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ORIGINAL RESEARCH

GLIM-Defined Malnutrition in Critically Ill Patients: A Comparison of Nutrition Risk Screening 2002 and Modified Nutrition Risk in Critically Ill as First-Step Screening Tools

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Purpose: Given the high prevalence and prognostic significance of malnutrition in critically ill patients, selecting an appropriate first-step screening tool within the Global Leadership Initiative on Malnutrition (GLIM) framework is critical. This study aimed to compare the consistency of Nutrition Risk Screening-2002 (NRS-2002) and the modified Nutrition Risk in the Critically Ill (mNUTRIC) as GLIM-based screening strategies and to assess their associations with clinical outcomes in this population.

Patients and Methods: A single-center prospective observational study was conducted involving 173 critically ill patients hospitalized ≥4 days in an intensive care unit (ICU). Nutritional risk was screened within 24 hours of admission using NRS-2002 or mNUTRIC. Patients screening positive underwent malnutrition diagnosis using GLIM (phenotypic: weight loss or low body mass index; etiologic: reduced intake or inflammation/disease burden). The consistency between the two screening strategies was assessed, and their associations with clinical outcomes were analyzed. The effect of nutritional treatment in patients with malnutrition has been explored in a subgroup analysis.

Results: Malnutrition prevalence was 18.5% (32/173) using NRS-2002+GLIM and 13.9% (24/173) using mNUTRIC+GLIM. The two screening strategies showed substantial agreement ($\kappa = 0.79$, $p < 0.001$). Malnutrition diagnosed by mNUTRIC+GLIM demonstrated stronger associations with adverse outcomes. These included significantly greater proportions of ICU days under sedation ($b = 0.20$, 95% confidence interval (CI): 0.08–0.33) and vasopressor ($b = 0.21$, 95% CI: 0.06–0.37), as well as a higher risk of adverse discharge status (odds ratio = 6.24, 95% CI: 2.20–18.38). In the exploratory subgroup analysis with a limited sample size, patients identified as malnutrition by mNUTRIC+GLIM showed lower in-hospital mortality following nutrition treatment. (0% vs. 66.7%; $p < 0.05$).

Conclusion: Substantial consistency was observed between NRS-2002+GLIM and mNUTRIC+GLIM, and both were significantly associated with unfavorable clinical outcomes. Notably, mNUTRIC+GLIM showed stronger prognostic value, indicating its potential as a more appropriate screening strategy in critically ill patients.

Keywords: malnutrition, nutrition assessment, intensive care units, nutrition risk

Introduction

Malnutrition is defined as a deficiency or imbalance of energy or nutrients resulting from inadequate intake or impaired utilization, leading to alterations in body composition, decline in physiological function, and ultimately adverse clinical outcomes.[1] This condition is highly prevalent among critically ill patients and represents a significant prognostic risk factor in the intensive care unit (ICU), adversely affecting outcomes such as discharge status, mortality, and length of

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stay.[2,3] Given that critically ill patients frequently exhibit a hypercatabolic, hyperconsumptive, and highly pro-inflammatory state, their nutritional risk and malnutrition are often exacerbated during ICU stay. Therefore, close monitoring, regular nutritional risk screening, and timely nutritional assessment are essential for patients with an ICU stay exceeding 48 hours, and early identification and nutritional intervention are critical components of effective management.[3]

Nutritional assessment in critically ill patients presents unique challenges. These patients often undergo substantial early fluid resuscitation and experience marked protein catabolism, leading to edema and volume shifts that render conventional anthropometric measurements and serum biomarkers unreliable. As a result, no universally accepted gold standard currently exists for assessing nutritional status in this population. Traditional assessment tools, such as the Subjective Global Assessment (SGA), may be less suitable for ICU patients because they do not integrate disease severity into the evaluation.[4] In response to these limitations, the Global Leadership Initiative on Malnutrition (GLIM) proposed a standardized two-step diagnostic framework that combines nutritional risk screening with phenotypic and etiologic assessment.[1] The GLIM criteria have demonstrated good reliability across various patient populations, including oncology and gastrointestinal surgery patients,[5–7] and have shown promising feasibility and accuracy in ICU settings.[8] A key component of the GLIM framework is the use of a validated screening tool for the initial identification of patients at nutritional risk. Notably, the five-year update consensus of the GLIM criteria emphasized that the choice of screening tool significantly influences the reported prevalence of GLIM-defined malnutrition, underscoring the need to compare different screening strategies in clinical practice.[9]

Among the available screening tools, the Nutrition Risk Screening 2002 (NRS-2002) and the modified Nutrition Risk in the Critically Ill (mNUTRIC) are widely used in critically ill populations.[10] Although NRS-2002 was originally developed for general hospitalized patients, it has been extensively validated across diverse inpatient settings and is broadly accepted for identifying malnutrition risk. In contrast, mNUTRIC was specifically designed and validated for ICU patients, incorporating objective variables that are readily available in the critical care environment. Both tools have demonstrated good predictive ability for adverse clinical outcomes.[11–14] Previous studies suggest that mNUTRIC may outperform NRS-2002 in assessing nutritional risk in ICU patients and may help identify those most likely to benefit from optimal macronutrient delivery in terms of mortality reduction.[15,16] However, it remains unclear which screening tool is more suitable for use as the first step within the GLIM framework for diagnosing malnutrition in critically ill patients.

Given this uncertainty, the present study aimed to evaluate the consistency between NRS-2002 and mNUTRIC when used as first-step screening tools within the GLIM framework, and to compare the associations with adverse clinical outcomes in critically ill patients.

Materials and Methods

Study Design and Patient Selection

This single-center prospective observational study was approved by the local ethics committee (No. 2022/123), and written informed consent was obtained from all patients or their families. Consecutive patients admitted to the ICU at the Linping Hospital of Zhejiang University School of Medicine between June 2023 and December 2023 for at least four days were enrolled. Exclusion criteria were as follows: age under 18 years; unreliable weight or height data; hemodynamic instability; pregnancy or lactation; ICU stay less than four days; missing data for key study variables; and patients who were readmitted to the ICU during the study period. All participants were followed from hospital admission until discharge, and clinical outcomes were recorded throughout the hospitalization period.

