

Incremental Prognostic Value of the Geriatric Nutritional Risk Index in Mechanically Ventilated Older ICU Patients: A Retrospective Cohort Study

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Abstract

Background

The Geriatric Nutritional Risk Index (GNRI) is a simple marker of nutrition-related risk in older adults, but its prognostic value in mechanically ventilated older intensive care unit (ICU) patients remains uncertain. We evaluated the association of GNRI with 28-day mortality and its incremental prognostic value beyond conventional severity scores.

Methods

This single-center retrospective cohort study included 285 ICU patients aged ≥ 65 years who received invasive mechanical ventilation between January 2025 and July 2026. Patients were classified as having nutritional risk (GNRI ≤ 98) or no nutritional risk (GNRI > 98). The primary outcome was 28-day mortality; extubation failure was evaluated as a secondary outcome. Multivariable logistic regression and receiver operating characteristic analyses were performed, and GNRI was compared with APACHE II and SOFA scores.

Results

Twenty-eight-day mortality was higher in patients with nutritional risk than in those without risk (52.6% vs. 14.0%; $p < 0.001$). GNRI-defined nutritional risk remained independently associated with mortality (adjusted OR 2.50, 95% CI 1.01–6.25; $p = 0.049$). GNRI showed moderate discrimination for mortality (area under the curve [AUC] 0.767, 95% CI 0.708–0.826) and outperformed SOFA (AUC 0.701; $p = 0.010$). Adding GNRI to SOFA increased the AUC to 0.772 ($p = 0.016$). Although GNRI was associated with extubation failure in unadjusted analysis, this association did not persist after multivariable adjustment.

Conclusions

GNRI was independently associated with 28-day mortality in mechanically ventilated older ICU patients and provided incremental prognostic information beyond SOFA. GNRI may serve as a simple complementary tool for early mortality risk stratification, but not as a standalone predictor of extubation failure.

1. INTRODUCTION

Mechanical ventilation is a cornerstone of life support in intensive care units (ICUs), particularly among older patients with severe acute illness. Despite advances in critical care, mechanically ventilated older adults remain at high risk of short-term mortality and other adverse outcomes. Conventional severity scores such as the Acute Physiology and Chronic Health Evaluation II (APACHE II) and Sequential Organ

Failure Assessment (SOFA) are widely used for risk stratification; however, they may not fully capture the nutritional and physiological reserve of older critically ill patients. Therefore, simple and readily available markers that provide complementary prognostic information may be clinically useful in this population.

Malnutrition and nutrition-related risk are common among older critically ill patients and are associated with unfavorable clinical outcomes. Critical illness is characterized by systemic inflammation, hypercatabolism, and accelerated skeletal muscle breakdown, which may further reduce already limited physiological reserves in older adults (3, 4). Loss of skeletal and respiratory muscle function may also contribute to prolonged mechanical ventilation and difficulties during weaning (5). The Geriatric Nutritional Risk Index (GNRI) is a simple and objective index derived from serum albumin concentration and the ratio of actual to ideal body weight (6). Lower GNRI values have been associated with adverse outcomes and increased mortality in several clinical settings, including critical illness (7–9).

Previous studies have reported associations between lower GNRI values and in-hospital or short-term mortality among critically ill older patients (10, 11). More recently, GNRI has also been investigated in relation to adverse post-extubation outcomes (12). However, evidence remains limited regarding the prognostic value of GNRI specifically in older ICU patients requiring invasive mechanical ventilation, particularly whether GNRI provides additional prognostic information beyond established severity scores such as APACHE II and SOFA. Furthermore, the relationship between GNRI and extubation failure in this high-risk population has not been fully clarified.

Therefore, the primary aim of this study was to evaluate the association between GNRI and 28-day mortality in mechanically ventilated ICU patients aged 65 years and older and to determine whether GNRI provides incremental prognostic information beyond conventional illness-severity scores. A secondary aim was to assess the association between GNRI and extubation failure.

2. MATERIALS AND METHODS

2.1 Study Design and Patient Population

This single-center retrospective cohort study was conducted to evaluate the prognostic value of the GNRI for 28-day mortality and its incremental prognostic contribution beyond conventional severity scores in older ICU patients requiring invasive mechanical ventilation. The association between GNRI and extubation failure was evaluated as a secondary objective. Electronic medical records of patients aged 65 years or older who were admitted to the ICU and received invasive mechanical ventilation between January 1, 2025, and July 31, 2026, were retrospectively reviewed.

The inclusion criteria were age ≥ 65 years, receipt of invasive mechanical ventilation during the ICU stay, availability of serum albumin measurements within the first 24 hours of ICU admission, documented height and body weight for GNRI calculation, and complete data for outcome assessment.

Patients who died within the first 24 hours of ICU admission or had insufficient data for GNRI calculation or outcome assessment were excluded. For patients with more than one ICU admission during the study period, only the first admission was included.

