Original Article

A novel combination of SARC-F, GLIM criteria, and calcium levels to predict short-term mortality in hospitalized older adults with advanced-stage cancer

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Background and Objectives: Sarcopenia and malnutrition are highly prevalent among older adults with advanced-stage cancers. Although the SARC-F is a simple and widely used screening tool for sarcopenia, its extended prognostic value remains under investigation. This study aimed to evaluate the relationship between SARC-F scores, nutritional status, inflammatory biomarkers, and short-term mortality in hospitalized older adults with advanced solid organ malignancies. **Methods and Study Design:** We conducted a retrospective cross-sectional analysis on 72 patients with advanced-stage solid tumors and 52 age and sex matched controls. Nutritional status was evaluated using the Mini Nutritional Assessment Short Form (MNA-SF), Nutrition Risk Screening (NRS-2002), and the Global Leadership Initiative on Malnutrition (GLIM) criteria. Functional and frailty assessments included Activities of Daily Living (ADL), Instrumental ADL (IADL), and the FRAIL scale. Laboratory markers of inflammation were also collected. Multivariate logistic regression and receiver operating characteristic (ROC) analyses were used to identify predictors of mortality. **Results:** A total of 124 participants were included (72 patients with advanced-stage cancer and 52 controls). The mean age was 74.3±9.4 years, and 58.1% were male. Mortality rates at 1, 3, and 6 months were 41.9%, 59.7%, and 65.3%, respectively. In multivariate analysis, calcium levels were independently associated with increased mortality risk (OR: 4.59, p <0.001). The SARC-F score demonstrated moderate discriminative ability for mortality prediction (AUC: 0.675), with high specificity (96.2%) but low sensitivity (30.6%) at a cut-off of ≥4. **Conclusions:** The SARC-F score serves as a multidimensional indicator reflecting sarcopenia risk, nutritional deficits, functional impairment, and short-term mortality. Its prognostic utility improves when combined with clinical and laboratory markers. This study proposes a novel prognostic model incorporating SARC-F, GLIM criteria, and serum calcium to enhance short-term mortality prediction in older adults with advanced cancer.

Key Words: SARC-F questionnaire, GLIM criteria, calcium, malnutrition, short-term mortality

INTRODUCTION

Sarcopenia is a geriatric syndrome characterized by age-related declines in skeletal muscle mass, muscle strength, and physical performance, and it directly affects older adults. In this population, it leads to functional impairments, increased risk of falls, greater dependency, and a marked reduction in quality of life. The diagnostic algorithm proposed by the European Working Group on Sarcopenia in Older People (EWGSOP) incorporates both functional performance tests and the SARC-F questionnaire, a practical tool designed for rapid and economical screening.[1,2]

Sarcopenia is more frequently observed in older adults with advanced-stage solid organ malignancies. Cancer-related inflammation, along with cachexia, appetite loss from treatments, and the muscle-wasting effects of chemotherapy and radiotherapy, speeds up muscle loss and worsens sarcopenia. As a result, patients face increased morbidity and mortality, reduced functional status, and shorter survival.[3,4] Malnutrition is also highly prevalent in individuals with advanced cancer and is closely linked to sarcopenia through shared pathophysiological mechanisms. The Global Leadership Initiative on Malnutrition (GLIM) criteria emphasize muscle mass loss as a key phenotypic indicator of malnutrition, highlighting the close association between sarcopenia and malnutrition.[4,5] Importantly, both sarcopenia and malnutrition extend beyond physical limitations; they are also associated with reduced treatment adherence, prolonged hospital stays, and increased dependence on healthcare services. In hospitalized patients, the coexistence of these

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conditions often leads to diminished functional capacity, heightened risk of complications, and poorer short-term prognosis. Therefore, early assessment of sarcopenia and nutritional status, particularly in patients with advanced cancer, is essential for timely intervention and effective clinical management.[4,5] In this context, the SARC-F questionnaire serves as a practical, rapid, and widely applicable tool for screening sarcopenia risk in older adults with advanced cancer.[6] Lower SARC-F scores have been linked to higher risks of falls, functional decline, prolonged hospitalization, and increased mortality. The systematic use of the SARC-F score in this patient group enables early evaluation of nutritional status and provides valuable insights into short-term prognosis. In this study, we aimed to examine the relationship between the SARC-F score and nutritional status, systemic inflammation, and short-term prognosis in hospitalized patients aged 60 years and older with advanced solid organ cancer, a group in which sarcopenia and malnutrition commonly coexist. Therefore, we aimed to evaluate a novel combination of the SARC-F score, GLIM criteria, and calcium levels to determine their collective prognostic value in predicting short-term mortality. Calcium was included as a biochemical marker because dysregulated calcium homeostasis is frequently observed in advanced cancer and may reflect underlying metabolic and inflammatory alterations linked to poor prognosis. The integration of metabolic markers such as calcium into functional and nutritional assessments may improve risk stratification, especially in oncology and palliative care contexts.