Data Collection

All patients were assessed for Sequential Organ Failure Assessment (SOFA) and Acute Physiology and Chronic Health Evalustion (APACHE II) within 24 hours of ICU admission by trained clinicians. Height and weight were measured for ambulatory patients using a calibrated stadiometer and scale (Omron SK-L08, China) following standard protocols.[17] For non-ambulatory critically ill patients, these data were obtained through patient self-report or family recall, a common

alternative in ICU studies, under the supervision of an experienced clinical dietitian. Biochemical tests and complete blood counts, including albumin, prealbumin, hemoglobin, and C-reactive protein (CRP), were measured upon ICU admission as part of routine clinical care. Clinical outcomes included discharge status, length of hospital and ICU stay, and durations of sedation, vasopressor use, and ventilatory support in ICU.

Nutritional Screening and Assessment

Within 24 hours of ICU admission, patients were screened for nutritional risk by trained clinical dietitians using NRS-2002[18] and mNUTRIC.[16] The NRS-2002 total score is the sum of three components: disease severity, nutritional status, and age. Data on food intake and weight changes for the nutritional status score were provided by the patients or their families. An NRS-2002 ≥ 3 indicates nutritional risk. The mNUTRIC, a modified version of NUTRIC that excludes IL-6, includes five items: age, APACHE II score, SOFA score, number of comorbidities, and pre-ICU hospitalization duration. Scores range from 0 to 9, with ≤ 4 indicating low risk and ≥ 5 indicating high risk; higher scores indicate greater malnutrition risk. The GLIM diagnostic criteria follow a two-step strategy to assess nutritional status:[1] Step 1 involves identifying patients at risk of malnutrition using NRS-2002 or mNUTRIC, and Step 2 involves further assessment of those identified as at-risk. GLIM's malnutrition diagnosis method is based on evaluating three phenotypic criteria (non-volitional weight loss, low body mass index [BMI], and reduced muscle mass) and two etiologic criteria (reduced food intake or assimilation, and inflammation or disease burden). A diagnosis of malnutrition requires meeting at least one phenotypic criterion and one etiologic criterion. Given the infeasibility of standing examinations, transportation risks, and limited accessibility to bedside muscle measurement techniques in ICU patients, coupled with the ongoing refinement of reference standards for muscle mass in the Chinese population,[19,20] this study did not incorporate muscle mass as routine diagnostic indicators for malnutrition assessment.

Nutritional Treatment

All patients admitted to the ICU received active nutritional treatment when their condition allowed:[21,22] oral diets were provided to patients who could eat; enteral nutrition was administered to those unable to eat orally; and parenteral nutrition (PN) was given to patients with contraindications to enteral nutrition. In cases where patients exhibit intolerance to enteral nutrition treatment and the following conditions are present, delayed nutritional treatment was initiated: (1) cardiovascular dysfunction or severe metabolic disorders not yet controlled, (2) the risk of parenteral nutrition complications outweighed potential benefits, (3) emergency surgery was needed, (4) uncontrolled infections such as early-stage severe pancreatitis were present. Nutritional treatment was defined as any form of feeding, oral nutritional supplements, enteral nutrition, or parenteral nutrition administered during the ICU stay.

Statistical Analysis

Continuous variables that follow a normal distribution (assessed using the Kolmogorov–Smirnov test) are reported as mean ± standard deviation (SD) and analyzed using an independent *t*-test. Non-normally distributed continuous variables are presented as median [interquartile range] and analyzed using the Kruskal–Wallis tests. Categorical variables were expressed as numbers (percentages) and analyzed using the chi-squared test. For categorical variables that do not conform to the chi-square test, the Fisher's precision probability test was used for comparison between groups. The sensitivity and specificity were referred to the research results of Miriam Theilla et al[8] This study expected a sensitivity of 85%, a specificity of 80%, and an allowable error of 10% for both. A two-sided test was required, with an α of 0.05. a total sample size of 60 was obtained through PASS version 15.0.5 (Power Analysis and Sample Size, NCSS, USA). Continuous variables are presented as mean ± standard deviation if normally distributed, or as median [interquartile range] otherwise. Categorical variables are summarized as frequencies (percentages). Differences between groups were assessed using ANOVA for normally distributed continuous variables, the Kruskal–Wallis test for non-normally distributed continuous variables, and the chi-square or Fisher's exact test for categorical variables, as appropriate. The area under the receiver operating characteristic curve (AUC) was used to evaluate the correlation between the two diagnostic methods, and the Kappa agreement test was employed to assess their consistency. Multivariate linear and logistic regression analyses were conducted to explore the relationship between malnutrition diagnosed by NRS-2002 +GLIM or mNUTRIC+GLIM and clinical outcomes in critically ill patients. To evaluate potential multicollinearity

among independent variables incorporated into the regression models, variance inflation factors (VIFs) were computed. All VIF values were close to 1 (VIF < 5), indicating no significant collinearity. Finally, a subgroup analysis was performed to explore the effect of nutrition treatment on clinical outcomes in patients diagnosed with malnutrition.

Results

Patient Characteristics

A total of 173 critically ill patients were included. The prevalence of malnutrition was 18.5% (32/173) according to the NRS-2002+GLIM and 13.9% (24/173) according to the mNUTRIC+GLIM. Regardless of which approach was used, the malnutrition group was older, had a lower BMI, and lower albumin and prealbumin levels compared to non-malnutrition patients. There were no significant differences between the malnutrition and non-malnutrition groups in terms of whether the patients had hepatic or renal disease at the time of admission to the ICU, whether they had Albumin infusion, or whether they underwent metachysis. Interestingly, when assessed using the mNUTRIC+GLIM, Hemoglobin and CRP indices in malnutrition patients were significantly different from those in the non-malnutrition group (Table 1).

