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Comparison of Nutritional Screening Tools in Patients Undergoing Surgery for Gastric Cancer

Mide Kanseri Nedeniyle Cerrahi Uygulanacak Hastalarda Beslenme Tarama Araçlarının Karşılaştırılması

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Abstract

Aim: Nutritional screening tools are mainly used to identify patients at risk of malnutrition. We aimed to compare commonly used nutritional tools in assessing the nutritional status of patients undergoing surgery for gastric cancer

Methods: Consecutive patients undergoing surgery for gastric cancer between January 2017 and May 2019 were retrospectively evaluated from the comprehensive database. Nutritional Risk Screening-2002 (NRS), Malnutrition Universal Screening Tool, Subjective Global Assessment, Mini Nutritional Assessment-Short Form (MNA-SF), Malnutrition Screening Tool, and Short Nutritional Assessment Questionnaire scores were calculated for all patients. The assessment capabilities of these tools were compared using the European Society for Clinical Nutrition and Metabolism (ESPEN) diagnostic criteria for malnutrition as the reference standard. The distinctive abilities of the tool risk groups were also evaluated using parameters reflecting nutritional status, including albumin, lymphocyte count, and fat-free mass index.

Results: One hundred forty patients with the mean age of 64.2±11.8 years were analyzed, and 29 (20.71%) of whom were diagnosed as malnourished based on the ESPEN criteria. The strongest association (phi=0.62, large effect) and the highest agreement (kappa=0.59, moderate agreement) between tools and malnutrition were found for MNA-SF. This exhibited the highest specificity (0.84, 95% CI: 0.76 to 0.90), positive predictive value (0.58, 95% CI: 0.42 to 0.73), accuracy (0.84, 95% CI: 0.77 to 0.90), area under curve (0.850, 95% CI: 0.777 to 0.923), and diagnostic odds ratio (32.29, 95% CI: 10.02 to 104.04). Statistically significant decreases in all three parameters were observed only for the NRS risk groups. Additionally, MNA-SF exhibited a statistically significant decrease in the fat-free

Öz

Amaç: Beslenme tarama araçları çoğunlukla malnutrisyon riski olan hastaları belirlemek için kullanılır. Bu çalışmada mide kanseri nedeniyle ameliyat planlanan hastaların beslenme durumlarını değerlendirmede sıklıkla kullanılan beslenme araçlarını karşılaştırmayı amaçladık.

Yöntemler: Ocak 2017-Mayıs 2019 tarihleri arasında mide kanseri nedeniyle ameliyat olan hastalar, kapsamlı veri tabanından elde edilen bilgiler ile retrospektif olarak değerlendirildi. Tüm hastalar için Nutritional Risk Screening -2002 (NRS), Malnutrition Universal Screening Tool, Subjective Global Assessment, Mini Nutritional Assessment - Kısa Form (MNA-SF), Malnutrition Screening Tool, ve Short Nutritional Assessment Questionnaire araçlarının skorları hesaplandı. Bu araçların beslenme değerlendirme becerilerinin karşılaştırılmasında, referans standart olarak Avrupa Klinik Beslenme ve Metabolizma Derneği'nin (ESPEN) malnutrisyon tanı kriteri kullanıldı. Araçların risk gruplarını ayırt edici özellikleri ise albümin, lenfosit sayısı ve yağsız kitle indeksi gibi beslenme durumunu yansıtan parametreler kullanılarak değerlendirildi.

Bulgular: Bu çalışmada yaş ortalaması 64.2±11.8 olan toplam 140 hasta analiz edildi ve bu hastaların 29'u (%20.71) ESPEN kriterlerine göre malnutre olarak saptandı. Tarama araçları ile malnutrisyon arasındaki en güçlü ilişki (phi=0.62, yüksek etki) ve en yüksek anlaşma (kappa=0.59, orta düzeyde anlaşma) gösteren araç olarak MNA-SF bulundu. Mini Nutritional Assessment - Kısa Form en yüksek özgüllüğe (0.84, %95 CI: 0.76-0.90), pozitif prediktif değere (0.58, %95 CI: 0.42-0.73), doğruluğa (0.84, %95 CI: 0.77-0.90), AUC değerine (0.850, %95 CI: 0.777-0.923) ve tanısal odds oranına (32.29, %95 CI: 10.02-104.04) sahipti. Her üç parametrede de istatistiksel olarak anlamlı düşüşler sadece NRS'nin risk grupları için gözlendi. Ek olarak, MNA-SF, düşük ve

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Abstract

mass index (-1.60, 95% CI: -2.49 to -0.71) between low- and high-risk groups.