METHODS

Study design and population

We designed this study as a retrospective and cross-sectional investigation. We included 72 patients who had advanced-stage (stage 3 or 4) gastrointestinal solid organ cancers and were hospitalized in the Internal Medicine and Palliative Care units. We selected 52 patients who did not have a cancer diagnosis with similar age and gender characteristics for the control group. We conducted the study in accordance with the ethical standards outlined in the Declaration of Helsinki, and the Ethics Committee of Istanbul Training and Research Hospital approved the protocol (Approval No: 370, dated 22.12.2023). We retrospectively collected all data from the hospital's electronic health records. We compared both the case and control groups, as well as patients with high and low SARC-F scores. We also monitored the survival status at 1, 3, and 6 months after admission using hospital records.

We assessed sarcopenia using the SARC-F questionnaire. This tool includes five questions and provides a total score between 0 and 10. We considered a score of 4 or above as indicative of sarcopenia risk.[1,2] Although the SARC-F questionnaire provided a practical approach for sarcopenia risk assessment, objective muscle mass measurements [e.g., bioelectrical impedance analysis (BIA) or dual-energy X-ray absorptiometry (DXA)] were not available due to the retrospective design and lack of routine data collection.

We assessed nutritional status using three tools: the Mini Nutritional Assessment-Short Form (MNA-SF), the Nutritional Risk Screening-2002 (NRS-2002), GLIM criteria. The MNA-SF serves as a quick and practical screening tool that helps identify malnutrition risk in older adults.[7] The NRS-2002 allows clinicians to detect the risk of undernutrition in hospitalized adult patients with strong clinical validity.[8] We followed the GLIM criteria to diagnose malnutrition, which combine phenotypic [weight loss, low Body Mass Index (BMI), reduced muscle mass] and etiologic (inadequate food intake, inflammation) factors.[4,5] In recent years, researchers and clinicians have widely accepted GLIM as the gold standard for identifying malnutrition.

We assessed functional status using the Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) scales. The ADL scale measures ability to perform basic physical functions independently.[9] The IADL scale evaluates more complex daily tasks, such as shopping, using the telephone, or managing medications.10 We assessed physical frailty using the FRAIL scale, a simple tool that includes five components: fatigue, resistance, ambulation, illness, and weight loss.11

All assessments, including the SARC-F, MNA-SF, NRS-2002, GLIM criteria, ADL, IADL, and FRAIL scales, were conducted by the same trained professional to ensure inter-rater consistency and reduce measurement variability.

We also recorded laboratory parameters from patient files, including hemoglobin, albumin, creatinine, C-reactive protein (CRP), 25-hydroxy vitamin D, calcium, sodium, potassium, magnesium, and the neutrophil-to-lymphocyte ratio (NLR).

Statistical analysis

We performed statistical analyses using SPSS software. For continuous variables, we applied either the independent samples t-test or the Mann–Whitney U test based on the distribution of data. For categorical variables, we used the Chi-square test. We evaluated independent variables associated with short-term mortality using multivariate logistic regression analysis. We considered a p-value of less than 0.05 statistically significant. Due to the retrospective design of the study, we did not conduct a priori sample size calculation. Instead, we included all patients who met the eligibility criteria within the defined time frame. This approach is commonly used in retrospective cross-sectional studies.[12] We performed ROC (Receiver Operating Characteristic) curve analysis to determine the predictive power of the SARC-F score in estimating short-term mortality. We calculated the Area Under the Curve (AUC) and compared the sensitivity and specificity of the total SARC-F score and the cut-off score. This analysis allowed us to quantitatively evaluate the prognostic value of the SARC-F score.

RESULTS

We examined the relationship between the SARC-F score and nutritional status, inflammatory markers, and short-term mortality in hospitalized patients aged 60 and older who were diagnosed with advanced-stage solid organ cancer. All patients included in the cancer group had

gastrointestinal malignancies. Among them, forty-one were diagnosed with colon cancer and thirty-one with gastric cancer. Based on the baseline demographic, clinical, and laboratory characteristics presented in Table 1, the mean age of the patients was 74.3 ± 9.4 years, and 58.1% were male. The mean BMI was calculated as 23.2 ± 5.0, while the average SARC-F, MNA-SF, and GLIM scores were 7.0 ± 2.7, 5.4 ± 2.7, and 2.7 ± 1.0, respectively. Mortality rates at the first, third, and sixth months following hospital admission were recorded as 41.9%, 59.7%, and 65.3%, respectively.