The study was approved by the Muş Alparslan University Scientific Research and Publication Ethics Committee on July 9, 2026 (Decision No. 41) and was conducted in accordance with the Declaration of Helsinki. The requirement for informed consent was waived by the ethics committee due to the retrospective nature of the study.

2.2 Data Collection

Data for the patients included in the study were obtained from electronic medical records. Demographic variables included age, sex, height, body weight, body mass index, and comorbidities, including hypertension, diabetes mellitus, coronary artery disease, heart failure, chronic kidney disease, chronic obstructive pulmonary disease, and malignancy. Clinical data included the Acute Physiology and Chronic Health Evaluation II (APACHE II), Sequential Organ Failure Assessment (SOFA), and Glasgow Coma Scale (GCS) scores. Laboratory parameters recorded within the first 24 hours of ICU admission included serum albumin, hemoglobin, leukocyte count, creatinine, and C-reactive protein (CRP).

Mechanical ventilation–related variables included the duration of mechanical ventilation, the need for reintubation, and tracheostomy status. In addition, ICU length of stay, hospital length of stay, and 28-day mortality were recorded.

2.3 Calculation of the Geriatric Nutritional Risk Index

The Geriatric Nutritional Risk Index (GNRI) was calculated using the formula originally described by Bouillanne et al.:

$$\text{GNRI} = (1.489 \times \text{serum albumin [g/L]}) + [41.7 \times (\text{actual body weight} / \text{ideal body weight})]$$

Ideal body weight was calculated using the Lorentz formula. According to the commonly used GNRI classification, values > 98 indicate no nutritional risk, 92–98 indicate low risk, 82–91 indicate moderate risk, and < 82 indicate major nutritional risk. In the present study, a binary classification was used to distinguish patients with any degree of nutritional risk from those without nutritional risk. Accordingly, patients with a GNRI > 98 were classified as having no nutritional risk (Group 1), whereas those with a GNRI ≤ 98, corresponding to low, moderate, or major nutritional risk, were classified as having nutritional risk (Group 2).

2.4 Outcomes

The primary outcome of the study was 28-day mortality. Secondary outcomes included extubation failure, duration of mechanical ventilation, need for tracheostomy, ICU length of stay, and hospital length of stay. Extubation failure was defined as the need for reintubation within 72 hours after discontinuation of invasive mechanical ventilation.

2.5 Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics (Version 25.0; IBM Corp., Armonk, NY, USA). The distribution of continuous variables was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. Normally distributed variables are presented as mean $\pm$ standard deviation, whereas non-normally distributed variables are expressed as median (minimum–maximum). Categorical variables are presented as numbers and percentages. Comparisons of continuous variables between GNRI risk groups were performed using the Student's *t* test or Mann–Whitney *U* test, as appropriate, while categorical variables were compared using the chi-square test or Fisher's exact test.

The associations of GNRI with 28-day mortality and extubation failure were initially evaluated using univariable logistic regression analyses. Variables associated with the outcomes in univariable analyses and considered clinically relevant were selected for inclusion in the multivariable logistic regression models. GNRI risk status was retained in the models as the primary independent variable. Components of the GNRI, as well as variables directly related to the GNRI by mathematical definition, were not included simultaneously in the same model. Analyses of extubation failure were restricted to patients who underwent extubation. Results are reported as odds ratios (ORs) with 95% confidence intervals (CIs).

The discriminative performance of GNRI for 28-day mortality and extubation failure was assessed using receiver operating characteristic (ROC) curve analysis, with GNRI analyzed as a continuous variable. The area under the curve (AUC) with 95% confidence intervals was calculated, and the optimal GNRI cutoff value was determined using the Youden index. For 28-day mortality, the AUC of GNRI was compared with those of APACHE II and SOFA using the DeLong test. To evaluate the incremental prognostic value of GNRI, GNRI was added to models including APACHE II or SOFA, and the resulting models were compared with models containing APACHE II or SOFA alone. Changes in AUC were assessed using the DeLong test, and differences in model fit were evaluated using the likelihood-ratio test. A two-sided *p* value < 0.05 was considered statistically significant.

3. RESULTS

A total of 285 patients were included in the study, of whom 129 were classified as having no nutritional risk (Group 1) and 156 as having nutritional risk (Group 2) according to the GNRI. The median age of the overall cohort was 80 (71–88) years, and age and sex distributions were comparable between the groups. Patients in Group 2 had lower anthropometric and nutritional measures and a higher prevalence of several comorbidities. They also exhibited greater disease severity, with higher APACHE II and SOFA scores and lower GCS scores, together with a less favorable laboratory profile. Detailed baseline characteristics are presented in Table 1.