Conclusion: Although all the tools analyzed were effective to a certain extent, MNA-SF, designed as a screening and assessment tool, was the most effective tool for assessing nutritional status based on the ESPEN malnutrition criteria in patients undergoing surgery for gastric cancer.

Keywords: Nutritional assessment, nutritional screening tools, malnutrition, stomach neoplasms, surgical procedure

Öz

yüksek riskli gruplar arasında yağsız kitle indeksinde (-1.60, %95 CI: -2.49 ila -0.71) istatistiksel olarak anlamlı bir düşüş gösterdi.

Sonuç: Analiz edilen tüm araçlar belli bir dereceye kadar etkili olmasına rağmen, MNA-SF, ESPEN malnutrisyon kriterlerine göre, mide kanseri nedeniyle ameliyat planlanan hastalarda beslenme durumunu değerlendirmede en etkili araç olarak saptanmıştır.

Anahtar Sözcükler: Beslenmenin değerlendirmesi, beslenme tarama araçları, malnutrisyon, mide neoplazileri, cerrahi prosedür

Introduction

The main guidelines published by the European Society for Clinical Nutrition and Metabolism (ESPEN), the American Society for Parenteral and Enteral Nutrition and Enhanced Recovery After Surgery strongly recommend perioperative nutritional therapy, particularly for patients with malnutrition, as well as those at nutritional risk (1-3). Since the benefit of nutritional therapy has been demonstrated in patients under severe nutritional risk, risk stratification before surgery and identifying patients who are malnourished or at risk of malnutrition have become essential elements of the preoperative period (4-6).

Several screening and assessment tools are available, including the Subjective Global Assessment (SGA), Nutritional Risk Screening-2002 (NRS), Malnutrition Universal Screening Tool (MUST), Mini Nutritional Assessment (MNA), Malnutrition Screening Tool (MST), and the Short Nutritional Assessment Questionnaire (SNAQ) (2,7-9). All these tools have been validated in distinct patient populations. However, no consensus on which is the optimal tool has been reached in studies comparing their accuracy (10-14). A systematic review of 32 screening tools for hospitalized patients demonstrated that no single tool by itself was capable of performing nutritional screening or assessment. The authors therefore recommended applying different tools in the same patient population, rather than development of a new tool (14).

Gastric cancer is one of the most common cancer types worldwide and is frequently accompanied by malnutrition. Preoperative malnutrition has been shown to cause poor short- and long-term outcomes in patients undergoing surgery for gastric cancer (15). Among the different screening tools, the NRS has largely been employed to assess nutritional status in this patient population, and has been identified as a predictor of postoperative complications, length of hospital-stay, and overall survival (16,17). The only study to compare the NRS, MUST, and the MNA-Short Form (MNA-SF) in gastrointestinal cancer patients identified the MUST as the best tool for identifying malnourished gastric cancer patients (18). However, there were a number of limitations to that study; other valuable tools, including SGA, were not evaluated, only geriatric patients (over 70 years) were included, and the fat-free mass index (FFMI), a key item of the ESPEN malnutrition criteria, was not been used. There is therefore still no consensus on the optimal tool for assessing nutritional status in gastric cancer patients in the preoperative period.

The aim of the present study was to compare and evaluate commonly used nutritional tools in assessing the nutritional status of patients with gastric cancer during preparation for surgery.

Methods

Patients

Consecutive patients undergoing preparation for gastric cancer surgery at the Karadeniz Technical University Department of Surgery, Turkey, between January 2017 and May 2019 were retrospectively evaluated for this study. Exclusion criteria were: (1) emergency surgery, (2) presence of malignancy other than adenocarcinoma, (3) receipt of neoadjuvant chemotherapy, (4) impossibility of assessment using screening tools due to disability or incompetence, and (5) insufficient data. Written informed consent was routinely obtained from all participants at the time of admission. Approval for the study protocol was granted by the Institutional Ethics Committee of Karadeniz Technical University (2019/193).

Data collection

A prospectively maintained comprehensive database was used for this study. All data were collected and recorded by medical doctors within two days before surgery. Parameters including demographics, patient comorbidities, smoking status, aim of surgery (curative vs palliative), disease stage, laboratory data, anthropometric data (current weight, actual weight, amount of weight loss, time elapsed during this weight loss, body mass index (BMI), fat-free mass (FFM)), changes in food intake, Eastern

Cooperative Oncology Group scores, symptoms (such as loss of appetite, functional capacity, and neurological symptoms), and physical examination findings (such as ascites, edema, and skin elasticity) were routinely recorded onto the electronic database.