According to Table 2 which compares the case and control groups based on their SARC-F scores: the case group had higher scores in both ADL (2.3 ± 2.3 vs. 1.2 ± 2.2; p = 0.005) and IADL (2.8 ± 2.8 vs. 1.3 ± 2.3; p = 0.001). The FRAIL score was lower in the case group compared to the control group (3.7 ± 0.7 vs. 4.0 ± 0.6; p = 0.010). The average SARC-F score was 6.3 ± 3.0 in the case group and 8.0 ± 2.0 in the control group (p = 0.001). Mortality at the sixth month was 68.1% in the case group and 61.5% in the control group, with no statistically significant difference (p = 0.452).

Table 3 presents the impact of the SARC-F score on mortality. In the multivariate analysis, each one-point increase in the SARC-F score was significantly associated with a reduced risk of mortality (OR: 0.784; 95% CI: 0.628–0.978; p = 0.031). Additionally, both calcium levels (OR: 4.589; p <0.001) and the IADL score (OR: 1.261; p = 0.004) showed significant associations with mortality.

According to the ROC curve analysis presented in Table 4, the AUC for the total SARC-F score was calculated as 0.675 (95% CI: 0.581–0.769; p = 0.001). When the cut-off value was set at ≥4 for the SARC-F score, the sensitivity was 30.6%, specificity was 96.2%, positive predictive value was 91.7%, and negative predictive value was 50.0% (Figure 1).

Table 5 compares patient characteristics based on SARC-F scores. Patients with SARC-F scores ≤3 had a higher mean MNA-SF score (6.7 ± 3.0) compared to those with scores ≥4 (5.1 ± 2.6; p = 0.008). ADL (5.0 ± 1.2 vs. 1.1 ± 1.9; p < 0.001) and IADL (5.5 ± 2.7 vs. 1.4 ± 1.9; p <0.001) scores were significantly higher in the low SARC-F group. Conversely, the FRAIL score was

Table 1. Demographic, clinical and laboratory characteristics of patients†

Variable	Min–Max	Median	Mean ± SD
Age	48–95	73.0	74.3 ± 9.4
Gender (Male)			72 (58.1%)
Gender (Female)			52 (41.9%)
Height (cm)	145–185	165.0	164.3 ± 8.6
Weight (kg)	35–110	61.0	62.8 ± 14.6
BMI (kg/m²)	12.9–43.0	22.5	23.2 ± 5.0
Diabetes Mellitus (-)			84 (67.7%)
Diabetes Mellitus (+)			40 (32.3%)
Hemoglobin (g/L)	37–151	92	102 ± 79
GFR (mL/min/1.73m²)	7.4–126.0	77.1	65.4 ± 33.0
Albumin (g/L)	10.7–48.3	27.7	28.4 ± 6.2
Creatinine (µmo/L)	6–526	90	139 ± 123
Urea (mmol/L)	0.4–85.8	44.9	67.2 ± 69.8
CRP (mg/L)	1.3–324.0	59.7	77.6 ± 65.8
Glucose (mmol/L)	0.1–24.6	7.2	7.0 ± 3.6
Sodium (mmol/L)	128–146	138.0	136.6 ± 18.3
Magnesium (mmol/L)	0.45–8.4	1.8	0.93 ± 0.27
Potassium (mmol/L)	2.6–5.3	4.1	7.4 ± 36.1
Calcium (mmol/L)	0.5–2.85	2.25	2.15 ± 0.28
CRP/Albumin Ratio	0.1–11.6	2.2	3.0 ± 2.7
NLR	0.2–136.8	6.2	10.7 ± 16.3
25-(OH)D_3 (mmol/L)	7.5–138.25	19.5	12.4 ± 11.3
NRS total	1.0–6.0	4.0	4.0 ± 1.0
MNA-SF	0.0–10.0	5.0	5.4 ± 2.7
ADL-total	0.0–6.0	0.0	1.8 ± 2.3
IADL-total	0.0–8.0	1.0	2.2 ± 2.7
FRAIL-total	2.0–5.0	4.0	3.8 ± 0.6
SARC-F total	0.0–10.0	8.0	7.0 ± 2.7
GLIM total	0.0–4.0	3.0	2.7 ± 1.0
1-month mortality (-)			72 (58.1%)
1-month mortality (+)			52 (41.9%)
3-month mortality (-)			50 (40.3%)
3-month mortality (+)			74 (59.7%)
6-month mortality (-)			43 (34.7%)
6-month mortality (+)			81 (65.3%)

