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Comparison of nutritional risk screening tools for predicting sarcopenia in hospitalized patients

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Background/aim: The aim of this study was to assess the risk of malnutrition in hospitalized patients with three different tests and to compare these tests in terms of long hospitalization periods and sarcopenia.

Materials and methods: Hospitalized patients in an internal medicine clinic were enrolled in this cross-sectional study. Patients were grouped as under 65 years (Group 1 = G1) and over 65 years old (Group 2 = G2). The nutritional status of the patients was evaluated with the Nutritional Risk Screening (NRS) 2002, Universal Malnutrition Screening Tool (MUST), Mini Nutritional Assessment Short Form (MNA-SF), and total Mini Nutritional Assessment (MNA) tests. Diagnosis of sarcopenia was assessed via bioimpedance analysis for muscle mass, a hand-grip strength test, and a "timed get up and go" test. Nutritional tests were compared in terms of sarcopenia and long hospitalization periods with receiver operating characteristic curve analysis.

Results: Mean ages were 54 (G1, n = 84) and 76 (G2, n = 112) years old. Sarcopenia was found in 5% in G1 and 33% in G2. The MNA-SF in G1 (area under curve (AUC) = 0.585, P = 0.26; sensitivity 41%, specificity 44%) and the MUST in G2 (AUC = 0.614, P = 0.048; 25%, 86%) were better predictors of prolonged hospitalization. The MNA-SF was associated with sarcopenia in both groups (G1: AUC = 0.716, P = 0.147; 63%, 64% and G2: AUC = 0.762, P < 0.001; 86%, 48%). In addition, the MNA-SF was a better predictor of low lean muscle mass index (AUC = 0.762, P < 0.001; 86%, 48%), low grip strength (AUC = 0.594, P = 0.27; 65%, 50%), and reduced walking speed (AUC = 0.642, P = 0.01; 71%, 47%) in G2.

Conclusion: None of the three tests are highly sensitive or specific for predicting sarcopenia. The MNA-SF is a better test to evaluate sarcopenia and/or related parameters than the others, and the MUST is related to prolonged hospitalization in older patients.

Key words: Hospitalized patients, long hospitalization period, malnutrition, sarcopenia

1. Introduction

Malnutrition is an important cause of mortality and morbidity in hospitalized patients (1), with a prevalence rate of 32%–50% in hospitalized adult patients (2). Malnutrition prevalence increases with age and number of comorbid diseases (3). Malnutrition is an important cause of secondary sarcopenia (3,4), and it has been found that the presence of sarcopenia in hospitalized, malnourished patients is related to increased mortality rates (5). Thus, diagnosing sarcopenia in hospitalized patients (especially older adults) is important for estimating mortality and morbidity. Malnutrition and sarcopenia, one of its negative consequences, are also associated with a prolonged hospitalization period (6–8).

Although there are many screening and diagnostic tools, including biochemical markers and anthropometric measures, there is no single test for evaluating nutritional status and its negative consequences in hospitalized patients. The Nutritional Risk Screening 2002 (NRS 2002) test for hospitalized patients (9), the Mini Nutritional Assessment (MNA) for elderly outpatients (10,11), and the Universal Malnutrition Screening Tool (MUST) for population screening (12) are commonly used to evaluate malnutrition risks (1). In previous studies, these tests were

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compared with each other in pairs (13,14) or in threes (15) to determine malnutrition status, mortality, prolonged hospitalization periods, and disease complications in hospitalized patients.

In practice, we thought that these tests could be used to predict the presence of sarcopenia due to their easy applicability and because of the malnutrition–sarcopenia relationship. However, as far as we know, there have been no studies comparing the relationship of malnutrition status with sarcopenia and/or lean muscle mass index (LMMI), hand grip strength, and walking speed using the three tests. Therefore, the aims of our study were to evaluate malnutrition risk in hospitalized patients in internal medicine inpatient clinics using the three different tests and to compare these tests in terms of predicting sarcopenia and prolonged hospitalization periods.