Table 1

Demographic, clinical, and laboratory characteristics of patients according to GNRI risk status

Variable	Overall (n = 285)	Group 1 (n = 129)	Group 2 (n = 156)	p
Demographic and anthropometric characteristics				
Age, years	80 (71–88)	79 (72–87)	80.5 (71–89)	0.689
Female, n (%)	140 (49.1)	60 (46.5)	80 (51.3)	0.495
Male, n (%)	145 (50.9)	69 (53.5)	76 (48.7)	
Height, cm	162.4 (156.9–170.0)	162.7 (157.0–168.7)	162.3 (156.9–170.6)	0.984
Weight, kg	54.6 (45.6–60.8)	60.9 (56.9–67.6)	46.1 (42.1–51.9)	< 0.001
BMI, kg/m ²	21.39 (17.10–23.09)	23.15 (22.43–23.85)	17.23 (16.13–18.37)	< 0.001
Ideal body weight, kg	58.57 ± 5.11	58.52 ± 4.77	58.60 ± 5.38	0.894
Weight/ideal body weight ratio	0.96 (0.78–1.05)	1.05 (1.02–1.09)	0.79 (0.74–0.85)	< 0.001
Serum albumin, g/L	36.2 (25.2–39.3)	39.6 (38.6–41.0)	25.9 (23.4–27.9)	< 0.001
GNRI	96.87 (69.44–102.46)	102.83 (100.64–105.11)	70.17 (66.82–74.30)	< 0.001
Comorbidities				
Hypertension, n (%)	102 (35.8)	29 (22.5)	73 (46.8)	< 0.001
Diabetes mellitus, n (%)	116 (40.7)	43 (33.3)	73 (46.8)	0.022
Coronary artery disease, n (%)	98 (34.4)	40 (31.0)	58 (37.2)	0.317
Heart failure, n (%)	62 (21.8)	18 (14.0)	44 (28.2)	0.004
Chronic kidney disease, n (%)	64 (22.5)	13 (10.1)	51 (32.7)	< 0.001
COPD, n (%)	71 (24.9)	22 (17.1)	49 (31.4)	0.006
Malignancy, n (%)	53 (18.6)	16 (12.4)	37 (23.7)	0.015
Disease severity and laboratory findings				
Data are presented as mean ± standard deviation, median (minimum–maximum), or number (%), as appropriate. Abbreviations: GNRI, Geriatric Nutritional Risk Index; BMI, body mass index; COPD, chronic obstructive pulmonary disease; APACHE II, Acute Physiology and Chronic Health Evaluation II; SOFA, Sequential Organ Failure Assessment; CRP, C-reactive protein.				

Variable	Overall (n = 285)	Group 1 (n = 129)	Group 2 (n = 156)	p
Demographic and anthropometric characteristics				
APACHE II	23 (18–28)	19 (14–21)	27.5 (24–31)	< 0.001
SOFA	8 (6–10)	6 (4–7)	10 (8–12)	< 0.001
Glasgow Coma Scale	10 (7–12)	11 (9–12)	8 (6–10)	< 0.001
Hemoglobin, g/dL	10.80 ± 1.48	11.58 ± 1.25	10.16 ± 1.34	< 0.001
Leukocyte count, ×10 ⁹ /L	12.41 ± 3.74	11.02 ± 3.38	13.56 ± 3.63	< 0.001
Creatinine, mg/dL	1.54 (1.13–2.14)	1.28 (0.95–1.60)	1.88 (1.40–2.40)	< 0.001
CRP, mg/L	99.9 (68.1–133.7)	71.8 (40.4–99.1)	123.2 (96.7–156.3)	< 0.001
Data are presented as mean ± standard deviation, median (minimum–maximum), or number (%), as appropriate. Abbreviations: GNRI, Geriatric Nutritional Risk Index; BMI, body mass index; COPD, chronic obstructive pulmonary disease; APACHE II, Acute Physiology and Chronic Health Evaluation II; SOFA, Sequential Organ Failure Assessment; CRP, C-reactive protein.				

Patients in Group 2 had a longer duration of mechanical ventilation and higher rates of tracheostomy and 28-day mortality than those in Group 1 (all $p < 0.001$). Among the 239 patients who underwent extubation, 48 (20.1%) experienced extubation failure, which was more frequent in Group 2 than in Group 1 (28.3% vs. 11.8%; $p = 0.002$). Pre-extubation death occurred only in Group 2 (7.7%; $p < 0.001$). Detailed clinical outcomes are presented in Table 2.

