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Original article

Nutritional screening on hospital admission and one-year clinical outcomes in a prospective cohort of older patients

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SUMMARY

Background & aims: Malnutrition negatively affects the prognosis and quality of life of hospitalized patients. However, there are several gaps between evidence-based knowledge and current clinical practice. Our primary aim was to describe the prevalence of malnutrition risk in a cohort of in a cohort of older inpatients; secondly, we explored its predictors and its independent impact on 12-month survival.
Methods: Prospective study focused on patients aged 65 years and older consecutively admitted for any reason to the acute geriatric and general medical units of an Italian university hospital. Comprehensive geriatric assessment data, including the short form of the Mini Nutritional Assessment (MNA-SF), were collected within 48 hours of admission. The prevalence of malnutrition and risk of malnutrition according to the MNA-SF represented the main outcome. Correlations among clinical variables, nutritional status, and one-year survival were analyzed using multivariable and Cox models.
Results: Among 594 patients (median age: 84 years, 49.5 % female), mostly living at home with moderate functional autonomy, 82.3 % were identified as probably malnourished or at risk of malnutrition according to MNA-SF (39.9 % and 42.4 %, respectively). Malnutrition and the risk of malnutrition were positively associated with living alone at home (OR 2.803, 95%CI 1.567–5.177, $p < 0.001$), and negatively associated with autonomy in IADL (OR 0.765, 95%CI 0.688–0.846, $p < 0.001$) and the best performance at HST (OR 0.901, 95%CI 0.865–0.936; $p < 0.001$). After 12 months, 31.8 % of patients was dead and mortality was positively correlated with malnutrition according to MNA-SF (OR 2.493, 95%CI 1.345–4.751, $p = 0.004$), institutionalization (OR 2.815, 95%CI 1.423–5.693, $p = 0.003$) and severe cognitive impairment (OR 1.701, 95%CI 1.031–2.803, $p = 0.036$).
Conclusion: Malnutrition is common among older inpatients upon admission, primarily influenced by their functional and cognitive status, and it is linked to a worse prognosis. Early incorporation of thorough nutritional and functional assessments into clinical practice is crucial to improve prognosis prediction and enable timely, focused interventions targeting modifiable causal factors in a patient-centered approach.

1. Introduction

Malnutrition is a complex and multifaceted phenomenon that poses significant challenges for healthcare providers and researchers alike. The European Society for Clinical Nutrition and Metabolism (ESPEN) defines malnutrition as a state resulting from

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undernutrition (including stunting, underweight, and wasting), micronutrient-related malnutrition, and overnutrition that leads to altered body composition and diminished physical and mental function [1,2]. Although a universal definition is still lacking, growing evidence is showing that malnutrition in older individuals has specific features and should be distinguished from the broad spectrum of malnutrition across all age groups [3]. Actually, one of the primary contributors is the intricate interplay of biological aging processes: age-related changes, such as shifts in body composition, reduced nutrient absorption, and diminished taste and smell sensitivity, may result in a decrease in appetite and food intake [4]. Additionally, many factors may contribute to the worsening of nutritional status [5], both clinical (i.e., concomitant diseases, drugs, dysphagia and eating-related problems, cognitive and mood disorders, low functional capacity) [6,7] and socio-economical (i.e., social isolation, limited access to nutritious food, economic constraints) [8,9]. Moreover, hospitalization itself is a risk factor due to illness-related loss of appetite, prescribed fasting for diagnostic procedures, limited food choices, insufficient time to consume meals, and inadequate management of impaired ability to eat and drink [10].

Malnutrition has detrimental effects on the prognosis and quality of life for hospitalized patients. It increases mortality, morbidity, infection rates, prolongs hospital stays, reduces the response to medical treatment, and leads to higher re-hospitalization rates and health expenditure [11–19]. Conversely, interventions to improve nutritional status, such as nutritional support, can lead to lower readmission rates and mortality [20–22].

For these reasons, multiple nutritional guidelines recommend routine screening for malnutrition in older adults across all health-care settings, regardless of an individual's weight, to identify subjects who are malnourished (or at risk of malnutrition) and would benefit from further systematic nutritional assessment and potential personalized intervention [23]. Despite the plethora of available screening tools [24], they all typically contain anthropometric measurement (i.e., body mass index [BMI], calf circumference, or mid-arm circumference) in combination with brief easy-to-administer questions regarding weight loss, changes in appetite, and food intake [10].

However, multiple gaps exist between evidence-based knowledge and current clinical practice, including positive screening not followed up by nutritional assessment, inappropriate advice given to lose weight, oral nutritional supplements given without any follow-up monitoring, and a scarcity of person-centered care [1]. Malnutrition is often underdiagnosed and undertreated during hospitalization, making it difficult to establish its real prevalence globally [23,25,26]. It is estimated that 20–50 % of the population presents malnutrition before hospital admission [24] and about 50 % of these patients maintain or worsen their nutritional status during hospitalization [27]. In geriatric patients, the prevalence of malnutrition is even higher, reaching about 90 % [28], with factors like old age, comorbidities, and polytherapy increasing the risk [29] but being generally underperceived [30]. However, malnutrition (along with various other lifestyle and health-related factors) initiates a well-recognized cascade of complications, including sarcopenia, frailty, and worsening disability, all of which significantly contribute to the risk of adverse clinical outcomes in hospitalized older patients. Therefore, the question of whether clinical interventions for malnutrition might significantly impact prognosis in such complex patients, who generally have poor health status and advanced functional and cognitive limitations affecting the risk of short-term adverse outcomes, remains debatable.

In this study, our primary aim was to describe the prevalence of malnutrition risk in a cohort of patients aged 65 years and older, admitted to both general medical and geriatric acute wards. Secondly, we explored its predictors and its independent impact on mortality, hospitalization, and loss of functional autonomy within 12 months of recruitment.