2. Materials and methods

2.1. Study design and participants

Patients admitted to internal medicine inpatient clinics at the Cerrahpaşa School of Medicine (excluding the oncology, hematology, and rheumatology clinics) between October 2013 and January 2014 were included in this cross-sectional study. The patients were examined in two groups: those less than 65 years of age (Group 1 = G1) and those over 65 years of age (Group 2 = G2). Demographic information, comorbid diseases, and the number of medications used by these patients were recorded.

Many methods are used to identify sarcopenia, and there are no assigned cutoff points in the devices used in its diagnosis in the Turkish population. In order to reflect the healthy population of Turkey in an effective manner, we enrolled 30 healthy male and 30 healthy female volunteer controls between the ages of 20 and 40. Volunteers had no chronic disease, had no history of medication use for any reason, and did not actively exercise (Table 1). The mean age was 30.8 ± 5.3 years in females and 28.2 ± 4.1 years in males. The study had the approval of the local ethics committee and the participants provided written informed consent.

2.2. Nutritional evaluation

Within the first 72 h after being hospitalized, each patient's nutritional status was evaluated by the research assistants on the team using the NRS 2002 (9), MUST (12), MNA Short Form (MNA-SF) (10), and MNA total tests (11). All of the nutrition tests were administered by the same researcher. Malnutrition risk was defined as ≥3 points on the NRS 2002, ≥2 points on the MUST, ≤11 points on the MNA-SF, and 17.5–23.5 points on the total MNA. Anthropometric measures (height, weight, and arm and calf circumferences) were recorded. Body mass index (BMI) (kg/m^2) was measured using height (m) and weight (kg) measurements. Hospitalization periods were calculated by evaluating hospitalization and discharge time. A long hospitalization period was defined as hospitalization of over 15 days.

2.3. Evaluation of sarcopenia

Sarcopenia was staged in three phases, namely presarcopenia, sarcopenia, and severe sarcopenia, by the European Working Group on Sarcopenia in Older People, formed by the European Union Geriatric Medicine Society (4). In the presarcopenia stage, there is only loss of muscle mass; muscle strength and performance are normal. In the sarcopenia stage, there are loss of muscle mass and effects on muscle strength and/or performance. In the severe sarcopenia stage, muscle mass, strength, and performance severely decline.

2.3.1. Evaluation of muscle mass

Bioimpedance analysis (BIA) is a method that evaluates muscle and fat mass in a cost-effective and easy manner, and it can be performed quickly in both hospitalized and ambulatory patients. In this study, the multifrequency, quarter-electrode BIA device Bodystat QuadScan 4000 (Bodystat Ltd., Isle of Man, UK) was used to measure the LMMI of the patients. All measurements were taken by the same researcher in accordance with the literature (16). Patients with contraindications to performing a BIA analysis, such as patients with prostheses, pacemakers, or diseases affecting BIA analysis results (e.g., decompensated congestive heart failure (NYHA III–IV), massive pleural effusion, acute or chronic kidney failure with hypervolemia, pregnancy, or severe muscle disorder), were excluded from the study. The patient's data were acquired and recorded by the device after a fasting period of 4 h. Four electrodes were placed on the patient's upper and lower extremities with the patient lying in a supine position for approximately 4–5 min. LMMI (kg/m^2) was calculated automatically with special equations from the device. The LMMIs of the controls were also calculated automatically by the device according to the individual's sex. In accordance with the literature, the muscle mass was accepted as declining if the LMMI of the patient was less than the cutoff point of –2 standard deviations (SDs) of the mean LMMI values of the healthy controls (Table 1) (17). The cutoff points of our healthy control group are similar to the results of a previous study made using the same BIA device in a Caucasian population (18).

2.3.2. Muscle strength evaluation

The hand grip strength test is an easily applicable, inexpensive, and simple test performed with an isometric hand dynamometer. In this study, a Jamar model hand dynamometer (Model SH500L, Four D Rubber Company Ltd., Derbyshire, UK) was used to measure the hand grip strength of the patients. The dominant hand was designated

by asking the patient which hand was more actively used. Measurements were performed by the same researcher in accordance with the literature (19). The patient was seated in a chair with elbows and arms on the table. The arms were flexed at 90° and positioned parallel to the ground. Three measurements were performed on both arms, with a 1-min rest period between each measurement. The mean of the three measurements was calculated; muscle strength was accepted as low when the hand grip strength test of the patient was below the cutoff point of –2 SDs of the mean hand grip strength (kg) of the healthy controls, grouped according to sex (Table 1).