BMI: Body mass index, GFR: Glomerular filtration rate , CRP: C-Reactive Protein, NLR: Neutrophil-to-lymphocyte ratio, NRS: Nutritional Risk Screening, MNA-SF: Mini Nutritional Assessment-Short Form, ADL: Activities of Daily Living, IADL: Instrumental Activities of Daily Living, FRAIL: Frailty tool, SARC-F: Sarcopenia Assessment Questionnaire , GLIM: Global Leadership Initiative on Malnutrition.

†Numeric variables were presented as median (minimum-maximum) or mean ± SD

Table 2. Comparison between control and case groups†

Variable	Control group	Case group	*p*-value
Age (years)	76.2 ± 9.0 (Med: 73)	72.9 ± 9.5 (Med: 73)	0.091
Gender (Male)	28 (53.8%)	44 (61.1%)	0.419
Gender (Female)	24 (46.2%)	28 (38.9%)	
Height (cm)	162.9 ± 7.7 (Med: 160)	165.2 ± 9.1 (Med: 165)	0.176
Weight (kg)	63.4 ± 15.0 (Med: 60)	62.4 ± 14.4 (Med: 64)	0.988
BMI (kg/m²)	23.9 ± 5.5 (Med: 22.7)	22.7 ± 4.6 (Med: 22.4)	0.518
Diabetes mellitus (−)	35 (67.3%)	49 (68.1%)	0.930
Diabetes mellitus (+)	17 (32.7%)	23 (31.9%)	
Hemoglobin (g/L)	95 ± 17 (Med: 93)	106 ± 104 (Med: 92)	0.776
GFR (mL/min/1.73m²)	64.0 ± 30.7 (Med: 75.4)	66.4 ± 34.7 (Med: 77.2)	0.717
Albumin (g/L)	28.7 ± 5.9 (Med: 28.1)	28.2 ± 6.5 (Med: 27.5)	0.579
Creatinine (µmol/L)	131 ± 119 (Med: 93)	144 ± 127 (Med: 88)	0.363
Urea (mmol/L)	62.5 ± 55.4 (Med: 47)	70.6 ± 78.8 (Med: 43.6)	0.771
CRP (mg/L)	75.3 ± 67.0 (Med: 58.6)	79.4 ± 65.4 (Med: 60.5)	0.684
Glucose (mmol/L)	6.6 ± 2.7 (Med: 5.8)	7.2 ± 4.2 (Med: 6.0)	0.520
Sodium (mmol/L)	137.7 ± 20.6 (Med: 139)	135.7 ± 16.5 (Med: 138)	0.077
Magnesium (mmol/L)	1.8 ± 0.4 (Med: 1.8)	8.0 ± 32.5 (Med: 1.8)	0.846
Potassium (mmol/L)	4.1 ± 0.7 (Med: 4.0)	9.8 ± 47.4 (Med: 4.1)	0.877
Calcium (mmol/L)	2.20 ± 0.30 (Med: 2.21)	2.3 ± 0.15 (Med: 9.1)	< 0.001
CRP/albumin ratio	2.9 ± 2.5 (Med: 2.1)	3.1 ± 2.8 (Med: 2.2)	0.693
NLR	8.7 ± 7.0 (Med: 7.0)	12.2 ± 20.5 (Med: 5.6)	0.649
25-(OH)D_3 (mmol/L)	23.5 ± 21.3 (Med: 6.7)	36.5 ± 31.3 (Med: 10.5)	0.033
NRS total	3.9 ± 0.8 (Med: 4.0)	4.1 ± 1.0 (Med: 4.0)	0.277
MNA-SF	5.2 ± 2.4 (Med: 5.0)	5.6 ± 2.9 (Med: 6.0)	0.349
ADL-total	1.2 ± 2.2 (Med: 0.0)	2.3 ± 2.3 (Med: 2.0)	0.005
IADL-total	1.3 ± 2.3 (Med: 0.0)	2.8 ± 2.8 (Med: 2.0)	0.001
FRAIL-total	4.0 ± 0.6 (Med: 4.0)	3.7 ± 0.7 (Med: 4.0)	0.010
SARC-F total	8.0 ± 2.0 (Med: 9.0)	6.3 ± 3.0 (Med: 8.0)	0.001
GLIM total	2.5 ± 1.2 (Med: 3.0)	2.9 ± 0.8 (Med: 3.0)	0.283
1-month mortality	38.5%	44.4%	0.505
3-month mortality	55.8%	62.5%	0.451
6-month mortality	61.5%	68.1%	