Disease Severity

In both approaches, the types of patients in the malnutrition group at the time of transfer to the ICU were predominantly non-surgical emergencies and others, whereas in the non-malnutrition group they were predominantly non-surgical emergencies and surgical emergencies, which was a significant difference ($p < 0.05$). The number of comorbidities, APACHE II scores, and SOFA scores at the time of ICU admission were significantly different between the two groups when assessed using the mNUTRIC+GLIM (Table 2).

Comparison of Clinical Outcomes

Univariate analysis showed that the relationship between malnutrition assessed by the two approaches and clinical outcomes was relatively consistent. There was a significant difference in the discharge status of patients between the two

Table 1 Comparison of Basic Characteristics of Malnutrition and Non-Malnutrition Populations

		NRS-2002+GLIM			mNUTRIC+GLIM		
		Non-Malnutrition (141)	**Malnutrition (32)**	**p-value**	**Non-Malnutrition (149)**	**Malnutrition (24)**	**p-value**
Sex (%)	Male Female	100 (70.9) 41 (29.1)	17 (53.1) 15 (46.9)	0.083	103 (69.1) 46 (30.9)	14 (58.3) 10 (41.7)	0.416
Age (years)		60.04 (17.54)	74.66 (15.72)	<0.001	60.17 (17.81)	78.75 (9.88)	<0.001
Height (cm)		166.06 (7.17)	160.06 (7.34)	<0.001	165.75 (7.19)	160.00 (7.98)	<0.001
Weight (kg)		65.82 (11.78)	47.84 (5.79)	<0.001	64.89 (12.17)	47.58 (5.87)	<0.001
BMI (kg/m^2)		23.77 (3.37)	18.65 (1.67)	<0.001	23.51 (3.48)	18.58 (1.73)	<0.001
HB (g/L)		112.00 [90.00, 132.00]	106.00 [83.75, 120.25]	0.177	112.00 [90.00, 132.00]	92.00 [82.25, 111.75]	0.045
CRP (mg/L)		22.70 [8.25, 55.58]	40.95 [13.82, 120.03]	0.088	24.15 [8.07, 56.77]	52.75 [19.02, 120.03]	0.037
ALB (g/L)		35.10 [31.00, 39.20]	30.25 [26.58, 34.62]	<0.001	34.90 [30.60, 39.20]	30.25 [27.78, 34.62]	0.001
PAB (mg/L)		179.00 [142.50, 208.00]	125.50 [65.25, 152.50]	<0.001	178.00 [141.00, 207.00]	125.50 [86.25, 150.50]	<0.001
Liver or kidney disease (%)	No Yes	105 (74.5) 36 (25.5)	21 (65.6) 11 (34.4)	0.427	110 (73.8) 39 (26.2)	16 (66.7) 8 (33.3)	0.628
Albumin infusion (%)[a]	No Yes	121 (85.8) 20 (14.2)	27 (84.4) 5 (15.6)	1.000	127 (85.2) 22 (14.8)	21 (87.5) 3 (12.5)	1.000
Metachysis (%)[a]	No Yes	122 (86.5) 19 (13.5)	26 (81.2) 6 (18.8)	0.626	129 (86.6) 20 (13.4)	19 (79.2) 5 (20.8)	0.519

Note: [a]Fisher's exact test.
Abbreviations: BMI, Body mass index; HB, Hemoglobin; CRP, C-Reactive Protein; ALB, Albumin; PAB, Prealbumin.

Table 2 Comparison of Disease Severity Between Malnutrition and Non-Malnutrition Populations

		NRS-2002+GLIM			mNUTRIC+GLIM		
		Non-Malnutrition (141)	**Malnutrition (32)**	**p-value**	**Non-Malnutrition (149)**	**Malnutrition (24)**	**p-value**
Type of ICU admission (%)[a]	Non-surgical emergency	57 (40.4)	17 (53.1)	0.002	61 (40.9)	13 (54.2)	0.012
	surgical emergency	56 (39.7)	2 (6.2)		56 (37.6)	2 (8.3)	
	Surgical elective	9 (6.4)	3 (9.4)		11 (7.4)	1 (4.2)	
	Others	19 (13.5)	10 (31.2)		21 (14.1)	8 (33.3)	
Number of comorbidities at ICU admission		4.00 [3.00, 7.00]	5.00 [3.00, 9.00]	0.238	4.00 [3.00, 7.00]	6.50 [3.75, 10.25]	0.047
APACHE II score at ICU admission		18.00 [13.00, 24.00]	19.50 [17.75, 25.25]	0.174	18.00 [12.00, 24.00]	23.00 [19.00, 28.00]	<0.001
SOFA score at ICU admission		6.00 [4.00, 9.00]	7.00 [4.75, 11.75]	0.118	6.00 [4.00, 9.00]	9.00 [7.00, 14.00]	0.001

Note: [a]Fisher's exact test.
Abbreviations: ICU, Intensive care unit; SOFA, Sequential Organ Failure Assessment; APACHE II, Acute Physiology and Chronic Health Evaluation.

assessment approaches, with most of the non-malnutrition patients being cured and improved, whereas the malnutrition patients were predominantly in an untreated state. There was also a significant difference in the proportion of patients treated with vasopressin during ICU in both groups, with the malnutrition group being significantly higher than the non-malnutrition group. The number of days of treatment with vasopressin in ICU was also significantly higher in malnutrition patients than in non-malnutrition patients when assessed using the mNUTRIC+GLIM. However, malnutrition patients received nutritional treatment for fewer days during their ICU stay (Table S1).

Consistency of Screening Strategies

mNUTRIC+GLIM demonstrated significantly higher specificity (0.99, 95% CI: 0.96–1.00). The two diagnostic pathways showed substantial agreement ($\kappa = 0.79$, $p < 0.001$) with a high Youden's index (Table 3). The ROC curve yielded an area under the curve of 0.95 (95% CI: 0.90–0.99) (Figure 1), reflecting a strong correlation between mNUTRIC+GLIM and NRS-2002+GLIM.