2.3.3. Muscle performance evaluation

The physical performances of the patients were evaluated with a "timed get up and go" test. In this test, while being timed, the patient starts from a seated position on a chair, gets up from the chair without any support, walks 3 m, turns and comes back, and sits back down on the chair without support. In this study, the walking speeds of the patients were calculated with a chronometer. Muscle performance was accepted as low if the test period was ≥15 s (20).

2.4. Statistical analysis

All data were analyzed using SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA). Demographic and clinical properties, malnutrition, and sarcopenia status were presented as basic clinical data. Student's t-test was used to compare numerical variables between groups, and chi-square tests were used to compare categorical variables. Nutritional tests were compared in terms of prolonged hospitalization period (≥15 days), sarcopenia, and its parameters (LMMI, hand grip strength, and walking speed) using receiver operating characteristic (ROC) curve analysis. $P < 0.05$ was accepted as statistically significant. Values were represented as mean ± SD.

3. Results

Sixty controls and 206 hospitalized patients were included in the study. Ten patients were excluded due to the inability to measure muscle mass because of technical problems. Table 2 presents the distribution of the groups, the demographic and clinical properties, and the sarcopenia and malnutrition measurements of the 196 patients. There were no differences in sex distribution between the groups ($P = 0.38$). G2 had a statistically higher number of comorbidities, but there were no statistically significant differences between the groups in the number of medications used ($P = 0.001$ and $P = 0.13$, respectively).

There were no significant differences in BMI between the groups in terms of anthropometric measurements. However, arm and calf circumference were significantly lower in G2, as expected ($P = 0.001$). Forty-six patients (23.5%) included in the study could not perform the "timed get up and go" test due to their clinical status, and they were not included in the mean walking speed measurements shown in Table 2.

Thirty-four patients in G2 (30%) could not perform the "timed get up and go" test. The mean walking speed of G2 was calculated as 14.8 s. However, when the number of patients who were unable to perform the test was taken into consideration, this value was expected to be higher.

The walking speeds of the patients who could not perform the "timed get up and go" test were accepted as low in the sarcopenia assessment. Table 3 shows the malnutrition risks and sarcopenia of all of the patients according to the three tests. Malnutrition risk and sarcopenia ratio were higher in G2, as expected.

The presence of malnutrition was significantly correlated with the presence of sarcopenia in our study ($P < 0.001$). The negative predictive value was 50%, and the positive predictive value was 85% when comparing the

Table 1. Cutoff points of lean muscle mass index and hand grip strength calculated according to healthy controls.

Sex	Female (n = 30)	Male (n = 30)
Age	30.8 ± 5.3	28.2 ± 4.1
LMMI (kg/m^2)	15.7 ± 1.13	20.2 ± 1.50
–2 SD	13.4	17.1
Hand grip strength (R) (kg)	29.3 ± 5.4	44.3 ± 7.4
–2 SD	18.5	29.5
Hand grip strength (L) (kg)	27.1 ± 4.7	39.8 ± 8.3
–2 SD	17.7	23.2

LMMI: Lean muscle mass index; SD: standard deviation.

Table 2. Demographic and clinical properties, sarcopenia, and malnutrition measurement values of all patients.

	G1 (n = 84)	G2 (n = 112)	P-value*
Sex (female/male)	45/39	68/44	0.38**
Mean age ± SD	54 ± 7.01	76.6 ± 8	<0.001
Mean comorbid disease ± SD	2.5 ± 1.5	3.3 ± 1.9	0.001
Mean number of medication ± SD	6.35 ± 5.2	7.3 ± 3.7	0.13
Mean hospitalization period ± SD (days)	29.3 ± 19.6	21.5 ± 14.5	0.002
Mean BMI ± SD (kg/m^2)	29.3 ± 7.3	28 ± 6	0.09
Mean arm circumference ± SD (cm)	29.6 ± 4.3	27.4 ± 4.4	0.001
Mean calf circumference ± SD (cm)	37 ± 4.7	34.2 ± 6.2	0.001
Mean LMMI ± SD (kg/m^2)	18.3 ± 2.7	15.9 ± 3	<0.001
Mean hand grip strength ± SD (kg)	21.2 ± 9.1	13.8 ± 8.3	<0.001
Mean walking speed ± SD (s)	10.5 ± 4.2	14.8 ± 7.2	<0.001
Mean NRS 2002 ± SD (points)	1.5 ± 0.99	2.4 ± 1.25	<0.001
Mean MUST ± SD (points)	0.6 ± 1.26	1.03 ± 1.42	0.03
Mean MNA-SF ± SD (points)	11 ± 2.77	9.8 ± 2.84	0.003
Mean MNA total ± SD (points)	23.9 ± 4.1	21.4 ± 4.5	<0.001