Validated screening tools, including NRS, MUST, SGA, MNA-SF, MST, and SNAQ, were selected for analysis. NRS is routinely performed for all hospitalized patients in our institution. Tools other than NRS are applied using the data in the database by an experienced medical doctor. All screening tools were assessed by a single team member. In case of uncertainty concerning scores, the existing nursing documentation in electronic patient records or files was checked, and the case was consulted with the study coordinator.

Height was measured using a Charder™ MS4900 device. Weight and FFM were measured using a Tanita™ SC-330 portable calibrated digital scale. BMI (current weight/height^2) and FFMI (FFM/height^2) were also calculated.

Nutritional Screening Tools

Nutritional Risk Screening 2002 (NRS): The NRS score is obtained by evaluating the two main components, impaired nutritional status and disease severity, and the age criterion is also added. For impaired nutritional status, weight loss ratio, decrease in dietary intake, and BMI are assessed on a scale of 0 to 3. Severity of disease based on disease-related nutritional requirements is also assessed on a scale of 0 to 3. These two scores were then summed, and another point was added to the total score in case of patients older than 70 (possible maximum score is 7). Patients with an NRS score ≥3 are considered to be nutritionally at-risk.

Malnutrition Universal Screening Tool (MUST): Three components are used to calculate the MUST score. BMI (on a scale of 0 to 2), weight loss ratio (on a scale of 0 to 2), and acute disease effect score (0 or 2) are assessed, and all scores are added to calculate the overall risk of malnutrition. Scores of 0 and 1 are regarded as low risk and medium risk, respectively, while scores ≥ 2 are considered high risk.

Subjective Global Assessment (SGA): Medical history (food intake, weight loss ratio, symptoms capable of affecting oral intake, and functional capacity) and physical examination (loss of body fat, loss of muscle mass, edema, and ascites) are assessed for the SGA. Patients are classified as grade A (well-nourished), grade B (mildly/moderately malnourished), or grade C (severely malnourished).

Mini Nutritional Assessment-Short Form (MNA-SF): MNA-SF is a short version (6 items) of the original MNA form (18 items). Food intake, weight loss, mobility, psychological stress or acute disease, neuropsychological problems, and BMI are assessed (for a maximum score of 14). Scores of 12-14 represent normal nutritional status, while scores of 8-11 indicate risk of malnutrition, and scores of 0-7 indicate malnourishment.

Malnutrition Screening Tool (MST): Weight loss and decreased food intake are assessed, and scores are summed. Patients scoring 0 or 1 are considered not at risk, and those scoring 2 or more are regarded as at risk.

Short Nutritional Assessment Questionnaire (SNAQ): Weight loss, decreased appetite, and use of supplemental drinks are used for SNAQ. A score of 2 indicates moderate malnourishment, and 3 indicates severe malnourishment.

Parameters for Comparison and Evaluation

Although nutritional tools are designed for different purposes, we categorized our patients into two groups (low risk vs high risk) in order to permit comparison and evaluation of the tools. NRS and MST, which contain two categories, were used as they were. NRS scores <3 were defined as low risk, and scores ≥3 as high risk (19). A MST score of 0 or 1 was defined as low risk, and a MST score of ≥2 as high risk (20). Screening tools containing three categories were grouped into two categories based on the current evidence (21,22). A MUST score of ≥2, SGA grade C, a MNA-SF score of ≤7, and a SNAQ score of ≥3 were defined as representing high-risk groups, while the remaining scores were defined as low risk.

The ESPEN diagnostic criteria for malnutrition were used as a reference standard to compare the validity of the tools in assessing nutritional status, and relationship between the screening tool risk groups and diagnosis of malnutrition were analyzed. Based on the ESPEN diagnostic criteria, any of two alternative sets of criteria confirm the diagnosis (7).

Option 1: BMI <18.5

Option 2: >10% weight loss (indefinite length of time) or >5% weight loss over 3 months,

and

- Low BMI (BMI<20 if under 70 years or BMI<22 if over 70) or
- Low FFMI (<15 for females and <17 for males)

Validated parameters reflecting nutritional status, including albumin, lymphocyte count, and FFMI, were used to evaluate the screening tools (23-25). Commonly used parameters, such as weight, weight loss, and BMI, were not used for this evaluation, since all these represent items in the tools described above.

Statistical Analysis

Continuous variables are presented as mean ± standard deviation or as median (1st-3rd quartiles). Student's t-test or the Mann-Whitney U test was used to compare categorical variables. The chi-square test (or

Fisher's exact test) was used to compare the proportion of malnourished patients according to the different screening tools. The Phi coefficient, a measure of association between two binary variables, and the Kappa coefficient, a measure of agreement between categorical variables, were used to explore the relationships between screening tools and malnutrition. Phi was interpreted as adapted by Cohen; 0.1-0.3, small effect size; 0.3-0.5, medium effect size; ≥0.5, large effect size. Kappa scores were interpreted as 0-0.19, poor concordance; 0.20-0.39, fair agreement; 0.40-0.59, moderate agreement; 0.60-0.79, substantial agreement; and ≥0.80, almost perfect agreement.

