9)	0.117	1.8 (±1.8)	2.5 (±2.4)	0.122
Length of stay:							
- Prior acute care unit	15.3 (±12.2)	16.4 (±16.2)	15 (±11.1)	0.666	13.8 (±11.7)	17.8 (±12.8)	0.145
- Postacute care	14.6 (±5.9)	18.7 (±8.4)	13.6 (±4.6)	**0.001**	15.8 (±6.6)	12.7 (±3.7)	**0.007**
Total proteins (g/dL)	5.7 (±0.7)	5.9 (±0.7)	5.7 (±0.7)	0.454	5.7 (±0.7)	5.6 (±0.7)	0.586
Albumin (g/dL)	3.3 (±0.4)	3.2 (±0.6)	3.4 (±0.4)	0.213	3.4 (±0.5)	3.3 (±0.4)	0.519
Cholesterol (mg/dL)	147.6 (±33.1)	127.8 (±29.5)	152.7 (±32.2)	**0.005**	143 (±32.7)	155.6 (±32.7)	0.094

Abbreviations: ASPEN/AND, American Society of Parenteral and Enteral Nutrition/Academy of Nutrition and Dietetics; **ESPEN**, European Society of Parenteral and Enteral Nutrition.
Data are given as numbers and percentages for sex distribution; continuous variables are expressed as mean (±standard deviation). Comparisons between malnourished and non-malnourished participants were based on independent samples *t*-test or Chi-square test, as appropriate. Significant p-values (<0.05) are indicated in **bold**.

Table 2
Prevalence of malnutrition according to ESPEN and ASPEN/AND definitions broken down by their respective components.

	Total sample (n = 84)	Malnutrition
ESPEN:		
Prevalence of malnutrition (alternative 1 and/or 2)	17 (20.2%)	
- Alternative 1:		
○ BMI < 18.5(kg/m^2):	4 (4.8%)	4 (23.5%)
- Alternative 2:		
○ Unintentional weight loss + low age-related BMI	7 (8.3%)	7 (41.2%)
○ Unintentional weight loss + low sex-related FFMI	15 (17.9%)	15 (88.2%)
ASPEN/AND:		
Prevalence of malnutrition (patients meet at least 2 ASPEN/AND criteria)	53 (63.1%)	
- Unintentional weight loss	25 (29.8%)	23 (43.4%)
- Loss of muscle mass	35 (41.7%)	25 (47.2%)
- Loss of subcutaneous fat	6 (7.1%)	5 (9.4%)
- Fluid accumulation	10 (11.9%)	10 (18.2%)
- Diminished hand grip strength	76 (90.5%)	52 (98.2%)

Data are given as numbers and percentages. All patients were at risk of malnutrition (MNA-SF score ≤ 11).
In the malnutrition column, calculation of percentages is based on the number of patients diagnosed as malnourished (ESPEN, n = 17; ASPEN/AND, n = 53).
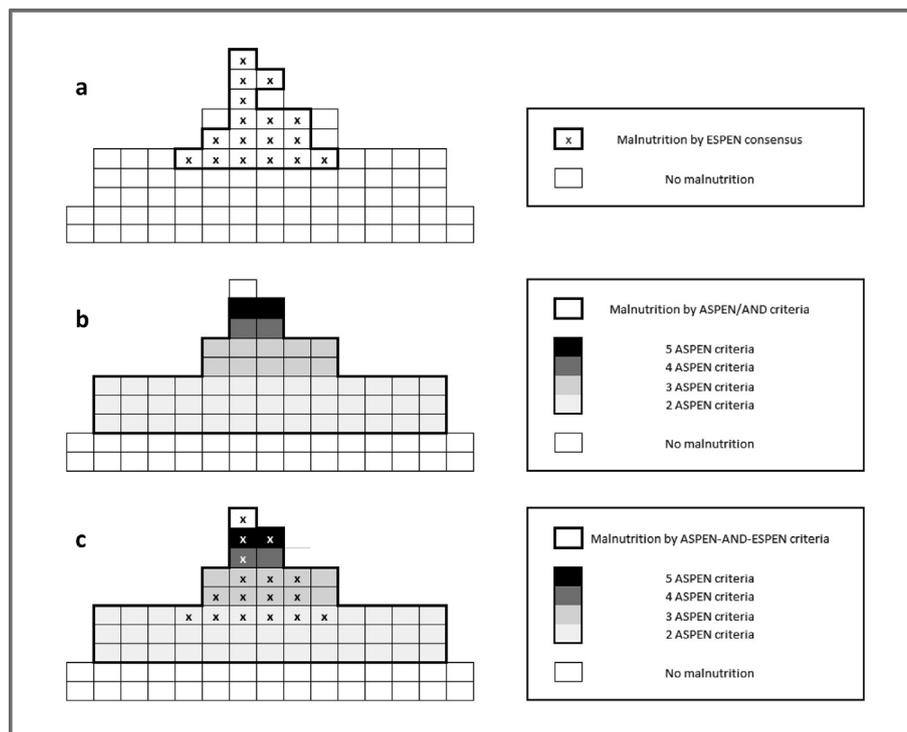