Assessing the Relationship Between Malnutrition and Clinical Outcomes

We aimed to explore the relationship between malnutrition diagnosed by both assessment approaches and clinical outcomes through logistic regression (Table 4). Sex, age, and number of comorbidities at the time of admission to the ICU were adjusted during the analyses. In the logistic analysis, we combined the four-category discharge status into a binary classification (improved: including improvement and cure; uncure: including uncure and death). In the context of malnutrition's impact, mNUTRIC+GLIM positive patients exhibited a more pronounced association with adverse discharge status [OR 6.24; 95% CI 2.20–18.38] compared to NRS-2002+GLIM-positive patients [OR 5.09; 95% CI 2.00–13.23]. Regardless of the nutritional screening tool used, malnutrition was significantly associated with vasopressor

Table 3 The Agreement in Identifying Malnutrition Between mNUTRIC+GLIM and NRS-2002+GLIM

Statistical Parameters	
Sensitivity	0.72 (0.53, 0.86)
Specificity	0.99 (0.96, 1.00)
Positive predictive value	0.96 (0.79, 1.00)
Negative predictive value	0.94 (0.89, 0.97)
Youden's index	0.71 (0.49, 0.86)
Kappa	0.79 p = 0.000

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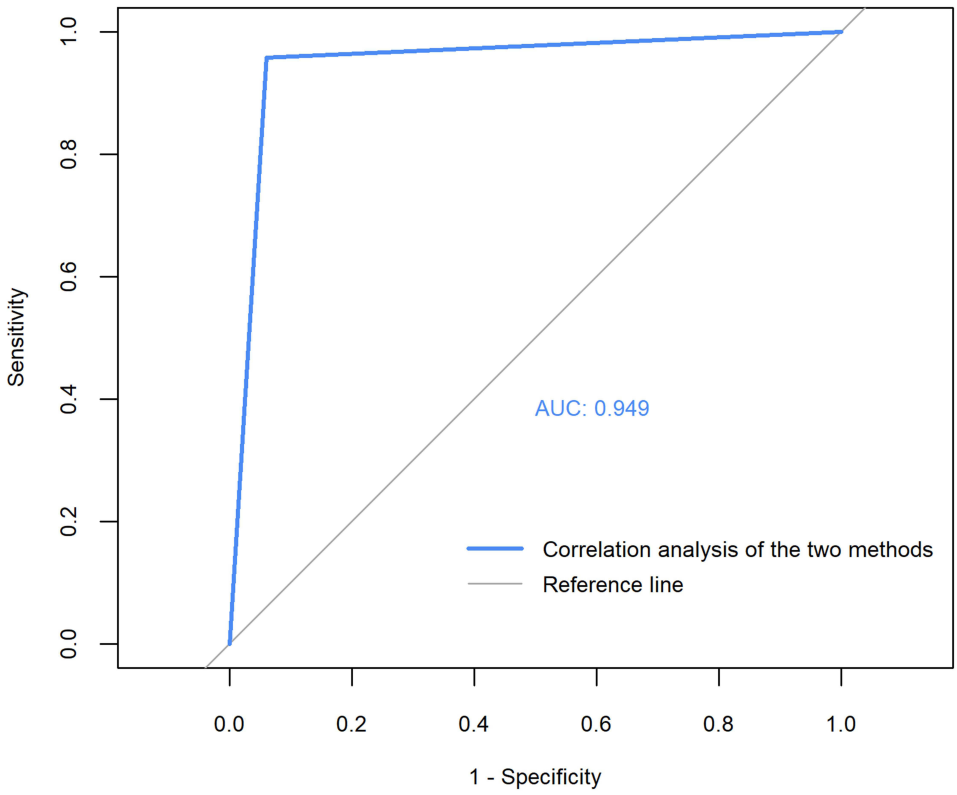

Figure 1 The correlation between mNUTRIC+GLIM and NRS-2002+GLIM.

use. Malnutrition had no significant effect on nutritional treatment for patients in the ICU. The associations of sedation and ventilatory support with malnutrition did not reach statistical significance.

Additionally, associations between malnutrition and the duration of hospitalization, ICU stay, ventilatory support, sedation, vasopressor use, and nutritional treatment were examined (Figure 2), along with the relationship between malnutrition and the proportion of ICU treatment days as measured by ventilatory support duration (Figure 3). Analyses were adjusted for sex, age, and the number of comorbidities at ICU admission. Results demonstrated that the number of days receiving nutritional treatment in the ICU was negatively associated with NRS-2002+GLIM-defined malnutrition ($p < 0.05$). The proportion of days receiving nutritional treatment was negatively associated with malnutrition assessed by both methods. Conversely, the proportion of days with sedation and vasopressor use showed positive associations with malnutrition ($p < 0.05$ for both methods).

Table 4 Multivariable Logistic Regression Analysis of the Associations Between GLIM-Defined Malnutrition (via NRS-2002 or mNUTRIC Screening) and Clinical Outcomes

	NRS-2002+GLIM			**mNUTRIC+GLIM**		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Discharge status	5.09	2.00, 13.23	<0.001	6.24	2.20, 18.38	<0.001
Nutritional treatment	0.62	0.20–2.20	0.429	0.79	0.20–3.99	0.754
Sedation	1.41	0.59–3.51	0.444	1.64	0.60–4.60	0.338
Vasopressors	3.09	1.15–9.98	0.037	6.87	1.78–45.76	0.015
Ventilatory support	1.19	0.50–3.00	0.700	1.39	0.52–3.98	0.523

Notes: Adjust for Age, Sex, Number of comorbidities at ICU admission.