Since there is no single perfect indicator for a screening test, various aspects of screening tools were evaluated using multiple indicators including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy, area under the receiver operating curve (AUC), and diagnostic odds ratio (OR) including their 95% confidence intervals (CI). All p values were two-sided, and statistical significance was defined as p<0.05. R software (R Foundation for Statistical Computing, Vienna, Austria) with required packages was used for statistical analyses and graphical representation.

Results

Patients

One hundred forty patients meeting the inclusion criteria were included in the analyses. Patient demographics and clinical characteristics are shown in Table 1.

Comparison of Screening Tools Based on ESPEN Malnutrition Criteria

Twenty-nine (20.71%) patients were diagnosed as malnourished based on the ESPEN malnutrition criteria. Distributions of numbers of non-malnourished vs malnourished patients according to the different screening tools are presented in Figure 1.

The chi-square test revealed statistically significant associations between all screening tools and malnutrition. The strongest association was observed between the MNA-SF (phi=0.62, large effect) and malnutrition, while NRS, SGA, and MST exhibited small effect size associations (phi <0.3). Cohen's kappa was also run to determine if there was any agreement between the screening tool and malnutrition, the highest agreement being observed for MNA-SF (kappa=0.59, moderate agreement). NRS and MST both exhibited poor agreement (kappa ≤0.20).

Various measures for test validity are presented in Figure 2. Four screening tools exhibited higher sensitivity (MUST, MNA-SF, MST, and SNAQ). The MNA-SF also exhibited the highest specificity. PPV and NPV for MNA-SF were 0.58 and 0.96, respectively. Overall accuracy for MNA-SF was 0.84.

Lower limits of confidence intervals for AUC values exceeded 0.5 for all screening tools. The highest AUC

Table 1. Patient demographics and clinical characteristics of the patients

Characteristics		Data† (n=140)
Age		64.2 ±11.8
Gender	Female	40 (28.6%)
	Male	100 (71.4%)
Comorbidity‡	Yes	84 (60%)
	Diabetes Mellitus	29 (20.1%)
	Hypertension	60 (42.9%)
	Ischemic heart disease	16 (11.4%)
	Heart failure	6 (4.3%)
	Liver disease	2 (1.4%)
	Chronic respiratory disease	16 (11.4%)
	Chronic renal disease	6 (4.3%)
	Cerebrovascular disease	6 (4.3%)
ASA score	ASA-I	13 (9.3%)
	ASA-II	83 (59.3%)
	ASA-III	43 (30.7%)
	ASA-IV	1 (0.7%)
Smoking status	Current or ex-smoker	78 (55.7%)
Pathological stage	Stage-I	21 (15%)
	Stage-II	40 (28.6%)
	Stage-III	60 (42.9%)
	Stage-IV	19 (13.5%)
Intent for surgery	Curative	114 (81.4%)
	Palliative	26 (18.6%)
Hemoglobin	-	11.92±2.06
Albumin	-	3.8 (3.4-4.1)
Total protein	-	6.7 (6.1-7.1)
Lymphocyte count	-	1790 (1217-2232)
Weight	-	67.75 (60-76.5)
Weight loss ratio	-	7.96 (3.59-13.85)
Body mass index	-	24.67 (22.37-28.18)
Fat free mass index	-	18.88 ± 2.57

ASA: The American Society of Anesthesiologists
†: Data were presented as n (percentage), mean ± standard deviation or median (1st-3rd quartile)
‡: Some patients have more than one comorbidity

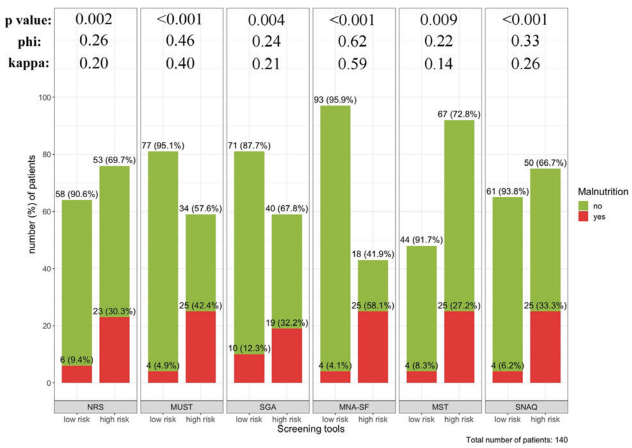

Figure 1. Distribution of the numbers (percentages) of non-malnourished vs malnourished patients according to the screening tools (based on ESPEN malnutrition criteria)
P value (the chi-square test) and phi coefficient for association, and Cohen's kappa coefficient for agreement between screening tools and malnutrition