BMI = Body Mass Index, GFR = Glomerular Filtration Rate, CRP = C-Reactive Protein, NRS = Nutrition Risk Screening, MNA-SF = Mini Nutritional Assessment Short-Form, ADL = Activities of Daily Living, IADL = Instrumental ADL, FRAIL = Frailty Index, SARC-F = Sarcopenia Assessment Questionnaire, GLIM = Global Leadership Initiative on Malnutrition.
†Continuous variables were compared using Mann–Whitney U or Independent Sample t-test; categorical variables with Chi-square test (χ^2). Results presented as mean ± SD or median (min–max). SI units applied.

Table 3. Independent predictors of short-term mortality according to logistic regression analysis†

Variable	Univariate OR	95% CI	*p*-value	Multivariate OR	95% CI	*p*-value
Calcium	6.41	3.16–13.01	< 0.001	4.59	2.27–9.26	< 0.001
25-(OH)D_3(mmol/L)	1.05	1.01–1.10	0.025	–	–	–
ADL-Total	1.24	1.05–1.47	0.013	–	–	–
IADL-Total	1.26	1.08–1.48	0.004	–	–	–
FRAIL-Total	0.44	0.22–0.89	0.023	–	–	–
SARC-F Total	0.77	0.65–0.91	0.002	0.78	0.63–0.98	0.031

ADL: Activities of Daily Living; IADL: Instrumental Activities of Daily Living; FRAIL: Frailty scale; SARC-F: Sarcopenia Assessment Questionnaire.
†Odds ratios (OR) and 95% confidence intervals (CI) were obtained from logistic regression analysis
**p* <0.05 was considered statistically significant.

Table 4. ROC curve analysis for SARC-F score†

Variable	AUC / Control group	95% CI / Case group	*p*-value
SARC-F total	0.675	0.581–0.769	0.001
SARC-F total (cut-off ≥ 3)	0.634	0.537–0.730	0.011
SARC-F ≤ 3	2	22	
SARC-F ≥ 4	50	50	

ROC: Receiver operating characteristic; AUC: Area under the curve.
†Sensitivity: 30.6%, specificity: 96.2%, positive predictive value: 91.7%, negative predictive value: 50.0%.

Table 5. Comparison of clinical and laboratory characteristics according to SARC-F score groups (≤3 vs ≥4)[†]

Variable	SARC-F ≤ 3	SARC-F ≥ 4	*p*-value
Age (years)	71.2 ± 8.0 (Med: 70)	75.0 ± 9.6 (Med: 74)	0.074
Gender (Male)	15 (62.5%)	57 (57.0%)	0.624
Gender (Female)	9 (37.5%)	43 (43.0%)	
Height (cm)	164.8 ± 7.9 (Med: 165)	164.1 ± 8.7 (Med: 160.5)	0.620
Weight (kg)	61.9 ± 10.2 (Med: 61)	63.0 ± 15.5 (Med: 61)	0.960
BMI (kg/m²)	22.8 ± 3.3 (Med: 22.2)	23.3 ± 5.3 (Med: 22.5)	0.884
Diabetes mellitus (−)	17 (70.8%)	67 (67.0%)	0.718
Diabetes mellitus (+)	7 (29.2%)	33 (33.0%)	
Hemoglobin (g/L)	98 ± 17 (Med: 92)	102 ± 88 (Med: 92)	0.385
GFR (mL/min/1.73 m²)	61.2 ± 36.2 (Med: 68.5)	66.4 ± 32.3 (Med: 77.2)	0.631
Albumin (g/L)	30.3 ± 6.3 (Med: 30.1)	27.9 ± 6.2 (Med: 26.9)	0.112
Creatinine (µmol/L)	141 ± 106 (Med: 94)	118 ± 110 (Med: 73)	0.102
Urea (mmol/L)	12.9 ± 17.4 (Med: 6.1)	10.8 ± 9.9 (Med: 7.8)	0.642
CRP (mg/L)	75.8 ± 60.5 (Med: 56.6)	78.1 ± 67.3 (Med: 59.7)	0.957
Glucose (mmol/L)	7.0 ± 3.5 (Med: 6.0)	7.0 ± 3.7 (Med: 6.0)	0.847
Sodium (mmol/L)	137.9 ± 4.5 (Med: 138)	136.3 ± 20.2 (Med: 139)	0.551
Magnesium (mmol/L)	0.78 ± 0.12 (Med: 0.74)	2.55 ± 11.3 (Med: 0.74)	0.954
Potassium (mmol/L)	4.2 ± 0.6 (Med: 4.3)	8.1 ± 40.2 (Med: 4.0)	0.189
Calcium (mmol/L)	2.30 ± 0.12 (Med: 2.30)	2.12 ± 0.30 (Med: 2.20)	<0.001
CRP/Albumin ratio	2.8 ± 2.5 (Med: 2.2)	3.0 ± 2.7 (Med: 2.2)	0.718
Neutrophil/Lymphocyte ratio	10.5 ± 14.8 (Med: 4.8)	10.8 ± 16.7 (Med: 6.2)	0.479
25-(OH)D_3 (nmol/L)	39.5 ± 25.8 (Med: 43.0)	29.0 ± 28.5 (Med: 17.5)	0.080
NRS total	4.0 ± 1.1 (Med: 4.0)	4.0 ± 0.9 (Med: 4.0)	0.906
MNA-SF	6.7 ± 3.0 (Med: 7.5)	5.1 ± 2.6 (Med: 5.0)	0.008
ADL-total	5.0 ± 1.2 (Med: 5.0)	1.1 ± 1.9 (Med: 0.0)	<0.001
IADL-total	5.5 ± 2.7 (Med: 6.5)	1.4 ± 1.9 (Med: 0.0)	<0.001
FRAIL-total	3.0 ± 0.9 (Med: 3.0)	4.0 ± 0.4 (Med: 4.0)	<0.001
GLIM-total	2.6 ± 0.9 (Med: 2.5)	2.8 ± 1.0 (Med: 3.0)	0.210
1-month mortality	33.3%	44.0%	0.342
3-month mortality	50.0%	62.0%	0.282
6-month mortality	54.2%	68.0%	0.201