2. Materials and methods

2.1. Study design and participants

This prospective observational single-center cohort study was carried out at a university teaching hospital in northern Italy. All patients aged 65 years or older consecutively admitted for any reason from the Emergency Department to the acute geriatric and general medical units involved between March and September 2022 were considered for inclusion in the present analysis. Patients who died within 48 hours from admission or with poor short-term prognosis because of known terminal illness were excluded.

The study was conducted according to the Recommendations Guiding Physicians in Biomedical Research Involving Human Subjects and approved by the local Ethics Committee with written informed consent obtained by all patients (or caregivers if they could not express a valid consent). The research was reported conforming to the Strengthening The Reporting of Observational Studies in Epidemiology statements.

2.2. Descriptive variables

Eligible patients were recruited by a resident doctor from the local section of Geriatrics under the supervision of senior specialists in Geriatrics and Internal Medicine within 48 h from admission from Monday to Friday. At the time of enrollment, age, gender, and living condition (i.e., at home with assistance, at home alone, institutionalized), as well as time of admission, duration of hospital stay and vital status at discharge were recorded for each patient. Among physical parameters, weight and height were collected and BMI was derived.

Each patient underwent a routine multidimensional geriatric evaluation by standardized scales to assess functional autonomy, cognitive status, and severity of critical illness. Functional status was evaluated using the Basic Activities of Daily Living scale (BADL; range 0–6, dependent if $\geq$ 2) and a modified version of the Instrumental Activities of Daily Living scale (IADL; range 0–14, partially or completely not autonomous if $\leq$ 9). Cognitive status was evaluated using the Short Portable Mental Status Questionnaire (SPMSQ, range 0–10, moderate to severe cognitive impairment if $\geq$ 5) [31]. Disease burden and severity were evaluated using the Cumulative Illness Rating Scale (CIRS) [32]. This tool rates the severity of diseases (range 1–5, with 1 indicating no affection and 5 severe impairment) according to major organ groups, hypertension, and psychiatric/behavioral area for a total of 14 items. From CIRS ratings, the composite measure of Comorbidity Index (CIRS-CI) was derived, representing the number of items scoring 3 or more excluding the psychiatric/behavioral category [32]. Number of drugs was also noted.

Muscle strength was assessed by handgrip strength test (HST), measured using a hand-held dynamometer (JAMAR hand dynamometer Model BK-7498, Fred Sammons Inc., Brookfield, IL). Participants were seated, positioned with their elbows in 90° of flexion and wrists in 0–30° of dorsiflexion and were asked to grip the dynamometer using maximum strength for about 5 s. Three trials for each hand were performed, and the highest value of the strongest hand was used in the analyses. According to the consensus by the European Working Group on Sarcopenia in Older People 2 (EWGSOP2), low muscle strength was described by values of less than 16 kg in women and 27 kg in men and define the

diagnosis of probable sarcopenia (the instrumental confirmation of sarcopenia went beyond the purpose of the present study and was not performed) [33].

2.3. Index tests evaluation

Nutritional status was initially screened with the short form of the Mini Nutritional Assessment (MNA-SF), which include recent reduction in food intake and/or weight loss, mobility, psychological stress or acute disease, dementia and/or depression and BMI (range 0–14, at risk of malnutrition if 8–11 points, malnutrition if $\leq$ 7) [34,35]. The prevalence of malnutrition or the risk of malnutrition was the primary outcome of the study.

2.4. Follow-up

The vital status of all patients within 12 months from recruitment was assessed through consultation of local registries.

For patients still alive, secondary health outcomes were collected within 12 months from recruitment through telephone contact with the patient or the main caregiver: living condition (i.e., at home with assistance, at home alone, institutionalized), occurring hospitalization and bone fractures and worsening functional autonomy in BADL and IADL.

2.5. Statistical analysis

For the expected prevalence of malnutrition or the risk of malnutrition among hospitalized older adults in Europe of 69.3 % [36], the required sample size was 568 for the margin of error 4 % in estimating the prevalence with 95 % confidence and considering the potential loss of 10 %. This sample size was calculated using the ScalaR SP [37].

Statistical analysis was performed using R Studio (Posit team 2023, Posit Software, PBC, Boston, MA). The absolute and relative frequencies of dichotomous and categorical variables were calculated, as well as the mean and standard deviation or median and 25th and 75th percentiles for normally distributed and not normally distributed continuous variables, as appropriate. Incidence of outcome and its 95 % confidence intervals (CI) were calculated. Univariate analysis of potential association between baseline variables and outcomes of interest was conducted using the analysis of variance for normally distributed continuous variables, the Mann–Whitney test for not normally distributed continuous variables and the Chi square test for dichotomous and categorical variables. Clinically relevant variables were then introduced in a multivariable logistic regression model, with malnutrition or the risk of malnutrition according to MNA-SF (11 points or less) as the dependent variable, and adjusted odds ratios (OR) and their 95 % CIs were calculated. Prognostic differences in terms of 1-year mortality between groups of nutritional status according to MNA-SF were observed using Kaplan–Meier survival curves and compared using the log-rank test. Associations between nutritional status according to MNA-SF and mortality were summarized with hazard ratios (HR) and 95 % CIs, estimated with Cox proportional-hazards regression model adjusted for clinically relevant variables. Significance level was set at $\alpha < 0.05$ for all tests.

3. Results

During the study period, a total of 741 patients were admitted to the general medical and geriatric wards involved; 146 subjects were excluded because of pre-specified criteria: 44 died within 48 h from admission or showed poor short-term prognosis (5.9 %), 36 patients were not enrolled within 48 h from admission (4.9 %), and 15 were transferred from other units of the same hospital (2.0 %). Furthermore, 52 patients were incapacitated to properly perform HST or give consent (e.g., dementia or acute illness, lack of relatives, language barriers; 7.0 %). A final sample of 594 patients was thus included in the analysis (222 and 372 patients in the general medical and geriatric units, respectively).