NRS: Nutritional Risk Screening-2002, MUST: Malnutrition Universal Screening Tool, SGA: Subjective Global Assessment, MNA-SF: Mini Nutritional Assessment - Short Form, MST: Malnutrition Screening Tool, SNAQ: Short Nutritional Assessment Questionnaire

value was observed for the MNA-SF. Diagnostic OR was highest for the MNA-SF (32.29, 95% CI: 10.02 to 104.04) and lowest for the SGA (3.37, 95% CI: 1.43 to 7.96). Diagnostic OR values for other tools were NRS: (4.19, 95% CI: 1.59 to 11.09), MUST: (14.15, 95% CI: 4.57 to 43.82); MST: (4.10, 95% CI: 1.34 to 12.60), and SNAQ: (7.63, 95% CI: 2.49 to 23.36).

Evaluation of Albumin, Lymphocyte Counts, and FFMI for the Screening Tool Risk Groups

Albumin, lymphocyte, and FFMI values of the low and high-risk groups were evaluated for each screening tool. Changes between low and high risks are also shown (Table 2 and Figure 3). Statistically significant decreases for all three parameters were observed only for the NRS risk groups.

All tools exhibited a statistically significant decrease in albumin values between low- and high-risk groups. A marked difference was observed for SGA (-0.40, 95% CI: -0.59 to -0.21). The lowest albumin value for the high-risk group was obtained from the MUST and SGA tools.

Only the NRS demonstrated a statistically significant decrease in lymphocyte values between low and high-risk groups (p=0.013). The lowest lymphocyte values for the

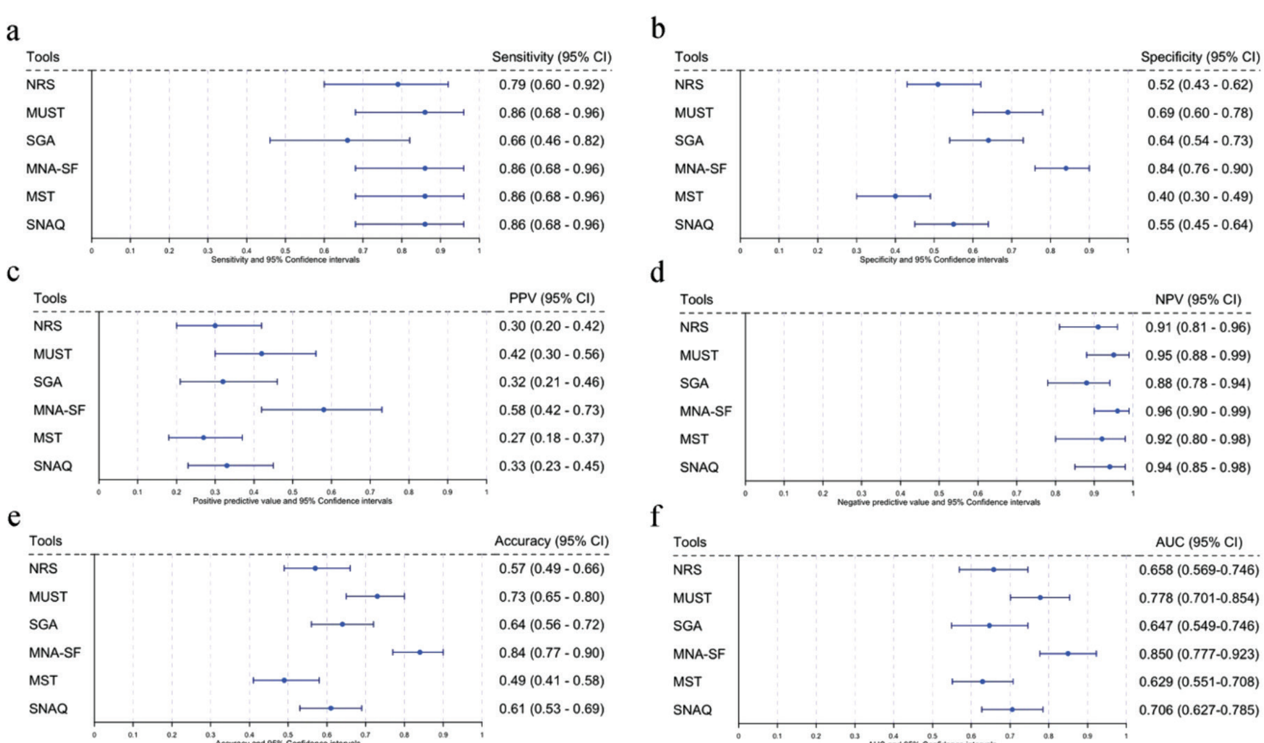

Figure 2. Sensitivity **(a)**, specificity **(b)**, PPV **(c)**, NPV **(d)**, accuracy **(e)**, AUC (f) values with 95% confidence intervals of the screening tools for assessing nutritional status based on the ESPEN malnutrition criteria