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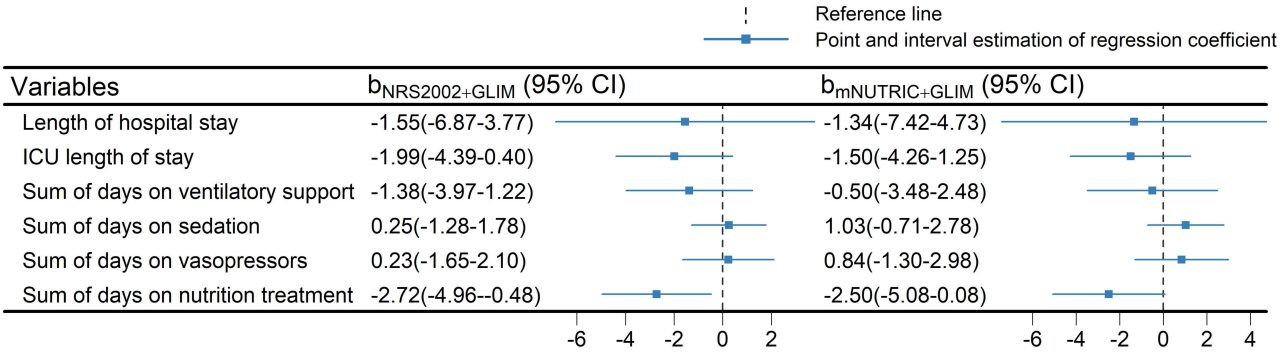

Figure 2 Relationship between malnutrition and clinical outcomes (days).

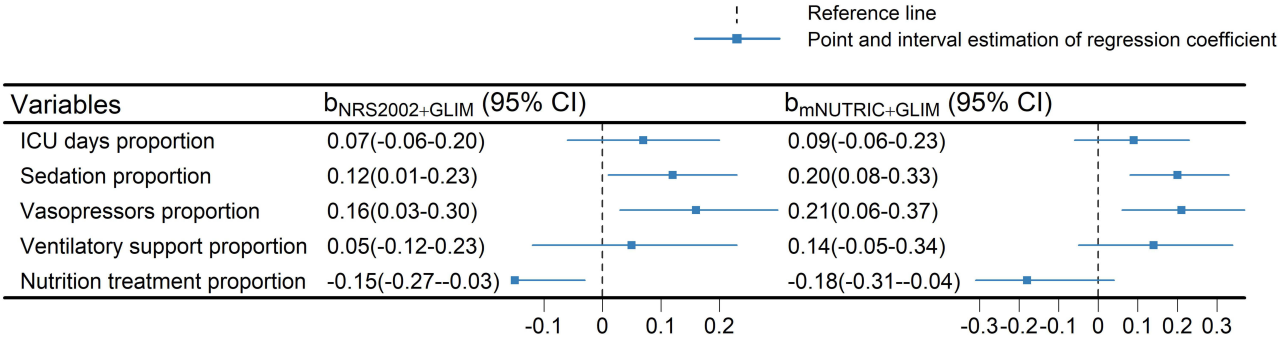

Figure 3 Relationship between malnutrition and clinical outcomes (proportion of days).

Impact of Nutritional Treatment on Malnutrition Populations

As shown in Table S2, there were no significant differences in the baseline characteristics of patients in the group undergoing nutritional treatment and the group with delayed nutritional treatment in the malnutrition population. Regardless of which assessment tool was used, the proportion of days treated in the ICU was significantly lower in the nutritional treatment group than in the delayed nutrition group ($p < 0.05$), and the total number of hospital days was significantly higher than in the delayed nutritional treatment group. The hospital mortality was significantly lower in the nutritional treatment group than in the delayed nutritional treatment group, as assessed using the mNUTRIC+GLIM. However, among NRS-2002+GLIM-positive patients, no statistically significant difference in hospital mortality was observed between the two groups (Table 5). Among patients identified as positive by both assessment methods, no associations were found between nutritional treatment and other clinical outcomes (Table 5).

Table 5 Effect of Nutritional Treatment on Clinical Outcomes in Malnutrition Population

		NRS-2002+GLIM			mNUTRIC+GLIM		
		Delayed Nutrition (n=5)	**Nutrition Treatment (n=27)**	**p-value**	**Delayed Nutrition (n=3)**	**Nutrition Treatment (n=21)**	**p-value**
Discharge status (%)[a]	Improve Uncure	1 (20.0) 4 (80.0)	17 (63.0) 10 (37.0)	0.198	0 (0.0) 3 (100.0)	12 (57.1) 9 (42.9)	0.217
Hospital died (%)[a]	No Yes	3 (60.0) 2 (40.0)	26 (96.3) 1 (3.7)	0.085	1 (33.3) 2 (66.7)	21 (100.0) 0 (0.0)	0.005

(*Continued*)

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Table 5 (Continued).