Table 2
Comparison of clinical outcomes according to GNRI risk groups

Clinical outcome	Overall (n = 285)	Group 1 (n = 129)	Group 2 (n = 156)	p
Duration of mechanical ventilation, days	8 (5–12)	6 (4–7)	12 (9–14)	< 0.001
Tracheostomy, n (%)	48 (16.8)	11 (8.5)	37 (23.7)	< 0.001
28-day mortality, n (%)	100 (35.1)	18 (14.0)	82 (52.6)	< 0.001
Intensive care unit length of stay, days	13 (10–19)	10 (8–12)	18 (15–22)	< 0.001
Hospital length of stay, days	19 (15–25)	17 (14–19)	24 (18–28)	< 0.001
Extubation failure*, n (%)	48/239 (20.1)	14/119 (11.8)	34/120 (28.3)	0.002
Death without extubation, n (%)	12 (4.2)	0 (0.0)	12 (7.7)	< 0.001
Direct tracheostomy, n (%)	34 (11.9)	10 (7.8)	24 (15.4)	0.065
Tracheostomy after extubation failure, n (%)	14 (4.9)	0 (0.0)	14 (9.0)	< 0.001
<i>*The extubation failure analysis was performed only among the 239 patients who underwent extubation.</i>				

In univariable logistic regression analysis, GNRI-defined nutritional risk was associated with higher odds of 28-day mortality (OR = 6.83; 95% CI: 3.79–12.31; $p < 0.001$). When analyzed as a continuous variable, each 1-point increase in GNRI was associated with lower odds of mortality (OR = 0.94; 95% CI: 0.92–0.95; $p < 0.001$). Several additional clinical and laboratory variables were also associated with 28-day mortality; detailed results are presented in Supplementary Table S1.

In multivariable logistic regression analysis, GNRI-defined nutritional risk remained independently associated with 28-day mortality (aOR = 2.50; 95% CI: 1.01–6.25; $p = 0.049$). Male sex was independently associated with lower odds of mortality (aOR = 0.42; 95% CI: 0.23–0.75; $p = 0.004$), whereas higher serum creatinine was associated with increased odds of mortality (aOR = 2.14; 95% CI: 1.34–3.47; $p = 0.002$). Other variables included in the model did not retain statistical significance (Table 3).

Table 3
Multivariable logistic regression analysis for 28-day mortality

Variable	Univariable OR (95% CI)	p	Adjusted OR (95% CI)	p
GNRI risk present (Group 2) vs. no risk (Group 1)	6.83 (3.79–12.31)	< 0.001	2.50 (1.01–6.25)	0.049
Sex, male vs. female	0.54 (0.33–0.89)	0.015	0.42 (0.23–0.75)	0.004
Hypertension	1.72 (1.04–2.84)	0.034	1.01 (0.55–1.85)	0.969
Coronary artery disease	1.67 (1.01–2.77)	0.047	1.42 (0.78–2.58)	0.246
APACHE II score	1.13 (1.08–1.18)	< 0.001	1.04 (0.98–1.10)	0.253
SOFA score	1.24 (1.14–1.35)	< 0.001	1.00 (0.89–1.13)	0.974
Glasgow Coma Scale score	0.87 (0.80–0.94)	< 0.001	0.97 (0.87–1.07)	0.511
Hemoglobin, g/dL	0.67 (0.56–0.80)	< 0.001	0.88 (0.71–1.10)	0.278
Leukocyte count, $\times 10^9/L$	1.13 (1.05–1.21)	< 0.001	1.03 (0.94–1.12)	0.557
Creatinine, mg/dL	3.37 (2.23–5.11)	< 0.001	2.14 (1.34–3.47)	0.002
CRP, per 10 mg/L increase	1.14 (1.07–1.20)	< 0.001	1.01 (0.94–1.08)	0.798
Note: For continuous variables, OR values are presented per one-unit increase in the respective variable unless otherwise specified. For CRP, univariable and adjusted OR values and 95% confidence intervals were rescaled per 10 mg/L increase to improve clinical interpretability. This rescaling does not change p values. For categorical variables, the OR represents the comparison of the specified category with the reference category. OR: odds ratio; CI: confidence interval; GNRI: Geriatric Nutritional Risk Index; APACHE II: Acute Physiology and Chronic Health Evaluation II; SOFA: Sequential Organ Failure Assessment; CRP: C-reactive protein.				

In univariable logistic regression analysis, GNRI-defined nutritional risk was associated with higher odds of extubation failure (OR = 2.97; 95% CI: 1.50–5.88; $p = 0.002$). When analyzed as a continuous variable, each 1-point increase in GNRI was associated with lower odds of extubation failure (OR = 0.96; 95% CI: 0.94–0.98; $p < 0.001$). Detailed results for other variables associated with extubation failure are presented in Supplementary Table S2.

In the adjusted model, GNRI-defined nutritional risk was not independently associated with extubation failure (aOR = 0.84; 95% CI: 0.26–2.50; $p = 0.759$), whereas SOFA remained significantly associated with the outcome (aOR = 1.21; 95% CI: 1.05–1.41; $p = 0.010$) (Table 4).