PPV: Positive predictive value, NPV: Negative predictive value, AUC: Area under the receiver operating curve, CI: Confidence intervals, NRS: Nutritional Risk Screening-2002, MUST: Malnutrition Universal Screening Tool, SGA: Subjective Global Assessment, MNA-SF: Mini Nutritional Assessment - Short Form, MST: Malnutrition Screening Tool, SNAQ: Short Nutritional Assessment Questionnaire high-risk group were obtained from the NRS, SGA, and MNA-SF.

The NRS and MNA-SF exhibited statistically significant decreases for FFMI between the low and high-risk groups. The lowest FFMI value for the high-risk group was observed for the MNA-SF.

Discussion

This study investigated the value of six different nutritional screening tools in patients scheduled for surgical treatment for gastric cancer. The validity of the tools in assessing nutritional status was analyzed using the ESPEN malnutrition criteria as the reference standard. Additionally, parameters reflecting nutritional status, including albumin, lymphocyte count, and FFMI, were used for the evaluation of these screening tools. The MNA-SF emerged as the most effective tool since it demonstrated the strongest association with the diagnosis of malnutrition. Only the MNA-SF and NRS high-risk groups exhibited a distinctive effect for both albumin and FFMI compared to the low-risk groups. NRS risk groups also exhibited a distinctive effect for lymphocyte counts.

All tools exhibited some degree of association with malnutrition in patients undergoing gastric cancer surgery. A statistically significant association was observed between all screening tools and malnutrition. Additionally, the lower limits of the confidence intervals for AUC values exceeded 0.5 for all tools. However, the main objective of this study was to determine the best screening tool for assessing nutritional status, and the MNA-SF emerged as the most effective. The strongest association (large effect size) and agreement (moderate agreement) were determined between the MNA-SF and the ESPEN malnutrition criteria. All test values in our study were higher than those of a previous study which compared three screening tools for geriatric gastric cancer patients (18). This discrepancy was probably due to differences in the selected patient population and the use of FFMI values, which formed part of the ESPEN malnutrition criteria in the present study.

Although screening tools share correlative items, the question that needs to be answered is what makes the MNA-SF superior to other tools in the present study population. The MNA-SF was designed as a comprehensive assessment tool in addition to its screening purpose. Its ability to assess nutritional status more deeply makes it superior to other tools, particularly to those designed only for screening purposes (26). On the other hand, the tools mainly designed as nutritional risk screening tools (such as NRS and MST) exhibited poor correlation with the ESPEN malnutrition criteria. This finding may confirm that tools designed for the assessment of nutritional status should also be recommended as screening tools owing to their diagnostic potential.

One of the most important findings of this study was the fact that the NRS, a commonly used and recommended screening tool, particularly in the in-hospital setting, lagged behind the other tools, correctly classifying only 57% of patients (7,17,27,28). The source of the difference was identified as the relatively low specificity of the NRS. In other words, the NRS was less capable of correctly identifying patients without malnutrition. This may be due to the NRS being intended only for screening purposes, not for assessment. The crucial clinical manifestation of this overestimation would be inaccurate identification of individuals requiring nutritional therapy.

Perioperative nutrition support is a component of standard treatment protocols in the high-risk patient

Table 2. Screening tools and albumin, lymphocyte, and FFMI values with changes according to the risk groups