		NRS-2002+GLIM			mNUTRIC+GLIM		
		Delayed Nutrition (n=5)	**Nutrition Treatment (n=27)**	**p-value**	**Delayed Nutrition (n=3)**	**Nutrition Treatment (n=21)**	**p-value**
Length of hospital stay		5.00 [5.00, 10.00]	19.00 [10.50, 29.50]	0.013	5.00 [4.00, 7.50]	19.00 [9.00, 30.00]	0.029
ICU length of stay		5.00 [5.00, 6.00]	6.00 [6.00, 10.00]	0.098	5.00 [4.00, 7.50]	6.00 [6.00, 9.00]	0.209
Ventilatory support (%)[a]	No Yes	2 (40.0) 3 (60.0)	9 (33.3) 18 (66.7)	1.000	1 (33.3) 2 (66.7)	7 (33.3) 14 (66.7)	1.000
Sum of days on ventilatory support		3.00 [0.00, 5.00]	4.00 [0.00, 7.00]	0.353	3.00 [1.50, 4.00]	6.00 [0.00, 7.00]	0.326
Sedation (%)[a]	No Yes	2 (40.0) 3 (60.0)	13 (48.1) 14 (51.9)	1.000	1 (33.3) 2 (66.7)	10 (47.6) 11 (52.4)	1.000
Sum of days on sedation		2.00 [0.00, 2.00]	1.00 [0.00, 3.50]	0.978	2.00 [1.00, 3.00]	1.00 [0.00, 4.00]	0.963
Vasopressors (%)[a]	No Yes	0 (0.0) 5 (100.0)	5 (18.5) 22 (81.5)	0.706	0 (0.0) 3 (100.0)	2 (9.5) 19 (90.5)	1.000
Sum of days on vasopressors		2.00 [2.00, 4.00]	2.00 [1.00, 4.50]	0.916	2.00 [1.50, 3.50]	3.00 [2.00, 6.00]	0.596
ICU days proportion[b]		0.88 (0.27)	0.55 (0.34)	0.050	1.00 (0.00)	0.56 (0.33)	0.032
Sedation proportion[c]		0.37 (0.37)	0.28 (0.36)	0.592	0.49 (0.43)	0.33 (0.39)	0.518
Vasopressors proportion[c]		0.57 (0.34)	0.43 (0.36)	0.448	0.59 (0.46)	0.49 (0.34)	0.648
Ventilatory support proportion[c]		0.60 (0.55)	0.54 (0.46)	0.797	0.67 (0.58)	0.60 (0.47)	0.823

Notes: [a]Fisher's exact test; [b]The proportion of total hospitalization time spent in the Intensive. Care Unit; [c]Proportion of days for different treatments in the ICU. Discharge status (improved: including improvement and cure; uncure: including uncure and death).
Abbreviation: ICU, Intensive care unit.

Discussion

This study demonstrated that mNUTRIC and NRS-2002, when used as the first-step screening tools within the GLIM two-step diagnostic framework, showed substantial consistency, and both were significantly associated with adverse clinical outcomes in critically ill patients. Patients diagnosed with malnutrition using mNUTRIC had a higher risk of adverse clinical outcomes, along with lower hospital mortality and a lower proportion of ICU stay days following nutritional treatment.

The prevalence of malnutrition in this study was 18.5% according to NRS-2002+GLIM criteria and 13.9% using the mNUTRIC+GLIM, both of which are relatively lower than rates reported in previous studies.[23,24] A potential reason may be the patient population: a majority of those admitted to the ICU for surgical or non-surgical emergencies were well-nourished at baseline, suggesting better nutritional reserves and a more favorable starting point for clinical management. In contrast, malnutrition was more common among patients admitted for non-surgical emergencies or those with significant pre-existing comorbidities. An additional factor that may have contributed to this result is the absence of muscle mass measurement as a component of the nutritional assessment. In the ICU, obtaining reliable anthropometric, dietary, or body composition data is often challenging during the acute phase. Although techniques such as dual-energy X-ray absorptiometry (DXA), bioelectrical impedance analysis (BIA), ultrasound, computed tomography (CT), and handgrip strength are available for body composition assessment, their routine application is frequently limited in critically ill patients. Sedation, impaired consciousness, and immobility often preclude functional or regional measurements, while fluid resuscitation can distort lean body mass estimates.[25,26] In light of the high prevalence of malnutrition in critically ill patients and the critical role of muscle mass assessment, future research should include larger, more representative cohorts and develop practical methods for muscle evaluation in the ICU, in order to establish the most appropriate nutritional assessment strategy.

GLIM endorses a two-step process for diagnosing malnutrition: initial risk screening with a validated tool, followed by phenotypic and etiologic assessment using GLIM criteria. An ideal screening tool should be practical, non-invasive,

cost-effective, and efficient to ensure reliable identification of at-risk patients while minimizing bias. In critical care, two common tools are the NRS-2002 and the mNUTRIC score. While both incorporate disease severity, the NRS-2002 was designed for a general inpatient population, whereas the mNUTRIC was specifically developed and validated for ICU patients, incorporating inflammatory status and baseline characteristics.[27,28] In addition, mNUTRIC relies on objective clinical parameters that are more readily available in the ICU setting. Our findings demonstrated good consistency between the two diagnostic approaches, and both were significantly associated with adverse clinical outcomes.

Several studies have evaluated the relationship between malnutrition assessment tools and clinical outcomes in critically ill patients. Recent systematic reviews and meta-analyses have found that malnutrition is associated with an increased risk of mortality in this population; however, the evidence regarding associations with other clinical outcomes shows substantial heterogeneity.[23,24] This heterogeneity may be attributed to factors such as differences in study populations, assessment tools, and assessment procedures. In terms of predicting clinical outcomes, malnutrition identified through either NRS-2002+GLIM or mNUTRIC+GLIM was positively associated with the proportion of days under sedation and vasopressor support in ICU. To account for variations in ICU length of stay, we used proportional measures (eg, vasopressor days/total ICU days) to minimize potential bias. Furthermore, malnutrition diagnosed by both approaches was significantly associated with unfavorable discharge status. This finding aligns with a nationwide claims-based historical cohort study in acute care hospitals, which reported that GLIM-defined malnutrition was associated with substantially higher 30-day and 60-day mortality rates—a relationship that persisted even in GLIM assessments with missing data.[29] Notably, malnutrition identified by mNUTRIC showed a stronger association with adverse discharge status (OR = 6.24; 95% CI: 2.20–18.38) than that identified by NRS-2002. Furthermore, among patients diagnosed as malnourished via the mNUTRIC+GLIM, those who received nutritional intervention had significantly lower in-hospital mortality. In the complex physiological context of critically ill patients, mNUTRIC demonstrates higher specificity than the NRS-2002-based GLIM, thereby improving the identification of patients likely to benefit from nutritional therapy. This aligns with the findings of Rahman et al, who externally validated the mNUTRIC and suggested its utility in identifying critically ill patients most likely to benefit from adequate macronutrient delivery in terms of mortality reduction.[16] Nevertheless, given the limited sample size and the exploratory nature of this subgroup analysis, this finding should not be interpreted as definitive evidence for guiding clinical nutrition therapy decisions. Instead, it should be viewed as hypothesis-generating and warrants confirmation in future well-designed studies.