Table 4
Multivariable logistic regression analysis for extubation failure

Variable	Univariable OR (95% CI)	p	Adjusted OR (95% CI)	p
GNRI risk present (Group 2) vs. no risk (Group 1)	2.97 (1.50–5.88)	0.002	0.84 (0.26–2.50)	0.759
Hypertension	2.01 (1.06–3.82)	0.034	1.46 (0.72–2.93)	0.294
SOFA score	1.27 (1.14–1.42)	< 0.001	1.21 (1.05–1.41)	0.010
Glasgow Coma Scale score	0.87 (0.78–0.98)	0.017	0.93 (0.82–1.05)	0.263
Hemoglobin, g/dL	0.79 (0.64–0.98)	0.034	1.01 (0.78–1.32)	0.941
Leukocyte count, $\times 10^9/L$	1.15 (1.04–1.26)	0.005	1.08 (0.97–1.20)	0.173
Creatinine, mg/dL	1.60 (1.00–2.55)	0.049	0.99 (0.57–1.70)	0.972
CRP, per 10 mg/L increase	1.10 (1.03–1.18)	0.005	1.03 (0.94–1.12)	0.558
Note: For continuous variables, OR values are presented per one-unit increase in the respective variable unless otherwise specified. For CRP, univariable and adjusted OR values and 95% confidence intervals were rescaled per 10 mg/L increase to improve clinical interpretability. This rescaling does not change p values. For categorical variables, the OR represents the comparison of the specified category with the reference category. OR: odds ratio; CI: confidence interval; GNRI: Geriatric Nutritional Risk Index; SOFA: Sequential Organ Failure Assessment; CRP: C-reactive protein.				

GNRI showed moderate discrimination for 28-day mortality (AUC = 0.767; 95% CI: 0.708–0.826) and lower discrimination for extubation failure (AUC = 0.654; 95% CI: 0.562–0.746) (Table 5 and Fig. 1).

Table 5
ROC analysis of GNRI for 28-day mortality and extubation failure

Endpoint	AUC (95% CI)	Optimal GNRI cutoff value	Sensitivity (%)	Specificity (%)
28-day mortality	0.767 (0.708–0.826)	80.27	78.0	71.9
Extubation failure	0.654 (0.562–0.746)	95.28	70.8	64.9

The discriminative performance of GNRI, APACHE II, and SOFA for 28-day mortality was compared. The AUCs were 0.767 (95% CI: 0.708–0.826) for GNRI, 0.724 (95% CI: 0.662–0.787) for APACHE II, and 0.701 (95% CI: 0.638–0.763) for SOFA. DeLong testing showed that GNRI had significantly greater discrimination than SOFA (Δ AUC = 0.066; p = 0.010), whereas the differences between GNRI and APACHE II (Δ AUC = 0.043; p = 0.094) and between APACHE II and SOFA (Δ AUC = 0.023; p = 0.418) were not statistically significant (Fig. 2).

The incremental prognostic value of GNRI beyond conventional severity scores was assessed by adding GNRI to APACHE II- and SOFA-based models. Adding GNRI increased the AUC from 0.724 to 0.768 for APACHE II, although the improvement did not reach statistical significance by DeLong testing ($\Delta\text{AUC} = 0.044$; $p = 0.065$). In contrast, adding GNRI to SOFA increased the AUC from 0.701 to 0.772, with a significant improvement in discrimination ($\Delta\text{AUC} = 0.071$; $p = 0.016$). Likelihood-ratio testing showed that GNRI significantly improved model fit for both models ($p < 0.001$ for both comparisons) (Table 6).

Table 6. Discriminative performance and incremental prognostic value of GNRI for 28-day mortality

A1. Discriminative performance of individual prognostic indicators

Indicator	AUC (95% CI)
GNRI	0.767 (0.708–0.826)
APACHE II	0.724 (0.662–0.787)
SOFA	0.701 (0.638–0.763)

A2. Pairwise comparison of ROC curves

Comparison	ΔAUC	DeLong p
GNRI vs. APACHE II	+0.043	0.094
GNRI vs. SOFA	+0.066	0.010
APACHE II vs. SOFA	+0.023	0.418

B. Incremental prognostic contribution of GNRI beyond APACHE II and SOFA

Model comparison	Baseline AUC	AUC after adding GNRI	ΔAUC	DeLong p	LRT p
APACHE II → APACHE II + GNRI	0.724	0.768	+0.044	0.065	<0.001
SOFA → SOFA + GNRI	0.701	0.772	+0.071	0.016	<0.001

Abbreviations: AUC, area under the curve; CI, confidence interval; ΔAUC , change in AUC; LRT, likelihood-ratio test; GNRI, Geriatric Nutritional Risk Index; APACHE II, Acute Physiology and Chronic Health Evaluation II; SOFA, Sequential Organ Failure Assessment.

The DeLong test was used to compare the discriminative performance of ROC curves, whereas the likelihood-ratio test was used to compare the fit of nested models.