The main characteristics of the overall study sample (median age 84.0 years, 49.5 % female) are presented in Table 1. Most of the enrolled patients lived at their home (546, 91.9 %), mostly with caregiver, more than one third was dependent in BADL (219, 36.9 %), almost two thirds were partially or not autonomous in IADL (375, 63.1 %) and around one out of five patients had severe cognitive impairment (117, 19.7 %). Median BMI was 23.8 kg/m^2 (21.4–27.1) and probable sarcopenia was diagnosed in 420 patients (70.7 %). Median length of hospital stay was 9.5 days (6–16).

According to the MNA-SF, 489 patients were probably malnourished or at risk of malnutrition (82.3 %; 237 and 252 patients, respectively). In the previous 3 months, 348 patients experienced a moderate-to-severe decrease in food intake (58.6 %, severe in one-third of cases) whereas 216 reported a weight loss of more than 3 kg (36.4 %). In Table 1 the distribution of variables according to the nutritional status is reported. At univariate analysis, compared with subjects with normal nutritional status, patients with malnutrition or at risk of malnutrition were older (median age 85.4 vs 84.8 vs 80.1 years; $p = 0.012$), more frequently institutionalized (21.0 % vs. 28.0 % vs 0 %, $p = 0.047$), more dependent in BADL (56.8 % vs 28.0 % vs 11.4 %; $p < 0.001$) and IADL (82.8 % vs 59.8 % vs 25.7 % partially or not autonomous; $p < 0.001$) and more frequently affected by severe cognitive impairment (33.3 % vs 13.4 % vs 2.9 %, $p < 0.001$) and worst performance at HST (76.5 % vs 68.3 % vs 42.9 %; $p < 0.001$).

The multivariable analysis showed that malnutrition and the risk of malnutrition, as assessed by the MNA-SF, were positively associated with living alone at home (OR 2.803, 95%CI 1.567–5.177, $p < 0.001$), and negatively associated with female sex (OR 0.308, 95%CI 0.162–0.571, $p < 0.001$), autonomy in IADL (OR 0.765, 95%CI 0.688–0.846, $p < 0.001$) and the best performance at HST (OR 0.901, 95%CI 0.865–0.936; $p < 0.001$) (Table 2).

A total of 189 patients died during the study period (31.8 %): 24 subjects died during hospitalization (4.0 %), whereas 165 died within 12 months from recruitment (27.8 %) after a median time of about 100 days. Compared with subjects with normal nutritional status, 1-year mortality rates were higher in probably malnourished patients or at risk of malnutrition (40.5 % vs 28.6 % vs 20.0 %, $p < 0.001$) (Fig. 1). After Cox regression analysis, mortality during hospitalization or within 12 months from recruitment was positively associated with malnutrition according to MNA-SF (OR 2.493, 95%CI 1.345–4.751, $p = 0.004$), institutionalization (OR 2.815, 95%CI 1.423–5.693, $p = 0.003$) and severe cognitive impairment at SPMSQ (OR 1.701, 95%CI 1.031–2.803, $p = 0.036$) and negatively associated with female sex (OR 0.471, 95%CI 0.313–0.703; $p < 0.001$) (Table 3).

Table 4 also reports health outcomes among the 405 patients still alive at 12-months follow-up. Compared with subjects with normal nutritional status and at risk of malnutrition, patients with malnutrition reported a lower incidence of institutionalization (2.1 % vs 18.3 % vs 3.6 %; $p < 0.001$), hospitalization (66.0 % vs 76.7 % vs 82.1 %; $p = 0.016$) and worsening ADL dependency (34.0 % vs 58.3 % vs 71.4 %; $p < 0.001$). A similar incidence of falls or fractures was observed among malnourished and at-risk patients (17.0 % vs 20.0 % vs 0 %; $p < 0.001$).

Table 1
Characteristics of the overall sample and across malnutrition assessment by MNA-SF.