This study validated the diagnostic performance of the mNUTRIC+GLIM approach in critically ill patients, demonstrating excellent consistency and validity compared with the NRS-2002+GLIM pathway. In assessing malnutrition, mNUTRIC+GLIM more closely reflects the pathological characteristics of hyperinflammatory states in critically ill patients, thereby offering a more precise tool for clinical practice. Given the prognostic significance of malnutrition in this population, further research is warranted to evaluate the concurrent and predictive validity of different diagnostic tools using objective muscle mass measurements in larger, more representative cohorts. Moreover, the impact of nutritional therapy on malnutrition and clinical outcomes should be explored in high-quality studies to inform clinical decision-making.

Limitations

Several limitations of this study should be acknowledged when interpreting our findings. First, the sample size was relatively small, which may have limited statistical power. When examining the association between malnutrition and clinical outcomes, the events per variable (EPV) for discharge status was 8.5, slightly below the recommended threshold of 10, suggesting that these results may not be fully robust. However, as noted by Vittinghoff et al,[30] when EPV ranges between 5 and 9, issues such as biased confidence interval coverage, inflated Type I error, or relative bias are not commonly observed. In the exploratory subgroup analysis evaluating the association between nutritional therapy and clinical outcomes, the sample size was limited, particularly in the delayed nutrition group. Although the observed findings are noteworthy, no direct causal relationship between nutritional therapy and mortality can be inferred, and the results should be interpreted with caution. Secondly, muscle mass was not included as a phenotypic criterion in our nutritional assessment. This decision was made due to practical constraints, including the risk of patient transport, radiation exposure, high costs, and the lack of validated diagnostic cutoffs for low muscle mass (or alternative measures)

in Chinese populations. Consequently, this modified application of the GLIM criteria—specifically the omission of the muscle mass phenotypic criterion—likely resulted in an underestimation of malnutrition prevalence and precluded severity grading compared to a full GLIM assessment. This may have attenuated the observed associations between malnutrition and clinical outcomes, as the inclusion of muscle mass could have identified a more severely malnutrition subgroup with potentially worse prognoses. Future studies should prioritize feasible methods for muscle assessment in the ICU, such as ultrasound, to validate these findings.

Conclusion

In critically ill patients, both NRS-2002 and mNUTRIC demonstrated substantial consistency when used as first-step screening tools within the GLIM diagnostic framework. Malnutrition identified by either strategy was significantly associated with adverse discharge status and a higher proportion of ICU days requiring vasopressor and sedative support. Notably, the mNUTRIC+GLIM approach showed stronger associations with adverse clinical outcomes, highlighting its potential value in identifying high-risk patients who may benefit from targeted nutritional interventions.

Abbreviations

APACHE II, Acute Physiology and Chronic Health Evaluation; AUC, area under the curve; BMI, body mass index; CRP, C-reactive protein; GLIM, Global Leadership Initiative on Malnutrition; ICU, intensive care unit; IL-6, interleukin 6 levels; LOS, length of stay; mNUTRIC, Modified Nutrition Risk in Critically ill; NUTRIC, Nutrition Risk in Critically ill in Critically ill; NRS-2002, Nutrition Risk Screening 2002; PN, parenteral nutrition; ROC, receiver operating characteristic; SOFA, Sequential Organ Failure Assessment; SGA, Subjective Global Assessment.

Data Sharing Statement

The data that support the findings of this study are available from Linping Campus, The Second Affiliated Hospital of Zhejiang University School of Medicine but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Linping Campus, The Second Affiliated Hospital of Zhejiang University School of Medicine.

Ethics Approval and Informed Consent

The study was approved by the Institution's Internal Review Board (Linping Campus, The Second Affiliated Hospital of Zhejiang University School of Medicine Ethics Committees and Institutional Review Boards, No.2022/123), and informed consent was obtained from either patients or their relatives. This study complies with the Declaration of Helsinki.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