Tool	Albumin			Lymphocyte†			FFMI		
	Low-risk	High-risk	Change (95% CI)	Low-risk	High-risk	p	Low-risk	High-risk	Change (95% CI)
NRS	3.94±0.39	3.56±0.61	-0.38 (-0.54, -0.20)	1965 (1422 - 2302)	1670 (1098 -2028)	0.013	19.35 ± 2.17	18.49 ± 2.83	-0.86 (-1.71, -0.01)
MUST	3.89±0.43	3.50±0.62	-0.39 (-0.58, -0.21)	1800 (1400 - 2230)	1710 (1075 - 2120)	0.092	19.1 ± 2.52	18.58 ± 2.64	-0.52 (-1.39, 0.34)
SGA	3.90±0.41	3.50±0.64	-0.40 (-0.59, -0.21)	1900 (1400 - 2230)	1670 (1075 - 2120)	0.065	18.94 ± 2.49	18.8 ± 2.71	-0.15 (-1.02, 0.72)
MNA-SF	3.8±0.53	3.57±0.58	-0.23 (-0.43, -0.03)	1800 (1370 - 2230)	1670 (1145 - 2255)	0.506	19.37 ± 2.45	17.77 ± 2.54	-1.60 (-2.49, -0.71)
MST	3.93±0.46	3.63±0.57	-0.30 (-0.47, -0.12)	1735 (1380 - 2165)	1795 (1192 - 2278)	0.986	19.15 ± 2.73	18.74 ± 2.49	-0.41 (-1.31, 0.50)
SNAQ	3.87±0.46	3.61±0.6	-0.26 (-0.44, -0.08)	1790 (1380 - 2220)	1790 (1170 - 2255)	0.564	19.08 ± 2.73	18.71 ± 2.44	-0.37 (-1.23, 0.48)

FFMI: Fat-free mass index, NRS-2002: Nutritional Risk Screening-2002, MUST: Malnutrition Universal Screening Tool, SGA: Subjective Global Assessment, MNA-SF: Mini Nutritional Assessment - Short Form, MST: Malnutrition Screening Tool, SNAQ: Short Nutrition Assessment Questionnaire, CI: Confidence intervals
†: Because the lymphocyte count showed nonparametric distribution, it was presented as median (1^{st}-3^{rd} quartile) and presenting changes was not available

group. However, the most important problem is to determine which patients should be defined as high-risk. The ESPEN defines the high-risk group as meeting at least one of the following four criteria: >10-15% weight loss within six months, BMI <18.5, albumin <3, and SGA grade C or NRS>5 (1). Although the use of the SGA and NRS is effective in various patient groups, the use of these screening tools did not elicit a satisfactory assessment of nutritional status in the present study, which included patients undergoing gastric cancer surgery (11,26,29-31). Moreover, although 76 (54.29%) patients had NRS scores of 3 and over in our study, only one had an NRS score >5 (data not presented). This may suggest that the use of the NRS >5 as a cut-off value should be questioned. Although