	Overall sample ($n = 594$)	Normal nutritional status ($n = 105$)	At risk of malnutrition ($n = 252$)	Probable malnutrition ($n = 237$)	*p*
Patient characteristics					
Age (years), median (25°–75°)	84.0 (79.0–88.2)	80.1 (77.6–83.7)	84.8 (79.6–89.6)	85.4 (79.7–89.7)	0.012
Sex male, n (%)	300 (50.5)	63 (60.0)	135 (52.4)	102 (44.4)	ns
Body weight (kg), median (25°–75°)	65 (55–75)	75 (66–85)	67 (60–75)	60 (50–70)	<0.001
BMI (kg/m^2), median (25°–75°)	23.8 (21.4–27.1)	26.6 (24.5–29.0)	24.4 (22.2–27.7)	21.4 (19.5–25.0)	<0.001
Living situation/social support					0.047
Home with a family member, n (%)	399 (67.2)	78 (74.3)	165 (67.1)	156 (64.2)	
Home alone, n (%)	147 (24.7)	27 (25.7)	18 (4.9)	51 (14.8)	
Nursing home, n (%)	48 (8.1)	0 (0)	69 (28.0)	30 (21.0)	
Functional autonomy					
BADL lost functions ≥2 (dependent), n (%)	219 (36.9)	12 (11.4)	69 (28.0)	138 (56.8)	<0.001
IADL					<0.001
5–9 (partially autonomous), n (%)	162 (27.3)	21 (20.0)	75 (30.5)	66 (27.2)	
≤4 (not autonomous), n (%)	213 (35.9)	6 (5.7)	78 (29.3)	129 (55.6)	
SPMSQ					<0.001
3–5 errors (mild cognitive impairment), n (%)	144 (24.2)	18 (17.1)	60 (23.2)	66 (28.4)	
≥6 errors (severe cognitive impairment), n (%)	117 (19.7)	3 (2.9)	33 (13.4)	81 (33.3)	
Clinical conditions/comorbidities					
CIRS-CI, median (25°–75°)	4 (2–5)	3 (2–5)	4 (2–5)	4 (3–5)	ns
Number of drugs at admission >6, n (%)	303 (51.0)	33 (31.4)	126 (51.2)	144 (59.3)	ns
Reduced muscle strength by HST, n (%)	420 (70.7)	15 (42.9)	56 (68.3)	62 (76.5)	<0.001
Nutritional status					
MNA-SF, median (25°–75°)	8 (6–11)	12 (12–14)	9 (8.25–10)	6 (4–6)	<0.001
Moderate-severe decrease in food intake, n (%)	348 (58.6)	18 (17.1)	123 (48.8)	205 (86.5)	<0.001
Recent weight loss >3 kg, n (%)	216 (36.4)	0 (0)	65 (25.8)	149 (62.9)	<0.001
Bed or chair bound, n (%)	198 (33.3)	6 (5.7)	59 (23.4)	132 (55.7)	<0.001
Recent psychological stress/acute disease, n (%)	348 (58.6)	18 (17.1)	141 (56.0)	187 (78.9)	<0.001
Severe dementia/depression, n (%)	111 (18.7)	6 (5.7)	25 (9.9)	79 (33.3)	<0.001
Characteristics of hospitalization					
Hospitalization setting					<0.001
Geriatric unit, n (%)	372 (62.6)	39 (37.1)	153 (59.6)	180 (76.5)	
Medical unit, n (%)	222 (37.4)	66 (62.9)	99 (40.2)	57 (23.5)	
Length of stay (days), median (25°–75°)	9.5 (6–16)	8 (6–13)	10 (6.25–16)	10 (7–19)	ns

BADL: Basic Activities of Daily Living; BMI: body mass index; CIRS-CI: Cumulative Illness Rating Scale, Comorbidity Index; HST: handgrip strength test; IADL: Instrumental Activities of Daily Living; MNA-SF: Mini Nutritional Assessment, short form; SPMSQ: Short Portable Mental State Questionnaire.

Table 2
Variables associated with malnutrition and risk of malnutrition by MNA-SF: results of the multivariable logistic regression model.

Variables	Odds ratio (95 % CI)	*p*
Sex female	**0.308 (0.162–0.571)**	**< 0.001**
Living situation/social support[a]		
Home alone	**2.803 (1.567–5.177)**	**< 0.001**
Nursing home	2.749 (0.001–1.685)	ns
BADL (lost functions)	0.883 (0.686–1.145)	ns
IADL	**0.765 (0.688–0.846)**	**< 0.001**
SPMSQ – severe cognitive impairment	**2.385 (0**.763–10.517)	ns
HST (kg)	**0.901 (0.865–0.936)**	**< 0.001**

BADL: Basic Activities of Daily Living; HST: handgrip strength test; IADL: Instrumental Activities of Daily Living; MNA-SF: Mini Nutritional Assessment, short form; SPMSQ: Short Portable Mental State Questionnaire.
[a] Living at home with caregiver was assumed as baseline category for this variable.

4. Discussion

In our single-center sample of older patients hospitalized for any reason in both general medical and geriatric units, mostly living at home with moderate functional autonomy, our findings showed that i) according to the MNA-SF, over 80 % of the sample was probably malnourished or at risk of malnutrition (39.9 % and 42.4 %, respectively); ii) worst nutritional status was associated with living alone at home, lack of autonomy in IADL, male sex, and reduced grip strength; iii) overall mortality (during hospitalization or within 12 months from recruitment) was positively associated with malnutrition according to MNA-SF, along with severe cognitive impairment, institutionalization, and male sex.

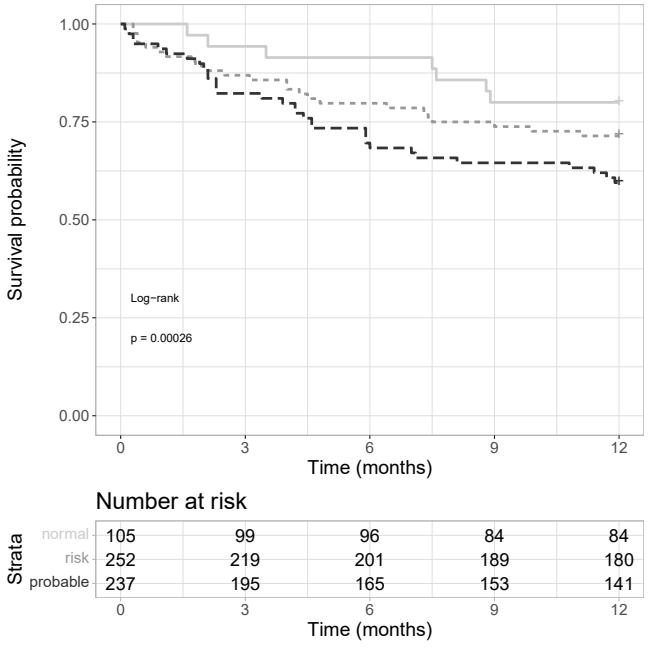

Fig. 1. Kaplan–Meier curves across malnutrition screening by MNA-SF.

Despite the unanimous recommendation, in practice several barriers prevent the routine screening for malnutrition from occurring [1]. On the one hand, the application of screening tools in

Table 3
Variables associated with in-hospital death or within 12 months from recruitment: results of the multivariable Cox regression model.