References

1. Cederholm T, Jensen GL, Correia MITD, 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. doi:10.1016/j.clnu.2018.08.002
2. Hill A, Elke G, Weimann A. Nutrition in the intensive care unit—a narrative review. *Nutrients*. 2021;13(8):2851. doi:10.3390/nu13082851
3. 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. *J Parenter Enteral Nutr*. 2017;41(5):744–758. doi:10.1177/0148607115625638
4. Anne C, Sarah P, Kelly R, Hannah R, Diane S. Use of 3 tools to assess nutrition risk in the intensive care unit. *J Parenter Enteral Nutr*. 2015;39 (1):28–33. doi:10.1177/0148607114532135
5. Dávalos-Yerovi V, Marco E, Sánchez-Rodríguez D, et al. Malnutrition according to GLIM criteria is associated with mortality and hospitalizations in rehabilitation patients with stable chronic obstructive pulmonary disease. *Nutrients*. 2021;13(2):369. doi:10.3390/nu13020369
6. Kakavas S, Karayiannis D, Bouloubasi Z, et al. Global leadership initiative on malnutrition criteria predict pulmonary complications and 90-day mortality after major abdominal surgery in cancer patients. *Nutrients*. 2020;12(12):3726. doi:10.3390/nu12123726
7. Emsley C, King S, Nyulasi I, Snell G. A GLIMmer of insight into lung transplant nutrition: enhanced detection of malnutrition in lung transplant patients using the GLIM criteria. *Clin Nutr*. 2021;40(5):2521–2526. doi:10.1016/j.clnu.2021.02.047
8. Theilla M, Rattanachaiwong S, Kagan I, Rigler M, Bendavid I, Singer P. Validation of GLIM malnutrition criteria for diagnosis of malnutrition in ICU patients: an observational study. *Clin Nutr*. 2021;40(5):3578–3584. doi:10.1016/j.clnu.2020.12.021
9. Jensen GL, Cederholm T, Correia MITD, et al. GLIM consensus approach to diagnosis of malnutrition: a 5-year update. *J Parenter Enteral Nutr*. 2025;49(4):414–427. doi:10.1002/jpen.2756
10. Taylor BE, McClave SA, Martindale RG, et al. Guidelines for the provision and assessment of nutrition support therapy in the adult critically ill patient: Society of Critical Care Medicine (SCCM) and American Society for Parenteral and Enteral Nutrition (A.S.P.E.N.). *Crit Care Med*. 2016;44(2):390–438. doi:10.1097/CCM.0000000000001525
11. Marchetti J, Reis AMD, Santos AFD, Franzosi OS, Luft VC, Steemburgo T. High nutritional risk is associated with unfavorable outcomes in patients admitted to an intensive care unit. *Rev Bras Ter Intensiva*. 2019;31(3):326–332. doi:10.5935/0103-507X.20190041
12. Im KM, Kim EY. Identification of ICU patients with high nutritional risk after abdominal surgery using modified NUTRIC score and the association of energy adequacy with 90-day mortality. *Nutrients*. 2022;14(5):946. doi:10.3390/nu14050946
13. Machado Dos Reis A, Marchetti J, Forte Dos Santos A, Franzosi OS, Steemburgo T. NUTRIC score: isolated and combined use with the NRS-2002 to predict hospital mortality in critically ill patients. *J Parenter Enteral Nutr*. 2020;44(7):1250–1256. doi:10.1002/jpen.1804
14. Mukhopadhyay A, Henry J, Ong V, et al. Association of modified NUTRIC score with 28-day mortality in critically ill patients. *Clin Nutr*. 2017;36 (4):1143–1148. doi:10.1016/j.clnu.2016.08.004
15. Canales C, Elsayes A, Yeh DD, et al. Nutrition risk in critically ill versus the nutritional risk screening 2002: are they comparable for assessing risk of malnutrition in critically ill patients? *J Parenter Enteral Nutr*. 2019;43(1):81–87. doi:10.1002/jpen.1181
16. Rahman A, Hasan RM, Agarwala R, Martin C, Day AG, Heyland DK. Identifying critically-ill patients who will benefit most from nutritional therapy: further validation of the "modified NUTRIC" nutritional risk assessment tool. *Clin Nutr*. 2016;35(1):158–162. doi:10.1016/j.clnu.2015.01.015
17. Fu P. Basic routine health monitoring methods require more standardization—Interpretation of the "Population Health Monitoring Anthropometric Methods" standard. *Chin Health Stand Manag*. 2013;4(1):2. (Chinese literature).
18. Kondrup J. Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. *Clin Nutr*. 2003;22(3):321–336. doi:10.1016/S0261-5614(02)00214-5
19. Geriatrics Branch of the Chinese Medical Association, National Clinical Research Center for Geriatric Diseases (Xiangya Hospital). Guidelines for the diagnosis and treatment of sarcopenia in China (2024 edition). *Chin Med J*. 2025;105(3):181–203. (Chinese literature).
20. Chinese Society of Critical Care Medicine. Clinical practice guidelines for nutritional assessment and monitoring in adult ICU patients in China. *Chin J Crit Care Med*. 2023;35(11):1121–1146. (Chinese literature).
21. Compher C, Bingham AL, McCall M, et al. Guidelines for the provision of nutrition support therapy in the adult critically ill patient: the American Society for Parenteral and Enteral Nutrition. *J Parenter Enteral Nutr*. 2022;46(1):12–41. doi:10.1002/jpen.2267
22. Singer P, Blaser AR, Berger MM, et al. ESPEN practical and partially revised guideline: clinical nutrition in the intensive care unit. *Clin Nutr*. 2023;42(9):1671–1689. doi:10.1016/j.clnu.2023.07.011
23. Gustavo D, Maria Isabel TDC, Maria Cristina G, Mariana R. The global leadership initiative on malnutrition criteria for the diagnosis of malnutrition in patients admitted to the intensive care unit: a systematic review and meta-analysis. *Clin Nutr*. 2023;42(2):175–183. doi:10.1016/j.clnu.2022.12.007
24. Stello BB, Zucatti KP, Freitas IM, et al. Concurrent and predictive validity of different tools for malnutrition diagnosis in adult critically ill patients: a systematic review with meta-analysis of observational studies. *Am J Clin Nutr*. 2026;123(3):101195. doi:10.1016/j.ajcnut.2026.101195
25. Berger MM, Reintam-Blaser A, Calder PC, et al. Monitoring nutrition in the ICU. *Clin Nutr*. 2019;38(2):584–593. doi:10.1016/j.clnu.2018.07.009
26. Suzie F. What is nutritional assessment? A quick guide for critical care clinicians. *Aust Crit Care*. 2020;33(3):295–298. doi:10.1016/j.aucc.2020.02.005
27. Coruja MK, Cobalchini Y, Wentzel C, Fink JDS. Nutrition risk screening in intensive care units: agreement between NUTRIC and NRS 2002 tools. *Nutr Clin Pract*. 2020;35(3):567–571. doi:10.1002/ncp.10419
28. Christian S, Aileen H, Kenneth BC, Arnold SK. Toward Precision in Nutrition Therapy. *Crit Care Med*. 2025;53(2):e367–e375. doi:10.1097/CCM.0000000000006537
29. Shimizu A, Tomata Y, Hasegawa Y, et al. GLIM Criteria-defined malnutrition and short-term mortality in acute care hospitals: a nationwide claims-based historical cohort study. *Clin Nutr*. 2025;54:83–90. doi:10.1016/j.clnu.2025.09.012
30. Vittinghoff E, McCulloch CE. Relaxing the rule of ten events per variable in logistic and Cox regression. *Am J Epidemiol*. 2007;165(6):710–718. doi:10.1093/aje/kwk052