4. DISCUSSION

The principal finding of this study was that GNRI provided additional prognostic information for 28-day mortality in older ICU patients requiring invasive mechanical ventilation. GNRI-defined nutritional risk remained independently associated with mortality after multivariable adjustment, and GNRI showed moderate discriminatory performance. Importantly, adding GNRI to conventional severity scores improved prognostic performance, particularly when combined with SOFA. In contrast, although GNRI was associated with extubation failure in unadjusted analyses, this association did not persist after adjustment. These findings suggest that GNRI may be more useful as a complementary marker of short-term mortality risk than as a standalone predictor of extubation outcome.

The independent association between GNRI-defined nutritional risk and 28-day mortality observed in our study is consistent with previous evidence from older critically ill populations. Peng et al. demonstrated in a cohort of 3,696 geriatric ICU patients that lower GNRI values were associated with higher in-hospital mortality, with progressively greater risk at lower GNRI levels (10). Similarly, Li et al. reported an independent and nonlinear association between GNRI and 28-day mortality in 2,834 older patients with sepsis (13). Together, these findings support an inverse association between GNRI and short-term mortality in critically ill older adults.

Among older patients with acute respiratory failure, Shi et al. similarly reported higher in-hospital mortality in patients with a $\text{GNRI} \leq 98$ and found that GNRI remained associated with mortality after adjustment (14). Notably, however, this association lost statistical significance in the subgroup receiving mechanical ventilation. In contrast, our cohort was restricted exclusively to older patients receiving invasive mechanical ventilation, and GNRI-defined nutritional risk remained independently associated with 28-day mortality. This finding suggests that GNRI may retain prognostic relevance even in a mechanically ventilated population with high illness severity.

During critical illness, hypercatabolism, immobilization, and systemic inflammation can rapidly deplete skeletal muscle reserves, which are already reduced in older adults. This biological vulnerability may partly explain the association between lower GNRI and adverse outcomes. Fazzini et al. demonstrated substantial skeletal muscle loss during the first week of critical illness and a high prevalence of ICU-acquired weakness (15), while another meta-analysis showed an association between low muscle mass and mortality (16). Given that GNRI can be calculated from routinely available clinical data, it may serve as a practical adjunct for early risk stratification in older critically ill patients..

Although GNRI-defined nutritional risk was associated with extubation failure in univariable analysis, this association did not persist after multivariable adjustment. Ye et al. reported that, among 1,153 critically ill older patients, those in the major GNRI risk category had a higher adjusted risk of reintubation within 72 hours (12). In our cohort, combining low, moderate, and major GNRI risk categories into a single at-risk group may have attenuated an effect driven primarily by patients with major nutritional risk. The nonlinear association reported by Ye et al. also suggests that the relationship between GNRI and extubation outcomes may not be strictly linear.

The multifactorial nature of extubation failure may also explain the lack of an independent association with GNRI. Previous studies have identified illness severity, cardiac and respiratory comorbidities, neurological status, physiological factors, and ICU-acquired weakness as important determinants of extubation outcome (17, 18). In our study, SOFA remained independently associated with extubation failure, suggesting that acute organ dysfunction may play a more direct role in extubation outcome than nutritional risk alone. Accordingly, GNRI may be better considered as a complementary component of overall risk assessment rather than as a standalone marker for extubation decision-making.

The prognostic value of GNRI was further supported by ROC analysis, which showed better discrimination for 28-day mortality than for extubation failure. The AUC for mortality was broadly consistent with previous reports in older critically ill populations, although performance has varied across studies (19, 20). The cohort-derived cutoff of 80.27 was also close to the threshold of 78.7 reported by Peng et al. (10). However, because this cutoff was derived and evaluated within the same cohort, it should not be considered a universal clinical threshold without external validation.

For 28-day mortality, GNRI showed greater discrimination than SOFA, whereas its performance did not differ significantly from APACHE II. More importantly, adding GNRI improved prognostic performance, particularly when combined with SOFA, and significantly improved model fit for both APACHE II- and SOFA-based models. These findings suggest that GNRI may capture complementary prognostic information related to nutritional and metabolic reserve that is not fully reflected by conventional severity scores. GNRI should therefore be considered as an adjunct to, rather than a replacement for, APACHE II or SOFA.

The clinical interpretation of GNRI should also take into account the biological characteristics of serum albumin. Albumin, a major component of GNRI, is influenced not only by nutritional status but also by systemic inflammation, capillary permeability, fluid balance, and organ dysfunction during critical illness. Accordingly, GNRI may be more appropriately interpreted as a marker of nutrition-related clinical risk rather than as a direct measure of malnutrition. The higher CRP, creatinine, APACHE II, and SOFA values observed in the nutritional-risk group further suggest that a low GNRI may partly reflect greater overall illness severity rather than nutritional depletion alone.

Several methodological and clinical strengths of the present study should be noted. The analysis focused on a well-defined, high-risk population of patients aged 65 years or older requiring invasive mechanical ventilation. GNRI was evaluated both as a categorical and a continuous variable, and both 28-day mortality and extubation failure were examined. Importantly, the analysis extended beyond simple associations to include discrimination, comparison with APACHE II and SOFA, and the incremental prognostic contribution of GNRI when added to these established severity scores.