Variables	Odds ratio (95 % CI)	*p*
Sex female	**0.471 (0.313–0.703)**	**< 0.001**
Living situation/social support[a]		
Home alone	0.627 (0.380–1.013)	ns
Nursing home	**2.815 (1.423–5.693)**	**0.003**
BADL (lost functions)	1.124 (0.983–1.286)	ns
IADL	0.959 (0.891–1.033)	ns
SPMSQ – severe cognitive impairment	**1.701 (1.031–2.803)**	**0.036**
MNA-SF[b]		
At risk of malnutrition	1.615 (0.906–2.963)	ns
Probable malnutrition	**2.493 (1.345–4.751)**	**0.004**

BADL: Basic Activities of Daily Living; HST: handgrip strength test; IADL: Instrumental Activities of Daily Living; MNA-SF: Mini Nutritional Assessment, short form; SPMSQ: Short Portable Mental State Questionnaire.
[a] Living at home with caregiver was assumed as baseline category for this variable.
[b] Normal nutritional status by MNA-SF was assumed as baseline category for this variable.

older populations has not been sufficiently tested so far and a gold standard is still lacking [1]. On the other, in hospital setting healthcare professionals have generally little time for, and little knowledge and awareness of the importance of, malnutrition screening in older adults [38,39]. Furthermore, a recent survey conducted among European geriatricians revealed that clinical assessment of malnutrition was rarely done using validated nutritional assessment tools [40]. A further concern is that coding for malnutrition diagnosis is frequently not added to an individual's medical records in the hospital setting which could hinder appropriate nutritional intervention and miss hospital reimbursement for its large associated costs [41,42].

For these reasons, although the prevalence of malnutrition is globally increasing due to the aging population and the concomitant rise in chronic illnesses [1,43], the comparison of our findings on malnutrition prevalence is very difficult due to the use of different screening and assessment tools across various settings and populations [44]. Recent comprehensive meta-analysis reported a wide varying prevalence of malnutrition, investigated using MNA (including its short form), in individuals over 65 years, ranging from 6.0 % to 29.4 %, with higher prevalence in acute, subacute, and rehabilitative settings [26,36,45,46]. Cereda et al. reported a prevalence of malnourished and at-risk patients among hospitalized individuals at 67.6 % (22.0 % and 45.6 %, respectively) [36]. In our cohort of hospitalized older subjects, the prevalence of malnutrition and risk of malnutrition was even higher, cumulatively reaching the 82.3 % of the sample (39.9 % and 42.4 %, respectively). As expected, probably malnourished or at-risk patients in our sample were older, more dependent in daily life activities, had worse cognitive profile and comorbidity burden and were more frequently institutionalized. Additionally, these patients exhibited not only lower BMI and reduced food intake but also a decreased handgrip strength. These associations seem to confirm the correlation between nutritional status and other geriatric syndromes (loss of functional autonomy, frailty, sarcopenia) and their synergistic impact on clinical outcomes of disability and mortality [45,47,48]. Furthermore, in our sample, 1-year mortality rate was high in the overall sample (31.8 %) and even higher among probably malnourished subjects (40.5 %). Along with malnutrition according to MNA-SF, mortality was positively associated with severe cognitive impairment, institutionalization, and male sex.

It is important to note that the nutritional assessment was conducted upon hospital admission. As such, it reflected a condition that was, at least partially, already determined in the living context. Unsurprisingly, living alone at home was positively associated with worst nutritional status. This data calls for contemplation on the living conditions of the older subjects and emphasizes the necessity for launching broader screening programs aimed at early identification of the risk of malnutrition in this population, that should involve family doctors as well as caregivers.

On the other hand, in our sample, the mortality rate during hospitalization or within 12 months from recruitment was 31.8 % and was positively linked with malnutrition as assessed by MNA-SF, as well as with severe cognitive impairment, institutionalization, and male sex. This finding tends to support our initial hypothesis of a significant proportion of older hospitalized patients with limited short-term life expectancy due to their poor health status and advanced functional and cognitive limitations, for whom the clinical benefit derived from interventions for malnutrition would be minimal, if any. In this regard, the results from multivariable analysis underscore the significance of nutritional screening as part of the routine comprehensive geriatric assessment in hospitals, taking a person-centered approach. This screening may help differentiate patients who could potentially benefit from targeted

Table 4
Follow-up of the overall sample and across malnutrition screening by MNA-SF.

	Overall sample ($n = 594$)	Normal nutritional status ($n = 105$)	At risk of malnutrition ($n = 252$)	Probable malnutrition ($n = 237$)	*p*
Deceased, n (%)	189 (31.8)	21 (20.0)	72 (28.6)	96 (40.5)	<0.001
In-hospital, n	24	0	12	12	
Within 12 months, n	165	21	60	84	
Time from discharge to death (months), median (25°–75°)	3.7 (1.6–6.8)	5.4 (1.6–8.6)	3.6 (1.3–6.6)	3.8 (1.7–5.8)	ns
≥1 hospitalization[a], n (%)	300 (74.1)	69 (82.1)	138 (76.7)	93 (66.0)	0.016
Falls/fractures[a], n (%)	60 (14.8)	0 (0)	36 (20.0)	24 (17.0)	<0.001
Weight loss >3 kg[a], n (%)	207 (51.1)	36 (42.9)	93 (51.7)	78 (55.3)	ns
BADL lost functions ≥2 (dependent)[a], n (%)	348 (85.9)	69 (82.1)	150 (83.3)	129 (91.5)	ns
Worsening from baseline, n (%)	213 (52.6)	60 (71.4)	105 (58.3)	48 (34.0)	<0.001
IADL[a]					<0.001
Partially autonomous, n (%)	105 (25.9)	12 (14.3)	60 (33.3)	33 (23.4)	
Not autonomous, n (%)	252 (62.2)	36 (42.9)	111 (61.7)	105 (74.5)	
Worsening from baseline, n (%)	171 (42.2)	39 (46.4)	81 (45.0)	51 (36.2)	ns
Institutionalization[a], n (%)	39 (9.6)	3 (3.6)	33 (18.3)	3 (2.1)	<0.001

BADL: Basic Activities of Daily Living; IADL: Instrumental Activities of Daily Living; MNA-SF: Mini Nutritional Assessment, short form.
[a] Among the 405 patients (84, 180 and 141, respectively) alive within 12 months from recruitment.

interventions for malnutrition from those who may not, given their overall poor short-term health outcomes.