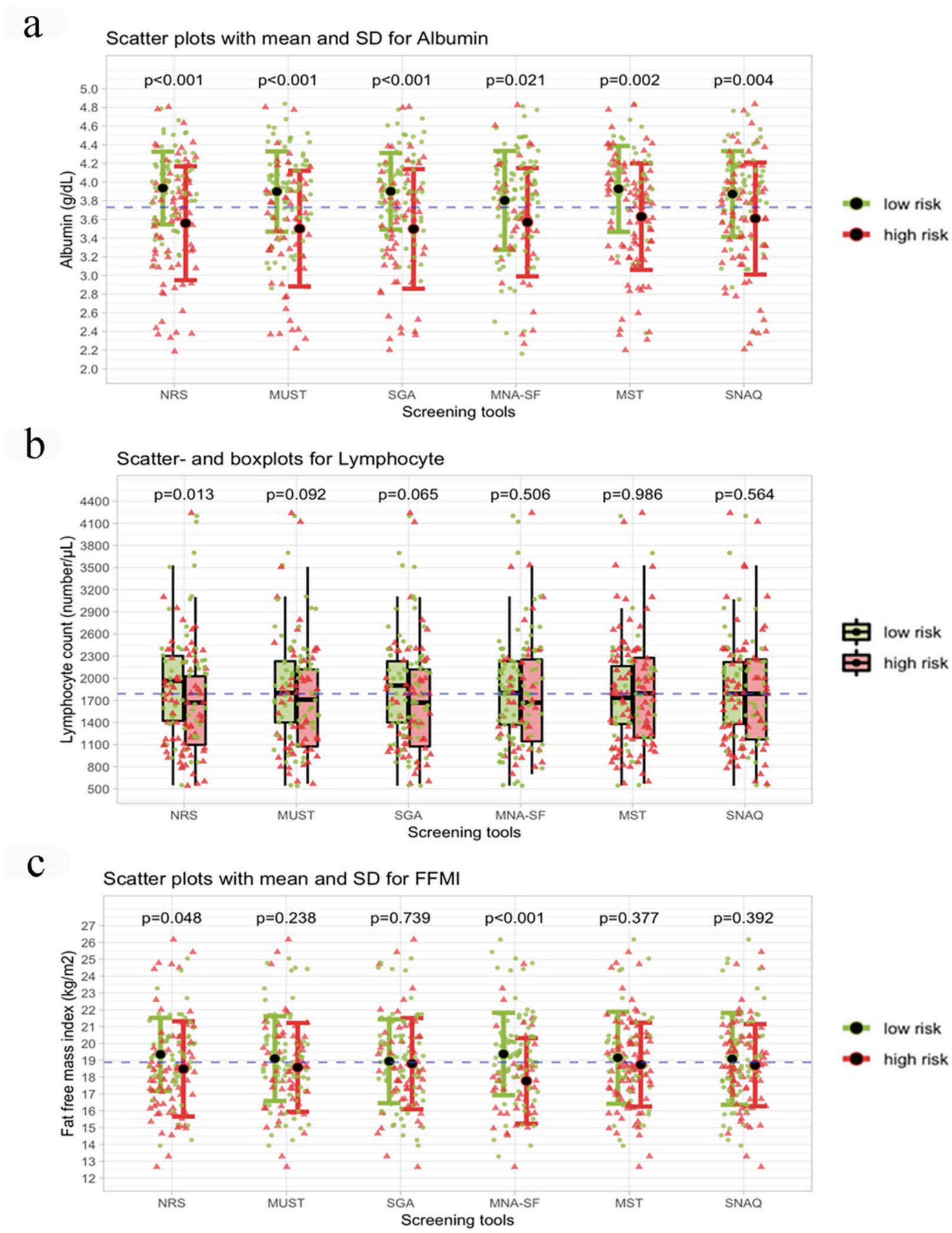

Figure 3. Albumin **(a)**, lymphocyte **(b)** and fat-free mass index **(c)** values for the low- and high-risk groups of the screening tools
Green circles represent low nutritional risk patients, and red triangles represent high nutritional risk patients. Blue horizontal lines represent mean (albumin, FFMI) or median (lymphocyte) values

FFMI: Fat-free mass index, SD: Standard deviation, NRS: Nutritional Risk Screening-2002, MUST: Malnutrition Universal Screening Tool, SGA: Subjective Global Assessment, MNA-SF: Mini Nutritional Assessment - Short Form, MST: Malnutrition Screening Tool, SNAQ: Short Nutritional Assessment Questionnaire previous studies have demonstrated that regrouping the NRS may be more effective, we believe that a standardized grouping system is vital for the universal use of the screening tools, rather than the use of different cut-off values (32,33). We also strongly agree that the development of new tools is redundant since dozens of screening tools are already available (10,14). Instead, a change in perspective is needed. Investigation of the tools in a single patient population will lead to new insights for researchers.

In addition to comparing the tools, we also evaluated their ability to differentiate risk groups using nutrition-related parameters, including albumin, lymphocyte count, and FFMI (24). Albumin levels, a parameter commonly used to assess nutritional status in surgical oncology, differed significantly between the low- and high-risk groups for all screening tools (23,34). However, only some screening tools demonstrated a difference in terms of lymphocytes and FFMI. Rather than indicating an inadequacy in the screening tools, this finding may suggest that each tool has the potential to reveal a different aspect of nutritional status, regarded as a multifactorial phenomenon (7).

Study Limitations

The present study has some limitations. First, although we used a prospectively maintained comprehensive database, this is a retrospective study from a single center. The NRS is a routinely collected variable of the dataset; however, we used existing data to calculate the scores for other tools. Second, we did not analyze the time required to apply the tool, which represents a key feature of screening tools in terms of applicability. Third, we did not evaluate clinical outcomes because this was not within the scope of the study. In the light of these limitations, we recommend that a future study be performed evaluating the value of screening and assessment tools in a specific gastric cancer patient population, including patients undergoing either curative or palliative surgery, and patients with metastatic or non-metastatic disease. Short-term clinical outcomes, including postoperative complications and operative mortality, should be the primary outcomes. Well-designed prospective trials are now needed to verify our results.

Conclusion

Nutritional assessment should be considered a natural component of surgical treatment in gastrointestinal cancer patients. Screening tools are commonly used, not only for risk stratification, but also to assess nutritional status. All screening tools exhibit a certain degree of association with malnutrition. Although the success of the different screening tools varies based on the reference standard used, in terms of the ESPEN malnutrition criteria, the MNA-SF emerged as the most effective tool for assessing nutritional status in patients with gastric cancer. Studies comparing short- and long-term clinical outcomes are now warranted to confirm the validity of the screening tools.

Authorship Contributions

Surgical and Medical Practices: R.Y., B.C., M.A.U., O.E., S.T., A.G. Concept: A.G., R.Y., B.C., O.E. Design: A.G., R.Y., S.T. Data Collection or Processing: R.Y., A.G., O.E. Analysis or Interpretation: A.G., M.A.U., S.T. Literature Search: R.Y., B.C., M.A.U. Writing: R.Y., B.C., A.G.

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