BMI: Body mass index; GFR: Glomerular filtration rate; CRP: C-reactive protein; NRS: Nutritional Risk Screening; MNA-SF: Mini Nutritional Assessment–Short Form; ADL: Activities of Daily Living; IADL: Instrumental Activities of Daily Living; FRAIL: Frailty scale; SARC-F: Sarcopenia Assessment Questionnaire; GLIM: Global Leadership Initiative on Malnutrition.
[†]Continuous variables were compared using Mann–Whitney U test or Independent Sample t-test; categorical variables using Chi-square test (χ^2). Values are presented as mean ± SD or median (min–max). All laboratory values are expressed in SI units

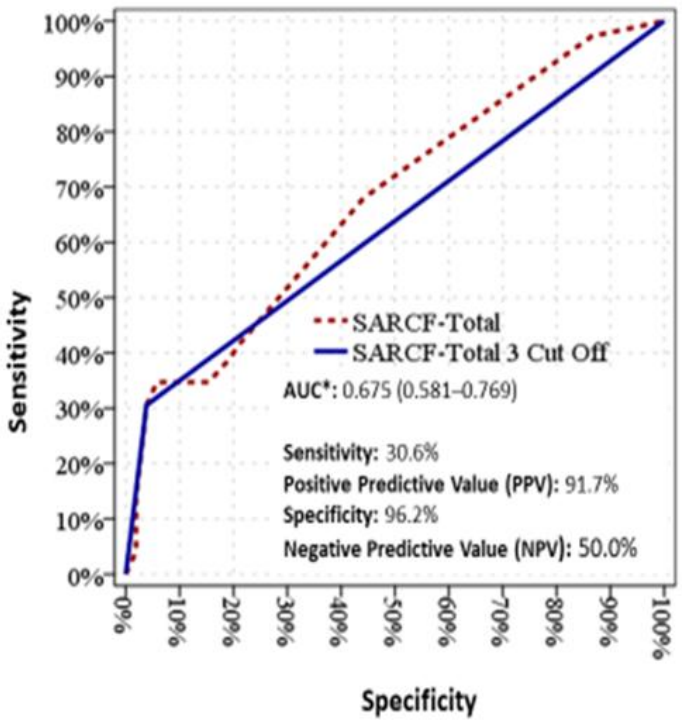

Figure 1. ROC curves for SARC-F total and SARC-F total 3 cut-off variables. AUC: Area under the curve

significantly higher in patients with SARC-F ≥4 (4.0 ± 0.4 vs. 3.0 ± 0.9; p <0.001). Calcium levels were also higher in the SARC-F ≤3 group (9.2 ± 0.5 vs. 8.5 ± 1.2; p <0.001).