Additionally, we observed worst secondary health outcomes at 1-year follow-up among patients at risk of malnutrition or even with normal nutritional status. These findings may be explained by the poor general health and performance status these patients already have, with limited possibilities of reversibility confirmed by higher mortality in this subgroup. Conversely, it is arguable that in patients at risk of malnutrition or with normal nutritional status at baseline the acute hospitalization represents the first moment of a clinical worsening cascade leading to falls, re-hospitalization, loss of functional autonomy, and institutionalization. Thus, the contribution of nutritional status to health outcomes should not be overlooked in these patients, who may represent ideal candidates for targeted person-centered interventions.

Some limitations of the present study need to be addressed. Firstly, the study design does not allow for definitive conclusions about either a confirmed diagnosis of malnutrition based on validated criteria or the temporal sequences of associations between the variables considered and nutritional status. Accordingly, many potential determinants were not available in the present cohort (i.e., socioeconomic conditions, education levels, depressive symptoms, etc.), including data concerning the nutritional status before hospital admission or regarding eating habits in the home context. Moreover, although assessed in the first hours from admission, the reason for hospitalization itself may have, at least partially, influenced the nutritional status. Finally, although MNA-SF represents the most common nutritional screening tool in older hospitalized patients, most validation studies have used the full-form MNA as the reference standard with questionable findings due to incorporation bias [24] and when compared to an accepted reference standard, it seems to overestimate malnutrition risk. Additionally, our study focuses on a population in a specific hospital setting and reflects the reality of a definite geographical area; thus, the generalizability of our findings is inevitably limited. Ultimately, secondary 1-year health outcomes may not take into proper account therapeutic interventions eventually prescribed at discharge and patients' adherence to them, which was beyond the aims of the present study.

Despite these limitations, the exceptionally high prevalence of the risk of malnutrition, its coexistence with other geriatric conditions, and their impact on health outcomes in our sample of older inpatients upon hospital admission should reaffirm the importance of integrating and implementing nutritional and functional screenings in clinical practice to identify malnutrition across all healthcare settings. Following recent guidelines, regularly assessing the nutritional status of older patients living in the community through the adoption of simple screening tools, even within the busy realm of general practice, would enable early recognition of the clinical risk of malnutrition. This, in turn, could lead to targeted interventions aimed at addressing, where possible, modifiable personal, nutritional, and environmental causes (e.g., dysphagia, chewing difficulties, inadequate caloric intake in terms of both quantity and quality, meal dependency, etc.) [5,49,50], as well as aiding in the better prediction of patients' clinical trajectories. A patient-centered approach including early behavioral, nutritional, and physical-rehabilitative interventions within an interdisciplinary team, even in primary healthcare settings, could have a significant impact on health outcomes and quality of life as well as on healthcare costs.

5. Conclusions

This prospective single-center cohort study revealed a remarkably high prevalence of malnutrition or risk of malnutrition among patients aged 65 and older hospitalized on admission in both general medical and geriatric units (82.3 %), associated with poorer functional autonomy, cognitive status, increased comorbidities, and reduced food intake and muscle strength at baseline, as well as with higher overall mortality (both during hospitalization and within 12 months from recruitment).

These findings emphasize the importance of early assessment of nutritional and functional status in the geriatric population, to reduce the risk of malnutrition as well as concomitant sarcopenia and its consequences. The mandatory integration of comprehensive nutritional and functional assessments into clinical practice across all healthcare settings (i.e., general practice, hospitalization, institutionalization) may not only enhance prognosis prediction but also allow for timely, targeted nutritional and physical interventions to address modifiable causal factors in a patient-oriented approach, potentially impacting health outcomes, quality of life and healthcare costs.

Research ethics

As reported in the manuscript, the present study adhered to the Recommendations Guiding Physicians in Biomedical Research Involving Human Subjects, received approval from the local Ethics Committee, and was reported in accordance with the Strengthening The Reporting of Observational Studies in Epidemiology statements.

Authors contribution

G.I.: Conceptualization, Methodology, Investigation, Resources, Writing - Original Draft, Writing - Review & Editing, Supervision, Project administration.

R.P.: Conceptualization, Methodology, Formal analysis, Writing - Original Draft, Writing - Review & Editing, Visualization, Project administration.

E.Br.: Conceptualization, Methodology, Writing - Review & Editing.

C.M.C.: Conceptualization, Investigation, Resources, Writing - Original Draft.

F.C.: Conceptualization, Investigation, Resources, Writing - Original Draft.

E.Be.: Conceptualization, Investigation, Resources, Writing - Original Draft.

C.V.: Conceptualization, Investigation, Resources, Writing - Original Draft.

F.C.: Conceptualization, Investigation, Resources, Writing - Review & Editing.

P.M.: Conceptualization, Methodology, Investigation, Resources, Writing - Review & Editing.

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M.B.: Conceptualization, Methodology, Investigation, Resources, Writing - Original Draft, Writing - Review & Editing, Supervision.