This study also has several limitations. First, its single-center retrospective design precludes causal inference and does not eliminate the possibility of residual or unmeasured confounding. Second, GNRI was calculated only from data obtained within the first 24 hours of ICU admission, and changes during the ICU stay were not assessed. Third, because serum albumin is influenced by inflammation, capillary

leakage, fluid balance, and organ dysfunction, low GNRI values should not be interpreted as reflecting chronic malnutrition alone. In addition, analyses of extubation failure were restricted to patients who underwent extubation, and selection or survivor bias cannot be excluded, particularly because pre-extubation deaths occurred in the nutritional-risk group.

Several factors that may influence extubation outcome, including diaphragmatic function, cough strength, secretion burden, Rapid Shallow Breathing Index, spontaneous breathing trial parameters, frailty, sarcopenia, and direct measures of muscle mass, were not available. Their absence, together with the relatively small number of extubation-failure events, may have limited the ability to identify an independent association between GNRI and extubation failure. Another limitation is the dichotomization of GNRI categories, which may have obscured dose–response or nonlinear relationships. This is particularly relevant because Ye et al. reported an independent association with reintubation specifically in the major GNRI risk group (12). Future studies should evaluate GNRI categories separately and consider nonlinear modeling where appropriate.

In conclusion, GNRI-defined nutritional risk was independently associated with 28-day mortality in older ICU patients receiving invasive mechanical ventilation. GNRI showed moderate discriminatory performance for mortality and provided incremental prognostic information beyond conventional severity assessment, particularly when added to SOFA. In contrast, its association with extubation failure did not remain independent after multivariable adjustment. These findings support the use of GNRI as a simple complementary tool for short-term mortality risk stratification rather than as a standalone marker for extubation decision-making. Further validation in multicenter prospective studies is warranted.

Declarations

Ethics approval and consent to participate

The study was approved by the Muş Alparslan University Scientific Research and Publication Ethics Committee on July 9, 2026 (Decision No. 41) and was conducted in accordance with the Declaration of Helsinki. The requirement for informed consent was waived by the ethics committee due to the retrospective nature of the study.

Clinical trial number

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request, subject to ethical and institutional restrictions.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

D.K.C. contributed to the conceptualization, investigation, methodology, project administration, resources, validation, visualization, writing of the original draft, and review and editing of the manuscript. **R.B.E.** contributed to data curation, formal analysis, and validation. Both authors read and approved the final manuscript.

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Authors' information

Not applicable.

Use of artificial intelligence

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) to assist with language refinement and manuscript organization. The authors subsequently reviewed and edited the content and take full responsibility for the final manuscript.