DISCUSSION

In our study we observed that the SARC-F score was associated with several clinical parameters, including nutritional status, systemic inflammation, functional independence, and frailty in older adults diagnosed with advanced-stage solid organ cancers. These findings, which are consistent with recent literature, suggest that the SARC-F score may serve not only as a screening tool but also as a potential indicator of a patient's overall clinical status and short-term prognosis.[13] We found significant relationships between the SARC-F score and indicators of malnutrition risk (such as MNA-SF and GLIM), inflammatory markers including NLR and CRP, as well as measures of physical function and frailty.[14] In particular, we found that malnutrition diagnosed according to the GLIM criteria, which are recognized as the gold standard, was significantly associated with higher SARC-F scores. These findings support the potential role of the SARC-F score as a simple and practical indicator of nutritional status in this patient population. To our knowledge, this is the first study to examine the combined utility of SARC-F, GLIM criteria, and calcium levels in predicting short-term mortality among hospitalized older adults with advanced solid tumors. This is the first study to evaluate this specific combination of sarcopenia screening, malnutrition diagnosis, and biochemical markers in a single predictive framework. This novel approach may help clinicians identify vulnerable patients early and guide timely interventions.

Early publications involving the SARC-F score primarily focused on its ability to detect muscle function loss, and several studies concluded that it may be insufficient as a standalone diagnostic tool due to its low sensitivity.[15-17] However, recent research has demonstrated that the SARC-F score is not only associated with muscle strength, but also with clinical outcomes such as physical performance, fall risk, hospitalization, and mortality.[18-21] In our study population, the average SARC-F score was high, serum albumin levels were low, and CRP levels were elevated. These findings suggest that inflammation-related malnutrition significantly contributes to the clinical status of these patients. Our multivariate analysis also showed that higher SARC-F scores were significantly associated with a lower risk of mortality. Notably, recent studies have highlighted that a SARC-F score of 4 or above can be a strong indicator of poor prognosis, particularly among patients receiving palliative care.[19] These results suggest that SARC-F could be more widely integrated into clinical decision-making and patient assessment routines. It may serve not only as a screening tool for sarcopenia but also as a practical component of multidisciplinary clinical assessment. In geriatric and oncology outpatient settings, especially among older adults with complex health conditions, the SARC-F score can offer a quick and practical approach for the early detection of functional decline, malnutrition, inflammation, and frailty risks.

In the comparative analysis of the case and control groups, individuals with lower SARC-F scores showed significantly higher scores in both ADL and IADL assessments. This finding suggests that muscle function is closely linked to daily living activities, and that the SARC-F score may reflect the level of functional independence. Additionally, we found an inverse relationship between the FRAIL score and the SARC-F score, indicating that sarcopenia and frailty syndromes may be evaluated together as interconnected clinical constructs.[20]

In the case group, higher levels of calcium and 25-hydroxy vitamin D compared to the control group suggest that these parameters may be associated not only with nutritional status but also with cancer-related biological processes. While malignancy-associated hypercalcemia is commonly observed in cancer patients, previous studies have reported that supportive care can help maintain adequate serum levels of 25-hydroxy vitamin D in some individuals. This may reflect a potential biological mechanism that positively influences functional capacity.[22,23] Although mortality rates were higher in the case group, the difference was not statistically significant. This result may reflect the typical course of clinical decline seen in patients with late-stage cancer. However, it is important to note that the control group also consisted of hospitalized patients with acute illnesses, multiple comorbidities, and comparable age profiles. Therefore, both groups carried a high mortality risk. These findings suggest that the SARC-F score alone may not be a definitive predictor of mortality.

The results of the multivariate analysis revealed that the SARC-F score was an independent and significant predictor of mortality. In this model, lower SARC-F scores were associated with a lower risk of mortality, and calcium level also emerged as an independent risk factor. These findings suggest that evaluating biochemical parameters alongside physical impairment may enhance their prognostic value.[22]

Although the AUC value of the SARC-F score in the ROC analysis was moderate, its high specificity was noteworthy. Similarly, the literature has reported that the SARC-F score tends to have high specificity but limited sensitivity.[17,24] Therefore, using the SARC-F score in combination with biomarkers and functional tests may yield more meaningful results than using it alone. Evidence from studies using modified SARC-F tools suggests an increase in sensitivity, with minimal compromise in specificity. In particular, SARC-CalF has demonstrated greater success in predicting mortality compared to the original SARC-F, with higher AUC values observed especially among older male cancer patients.[25,26]