Data management and sharing

All Authors had all access to the data in this work and approved the submission of the present manuscript. All material in this assignment is Authors' own work and does not involve plagiarism. The data that support the findings of this study are available from the corresponding Author upon reasonable request.

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Declaration of competing interest

The Authors of this manuscript declare they have no conflict of interest to disclose.

References

[1] Dent E, Wright ORL, Woo J, Hoogendijk EO. Malnutrition in older adults. Lancet 2023;401(10380):951–66.
[2] Fávaro-Moreira NC, Krausch-Hofmann S, Matthys C, Vereecken C, Vanhauwaert E, Declercq A, et al. Risk Factors for Malnutrition in Older Adults: A Systematic Review of the Literature Based on Longitudinal Data. Adv Nutr 2016;7(3):507–22.
[3] Cederholm T, Barazzoni R, Austin P, Ballmer P, Biolo G, Bischoff SC, et al. ESPEN guidelines on definitions and terminology of clinical nutrition. Clin Nutr 2017;36(1):49–64.
[4] Amarya S, Singh K, Sabharwal M. Changes during aging and their association with malnutrition. Journal of Clinical Gerontology and Geriatrics 2015;6(3):78–84.
[5] O'Keeffe M, Kelly M, O'Herlihy E, O'Toole PW, Kearney PM, Timmons S, et al. Potentially modifiable determinants of malnutrition in older adults: a systematic review. Clin Nutr 2019;38(6):2477–98.
[6] Bellanti F, Lo Buglio A, Quiete S, Vendemiale G. Malnutrition in hospitalized old patients: screening and diagnosis, clinical outcomes, and management. Nutrients 2022;14(4):910.
[7] Nakamura T, Itoh T, Yabe A, Imai S, Nakamura Y. Mizokami Y, et al. Polypharmacy is associated with malnutrition and activities of daily living disability among daycare facility users: a cross-sectional study. Medicine (Baltim) 2021;100(34):e27073.
[8] Bardon LA, Corish CA, Lane M, Bizzaro MG, Loayza Villarroel K, Clarke M, et al. Ageing rate of older adults affects the factors associated with, and the determinants of malnutrition in the community: a systematic review and narrative synthesis. BMC Geriatr 2021;21(1):676.
[9] Delerue Matos A, Barbosa F, Cunha C, Voss G, Correia F. Social isolation, physical inactivity and inadequate diet among European middle-aged and older adults. BMC Publ Health 2021;21(1):924.
[10] 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.
[11] Felder S, Lechtenboehmer C, Bally M, Fehr R, Deiss M, Faessler L, et al. Association of nutritional risk and adverse medical outcomes across different medical inpatient populations. Nutrition 2015;31(11–12):1385–93.
[12] Söderström L, Rosenblad A, Thors Adolfsson E, Bergkvist L. Malnutrition is associated with increased mortality in older adults regardless of the cause of death. Br J Nutr 2017;117(4):532–40.
[13] O'Shea E, Trawley S, Manning E, Barrett A, Browne V, Timmons S. Malnutrition in hospitalised older adults: a multicentre observational study of prevalence, associations and outcomes. J Nutr Health Aging 2017;21(7):830–6.
[14] Lengyel CO, Jiang D, Tate RB. Trajectories of nutritional risk: the Manitoba follow-up study. J Nutr Health Aging 2017;21(6):604–9.
[15] Sharma Y, Miller M, Kaambwa B, Shahi R, Hakendorf P, Horwood C, et al. Malnutrition and its association with readmission and death within 7 days and 8-180 days postdischarge in older patients: a prospective observational study. BMJ Open 2017;7(11):e018443.
[16] Rosted E, Prokofieva T, Sanders S, Schultz M. Serious consequences of malnutrition and delirium in frail older patients. J Nutr Gerontol Geriatr 2018;37(2):105–16.
[17] Ishida Y, Maeda K, Nonogaki T, Shimizu A, Yamanaka Y, Matsuyama R, et al. Malnutrition at admission predicts in-hospital falls in hospitalized older adults. Nutrients 2020;12(2):541.
[18] 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.
[19] Lengfelder L, Mahlke S, Moore L, Zhang X, Williams G, Lee J. Prevalence and impact of malnutrition on length of stay, readmission, and discharge destination. JPEN - J Parenter Enter Nutr 2022;46(6):1335–42.
[20] Beck AM, Dent E, Baldwin C. Nutritional intervention as part of functional rehabilitation in older people with reduced functional ability: a systematic review and meta-analysis of randomised controlled studies. J Hum Nutr Diet 2016;29(6):733–45.
[21] Lew CCH, Yandell R, Fraser RJL, Chua AP, Chong MFF, Miller M. Association between malnutrition and clinical outcomes in the intensive care unit: a systematic review [formula: see text]. JPEN - J Parenter Enter Nutr 2017;41(5):744–58.
[22] Kaegi-Braun N, Mueller M, Schuetz P, Mueller B, Kutz A. Evaluation of nutritional support and in-hospital mortality in patients with malnutrition. JAMA Netw Open 2021;4(1):e2033433.
[23] 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. J Cachexia Sarcopenia Muscle 2019;10(1):207–17.
[24] Power L, Mullally D, Gibney ER, Clarke M, Visser M, Volkert D, et al. A review of the validity of malnutrition screening tools used in older adults in community and healthcare settings - a MaNuEL study. Clin Nutr ESPEN 2018;24:1–13.
[25] Sánchez-Rodríguez D, Marco E, Ronquillo-Moreno N, Maciel-Bravo L, Gonzales-Carhuancho A, Duran X, et al. 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. Clin Nutr 2019;38(1):297–302.
[26] Leij-Halfwerk S, Verwijs MH, van Houdt S, Borkent JW, Guaitoli PR, Pelgrim T, et al. Prevalence of protein-energy malnutrition risk in European older adults in community, residential and hospital settings, according to 22 malnutrition screening tools validated for use in adults ≥65 years: a systematic review and meta-analysis. Maturitas 2019;126:80–9.
[27] Guenter P, Abdelhadi R, Anthony P, Blackmer A, Malone A, Mirtallo JM, et al. Malnutrition diagnoses and associated outcomes in hospitalized patients: United States, 2018. Nutr Clin Pract 2021;36(5):957–69.
[28] Orlandoni P, Venturini C, Jukic Peladic N, Costantini A, Di Rosa M, Cola C, et al. Malnutrition upon hospital admission in geriatric patients: why assess it? Front Nutr 2017;4:50.
[29] Andersen AL, Nielsen RL, Houlind MB, Tavenier J, Rasmussen LJH, Jørgensen LM, et al. Risk of malnutrition upon admission and after discharge in acutely admitted older medical patients: a prospective observational study. Nutrients 2021;13(8):2757.
[30] Lueg G, Wirth R, Kwiatkowski J, Rösler A, Jäger M, Gehrke I, et al. Low self-perception of malnutrition in older hospitalized patients. Clin Interv Aging 2020;15:2219–26.
[31] Pfeiffer E. A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. J Am Geriatr Soc 1975;23(10):433–41.
[32] Parmelee PA, Thuras PD, Katz IR, Lawton MP. Validation of the cumulative illness rating scale in a geriatric residential population. J Am Geriatr Soc 1995;43(2):130–7.
[33] Cruz-Jentoft AJ, Bahat G, Bauer J, Boirie Y, Bruyère O, Cederholm T, et al. Sarcopenia: revised European consensus on definition and diagnosis. Age Ageing 2019;48(1):16–31.
[34] Rubenstein LZ, Harker JO, Salvà A, Guigoz Y, Vellas B. Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). J Gerontol A Biol Sci Med Sci 2001;56(6):M366–72.
[35] Kaiser MJ, Bauer JM, Ramsch C, Uter W, Guigoz Y, Cederholm T, et al. Validation of the Mini Nutritional Assessment short-form (MNA-SF): a practical tool for identification of nutritional status. J Nutr Health Aging 2009;13(9):782–8.
[36] Cereda E, Pedrolli C, Klersy C, Bonardi C, Quarleri L, Cappello S, et al. Nutritional status in older persons according to healthcare setting: a systematic review and meta-analysis of prevalence data using MNA. Clin Nutr 2016;35(6):1282–90.
[37] Naing L, Nordin RB, Abdul Rahman H, Naing YT. Sample size calculation for prevalence studies using Scalex and ScalaR calculators. BMC Med Res Methodol 2022;22(1):209.
[38] Bassola B, Tommasi V, Bonetti L, Bauer S, Lusignani M. Nurses' knowledge about malnutrition in older people: a multicenter cross-sectional study. Nutrition 2020;78:110947.
[39] Bonetti L, Terzoni S, Lusignani M, Negri M, Froldi M, Destrebecq A. Nutritional care of older people: investigating nurses' attitudes in medical and surgical units. Contemp Nurse 2021;57(3–4):159–71.
[40] Sanchez-Rodriguez D, Annweiler C, Marco E, Hope S, Piotrowicz K, Surquin M, et al. European Academy for medicine of ageing session participants' report on malnutrition assessment and diagnostic methods; an international survey. Clin Nutr ESPEN 2020;35:75–80.
[41] McCauley SM, Barrocas A, Malone A. Hospital nutrition care betters patient clinical outcomes and reduces costs: the malnutrition quality improvement initiative story. J Acad Nutr Diet 2019;119(9 Suppl 2):S11–4.
[42] Fernandes AC, Pessoa A, Vigário MA, Jager-Wittenaar H, Pinho J. Does malnutrition influence hospital reimbursement? A call for malnutrition diagnosis and coding. Nutrition 2020;74:110750.
[43] Fleurke M, Voskuil DW, Beneken Genaamd Kolmer DM. The role of the dietitian in the management of malnutrition in the elderly: a systematic review of current practices. Nutr Diet 2020;77(1):60–75.
[44] Imoberdorf R, Meier R, Krebs P, Hangartner PJ, Hess B, Stäubli M, et al. Prevalence of undernutrition on admission to Swiss hospitals. Clin Nutr 2010;29(1):38–41.