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Figures

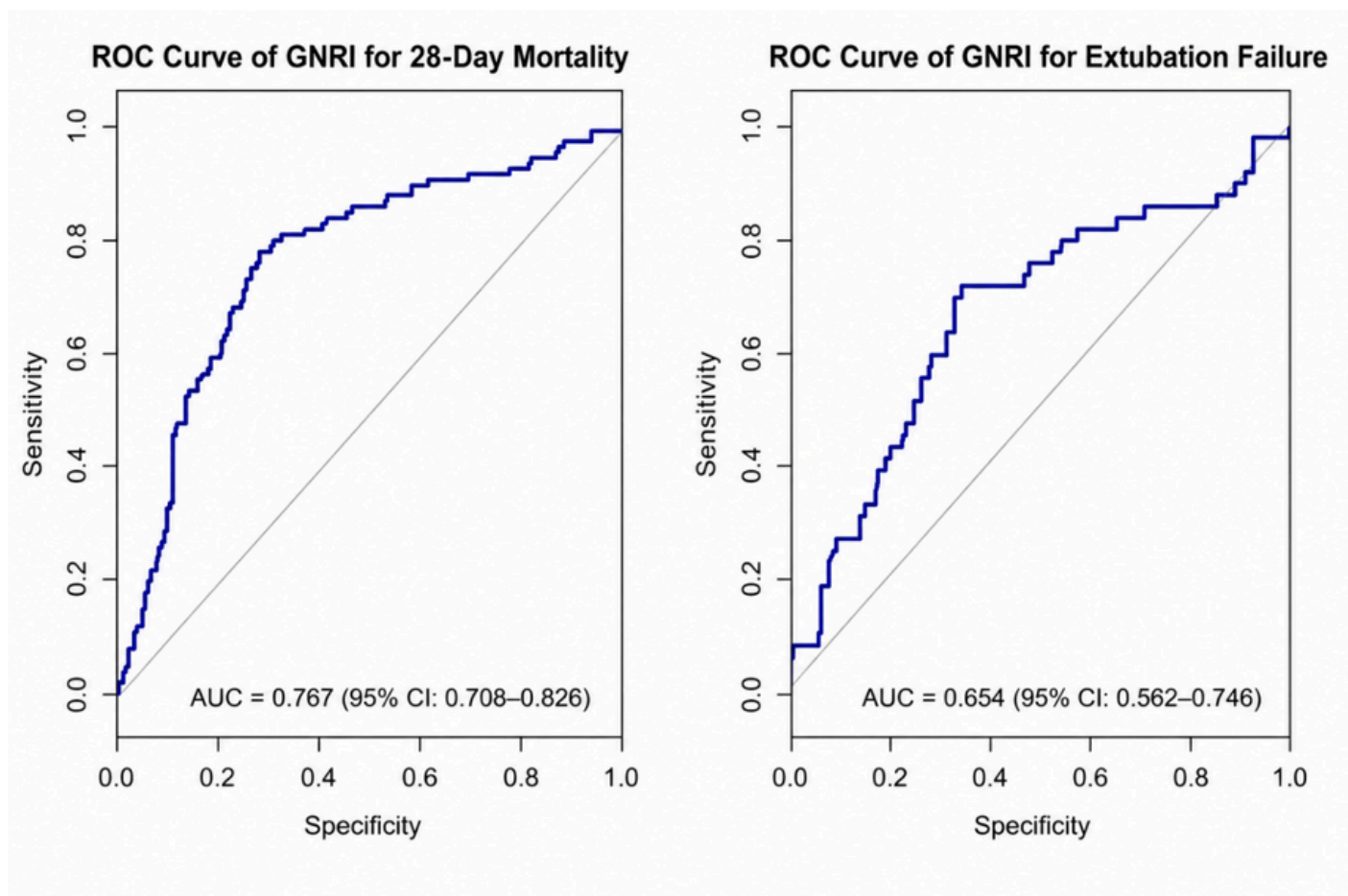


Figure 1

Receiver operating characteristic (ROC) curves of the Geriatric Nutritional Risk Index (GNRI) for predicting 28-day mortality and extubation failure.

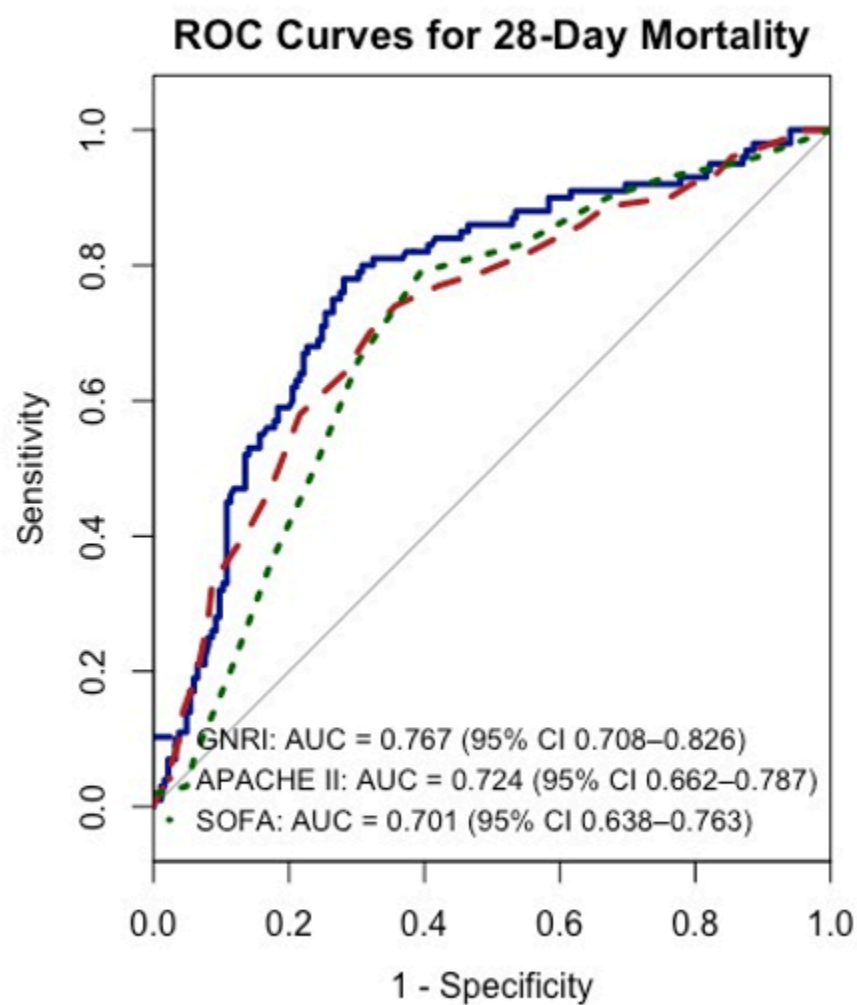


Figure 2

Comparison of ROC curves of GNRI, APACHE II, and SOFA scores for predicting 28-day mortality.

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