Fig. 1. The Ship and Sailboat analogy: all blocks represent individuals at risk of malnutrition (n = 84). **a.** Malnutrition diagnosed by ESPEN criteria ("sailboat" shape). **b.** Application of ASPEN/AND criteria for malnutrition diagnosis; shading indicates the number of criteria fulfilled ("ship" shape). **c.** The ESPEN sailboat superimposed on the ASPEN/AND ship: the ASPEN-AND-ESPEN cargo ship.

Weight loss combined with low FFMI was present in almost all the postacute malnourished patients. Low FFMI was independently associated with functional decline within 4 years after adjustment for age, muscle strength, physical performance and comorbidities

Table 3
Contingency table showing frequency of malnutrition according to ASPEN/AND basic definition and ESPEN basic diagnosis in postacute care (n = 84).

		ESPEN basic diagnosis		
		Positive	Negative	Total
ASPEN/AND basic	Positive	16	37	53
definition of malnutrition	Negative	1	30	31
	Total	17	67	84

Abbreviations: ASPEN/AND, American Society of Parenteral and Enteral Nutrition/Academy of Nutrition and Dietetics; **ESPEN**, European Society of Parenteral and Enteral Nutrition.

in community-dwelling older women [28]; it was also associated with the highest risk of malnutrition, increased risk of 6 and 9 months mortality and a trend towards higher hospitalization in patients with COPD diagnosed as malnourished by the ESPEN definition [26].

Table 4
Metrological statistics for the application of the ASPEN/AND definition of malnutrition.

	Value	95% CI
Sensitivity (%)	94.1	80.0–100
Specificity (%)	44.8	32.1–57.4
Positive predictive value (%)	30.2	16.9–43.5
Negative predictive value (%)	96.8	88.9–100
Accuracy	54.8	43.5 to 6
Positive likelihood ratio	1.7	1.3–2.2

Most of the patients identified as malnourished by ASPEN/AND criteria had low handgrip strength. Nevertheless, diminished handgrip was also present in 24 patients (28.6%) who did not fulfill ASPEN/AND criteria. Although some authors have suggested that muscle weakness seems to have greater impact on functional outcomes and prognosis than muscle mass in older people [29], it may be less specific in term of nutritional assessment.