[45] Ligthart-Melis GC, Luiking YC, Kakourou A, Cederholm T, Maier AB. 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.
[46] Crichton M, Craven D, Mackay H, Marx W, de van der Schueren M, Marshall S. A systematic review, meta-analysis and meta-regression of the prevalence of protein-energy malnutrition: associations with geographical region and sex. Age Ageing 2019;48(1):38–48.
[47] Cerri AP, Bellelli G, Mazzone A, Pittella F, Landi F, Zambon A, et al. Sarcopenia and malnutrition in acutely ill hospitalized elderly: prevalence and outcomes. Clin Nutr 2015;34(4):745–51.
[48] Madeira T, Severo M, Correia D, Lopes C, Gorjão Clara J. Nutritional intake and malnutrition in institutionalised and non-institutionalised older adults. Br J Nutr 2022;128(5):921–31.
[49] Schuetz P, Fehr R, Baechli V, Geiser M, Deiss M, Gomes F, et al. Individualised nutritional support in medical inpatients at nutritional risk: a randomised clinical trial. Lancet 2019;393(10188):2312–21.
[50] van den Berg GH, Huisman-de Waal GGJ, Vermeulen H, de van der Schueren MAE. Effects of nursing nutrition interventions on outcomes in malnourished hospital inpatients and nursing home residents: a systematic review. Int J Nurs Stud 2021;117:103888.