In the ROC analysis, the total SARC-F score had an AUC of 0.675, which was statistically significant. This value indicates a moderate level of discriminative power for predicting mortality. When the threshold was set at ≥3, the tool demonstrated high specificity at 96.2%, but sensitivity remained limited at 30.6%. These results highlight that while the SARC-F score may be useful for identifying patients unlikely to experience adverse outcomes due to its low false-positive rate, it may miss a significant number of high-risk individuals. Therefore, although its high specificity makes it a valuable tool in clinical set-

tings, the SARC-F score should not be used alone as a screening or decision-making instrument. These findings suggest that SARC-F may be integrated with simple laboratory parameters, such as calcium levels, to form a cost-effective and rapid prognostic tool suitable for use in internal medicine and palliative care wards. It must be supported by additional biomarkers and functional assessments.[17,24]

In the univariate analyses, higher ADL and IADL scores were positively associated with mortality, suggesting that increased functional dependence may accompany clinical deterioration. On the other hand, the inverse relationship observed with the FRAIL score may indicate that healthcare professionals who recognize frailty are more likely to initiate timely interventions, potentially reducing complications. Subgroup analyses revealed that individuals with lower SARC-F scores had higher calcium levels and better nutritional assessment scores. This finding suggests that metabolic reserve may play an important role in both functional status and short-term prognosis.[22]

When comparing individuals with SARC-F scores ≤3 and those with scores ≥4, significant differences were observed in terms of functional capacity and nutritional status. Participants with lower SARC-F scores had significantly higher ADL and IADL scores, indicating that they were more capable of maintaining independence in daily living activities. Additionally, their higher MNA-SF scores reflected better nutritional status. In contrast, individuals with higher SARC-F scores exhibited elevated FRAIL scores, pointing to increased levels of frailty. This finding is consistent with previous reports that have described a strong association between SARC-F scores and frailty.[24] Calcium levels were significantly lower among individuals with high SARC-F scores, which may be related to metabolic alterations accompanying functional impairment. Although 25-hydroxy vitamin D levels were higher in the low SARC-F group, the difference did not reach statistical significance; however, this trend remains clinically noteworthy, as vitamin D deficiency has been repeatedly linked to sarcopenia and functional decline in the literature.[22] Collectively, these findings suggest that the SARC-F score should be considered a multidimensional indicator that reflects not only physical impairment but also nutritional status and frailty.

This study has several limitations. As this was a retrospective, cross-sectional study, causal links could not be determined. Additionally, no prior sample size calculation was performed; all patients fitting the inclusion criteria during the study period were enrolled. Furthermore, the study was conducted at a single center, which limits the generalizability of the findings. Only older adults with advanced solid tumors were included in the study, without stratifying the sample by cancer type. As a result, the potential differential effects of various malignancies on sarcopenia, inflammation, and nutritional status could not be evaluated. In our study, muscle mass was assessed only with the SARC-F questionnaire, without objective methods such as DXA or BIA. This reliance on a subjective tool limits the strength and generalizability of our findings. This reliance on the SARC-F alone may also have underestimated or overestimated the true prevalence of muscle loss in this population.

These limitations reduce the extent to which the findings can be interpreted in a broader clinical context. Nevertheless, the data provide important insights into the potential clinical utility of the SARC-F score in older adults with advanced cancer.

Despite these limitations, our findings highlight the practical clinical value of the SARC-F score in internal medicine. It can serve as a rapid screening tool in daily practice and, when combined with simple laboratory markers, may help clinicians identify older cancer patients at high risk of short-term mortality. This combined approach may also be considered for incorporation into established screening protocols such as MNA-SF or NRS-2002, particularly in oncogeriatric care settings.

Conclusion

Our findings suggest that the SARC-F score reflects not only sarcopenia risk but also nutritional status, functional capacity, inflammation, and short-term mortality. Lower SARC-F scores were associated with greater functional independence, lower risk of malnutrition, and a significantly reduced risk of mortality. These findings support the value of the SARC-F score as a multidimensional tool that may facilitate early intervention in clinical settings. While SARC-F is highly specific, its low sensitivity limits its use alone. Pairing it with biomarkers or functional tests can make it more clinically useful. Future studies evaluating the combined use of SARC-F with biomarkers and objective measurements may further strengthen its clinical applicability. The integration of simple functional and biochemical parameters such as SARC-F, GLIM, and calcium may provide a feasible bedside tool for early mortality risk assessment in hospitalized older adults with cancer.

DISCLOSURE ON THE USE OF AI AND AI-ASSISTED TECHNOLOGIES

This manuscript was prepared without the use of AI or AI-assisted technologies. All authors take full responsibility for the content of the manuscript.

CONFLICT OF INTEREST AND FUNDING DISCLOSURES

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