Both ASPEN/AND and ESPEN criteria are valid and reliable tools to identify patients with malnutrition, but both also have their pros and cons. The malnutrition grading and approach to distinguishing the malnutrition context (injury, acute or chronic illness, and environmental or social circumstances) are strong points of the ASPEN/AND criteria; however, it is a complex tool using subjective assessment skills rather than objective body composition measures. Conversely, the ESPEN is based on objective anthropometric measurements (BMI and FFMI), but some of them have limited availability in clinical settings and are overly restrictive [9]. Moreover, the etiology-based scheme of ESPEN malnutrition diagnosis emphasizes the role of pathophysiology and distinguishes between disease-related malnutrition with and without inflammation, and malnutrition without disease [9,10]. Another reason to consider the ESPEN basic diagnosis of malnutrition as the gold standard for the purpose of this study was its association with clinical outcomes (functional prognosis and length of stay) in postacute care [16]. In comparison with ESPEN, the ASPEN/AND definition has good sensitivity (94.1%) but low specificity (44.8%), suggesting that ASPEN/AND could probably be more useful to identify early stages of malnutrition or nutrition-related syndromes such as sarcopenia.

Several aspects that might explain the observed differences in the prevalence of malnutrition, favoring the use of the less restrictive ASPEN/AND over ESPEN criteria in postacute care, merit further attention. Even patients with no history of malnutrition may experience extreme metabolic stress due to the acute process, especially frail older people who lack reserves. Accordingly, both age and disease progression could affect the development of malnutrition despite medical therapies and nutritional interventions. Although it is possible that ESPEN criteria are also more sensitive than ASPEN/AND in the acute phase of disease, this cannot be deduced from our observations. We consider it likely that a higher prevalence of malnutrition would be found in acute care using the ASPEN/AND criteria; further studies are needed to address this possibility.

Our study also provides evidence of the lack of association between the two definitions and total proteins, serum albumin and cholesterol levels as markers of malnutrition. Serum albumin and protein C reactive have been included in ESPEN Guidelines as markers of inflammation, useful to distinguish between malnutrition with or without inflammation, but are not themselves markers of malnutrition [30].

Several limitations of this study must be addressed. First, the admission criterion based on a patient's capacity to undergo a short-term rehabilitation program is an initial selection bias for studies conducted in postacute care. Second, the short-form questionnaire administered to screen malnutrition, instead of the full-length MNA, might have increased specificity; nevertheless, the MNA-SF is highly sensitive, which makes it a desirable screening tool [21]. Third, unintentional weight loss is an important component of both ESPEN and ASPEN/AND definitions, but is often difficult to ascertain in the geriatrics practice [31], therefore, it should be measured systematically as part of the comprehensive assessment in all geriatric settings [32]. Finally, the body composition parameters measured by impedance analysis may underestimate fat-free mass because of inherent assumptions about fat distribution and cellular hydration [33].

4.1. Conclusions and future lines of clinical research

Very different prevalence rates for malnutrition assessment were obtained when the ASPEN/AND and ESPEN definitions of malnutrition were applied in postacute care (63.1% and 20.2%, respectively). Both definitions were identified patients with longer length of hospital stay; in addition, the ESPEN basic definition had predictive value for worse functional outcomes after completion of the rehabilitation program. The ASPEN/AND set of basic criteria remained in the low range of fair validity and agreement with the ESPEN consensus. Promoting a simple, valid, universal consensus for nutritional assessment might help researchers and clinicians to counteract malnutrition. The main societies concerned with parenteral and enteral nutrition are immersed in a global conversation seeking a consensus protocol for the diagnosis of malnutrition. Clinicians and researchers, but especially patients, will benefit from the development of tools to facilitate early identification and treatment of malnutrition and nutrition-related conditions, often unrecognized and undertreated in geriatrics care. Our study highlights the need to apply emerging research in clinical settings to improve geriatric care.

Author contributions

DSR and EM conceived and designed the experiments; DSR, EM, and NRM performed the experiments; DSR, EM, and XD analyzed and interpreted the data; DSR, EM, NRM, LMB, AGC, OVI, FE and JMM contributed reagents, materials, analysis tools or data; DSR and EM wrote the draft.

Conflict of interest

All authors declare they do not have any financial or personal relationships with other people or organizations that could inappropriately influence their work.

Acknowledgments

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