G1 = Group 1, G2 = group 2, n = number of patients, SD = standard deviation, BMI = body mass index, LMMI = lean muscle mass index, NRS 2002 = Nutritional Risk Screening 2002, MUST = Malnutrition Universal Screening Test, MNA-SF = Mini Nutritional Assessment Short Form.
*Student's t-test, ** chi-square test.

Table 3. Malnutrition risk and sarcopenia rates of all of the patients based on nutrition tests.

	Group 1, n (%)	Group 2, n (%)	P-value*
Nutritional status			
NRS 2002 MR	12 (14.3)	45 (40.5)	<0.001
MUST MR	15 (18)	33 (30)	0.057
MNA screening MR	37 (44)	79 (71)	0.001
MNA total			
MR	28 (33)	59 (68)	<0.001
Malnutrition	5 (6)	19 (17)	
Sarcopenia	4 (5)	37 (33)	<0.001
Presarcopenia	1 (1.2)	3 (2.7)	
Sarcopenia/severe sarcopenia	3 (3.6)	34 (30.4)	

n = Number of patients, MR: malnutrition risk, NRS 2002 = Nutrition Risk Screening 2002, MUST = Malnutrition Universal Screening Test, MNA = Mini Nutritional Assessment.
*Chi-square test.

presence of malnutrition with sarcopenia, according to the total MNA scores of all patients. The three malnutrition tests were compared with ROC curve analysis between the groups in terms of sarcopenia, sarcopenia parameters (LMMI, hand grip strength, and walking speed), and prolonged hospitalization periods. Among the three screening tests, the MNA-SF was better at detecting sarcopenia in G1 (AUC = 0.716, P = 0.147; sensitivity 63%, specificity 64%); however, the differences were not statistically significant (Figure 1a). In G2, the MNA-SF was more significantly related to the presence of sarcopenia than the other tests (Figure 1b). In G1, the MNA-SF was a better indicator of a prolonged hospitalization period than the other tests (AUC = 0.585, P = 0.26; sensitivity 41%, specificity 44%); however, the differences were not statistically significant (Figure 2a). The MUST was a better evaluator of a prolonged hospitalization in G2 (AUC = 0.614, P = 0.048; sensitivity 25%, specificity 86%) (Figure 2b).

When the sarcopenia parameters are compared among the three screening tests, LMMI results were the same with sarcopenia (Figure 1a and 1b). Although hand grip strength in the two groups was evaluated more efficiently with the MNA-SF than with the other tests, the differences were not statistically significant (AUC = 0.584, P = 0.18; sensitivity 46%, specificity 70%, and AUC = 0.594, P = 0.27; sensitivity 65%, specificity 50%, respectively). In addition, the MNA-SF was better than the other tests at evaluating low walking speed; however, there were no statistical differences. In G2, low walking speed was correlated more closely with the MNA-SF than with the other tests in terms of statistical significance (AUC = 0.642, P = 0.01; sensitivity 71%, specificity 47%).

4. Discussion

In this cross-sectional study, the malnutrition risk and malnutrition rate of patients under the age of 65 were 33% and 6.65%, respectively; the malnutrition risk and malnutrition rate of patients over the age of 65 were 68% and 17%, respectively, which were both quite high.

The prevalence of sarcopenia was 5% under the age of 65 but 33% over the age of 65. Sarcopenia and/or severe sarcopenia occurred in almost 30% of the patients in the elderly group. In a study of 104 patients hospitalized in a geriatrics inpatient clinic, the malnutrition risk was 48% and the malnutrition rate was 22%, which is similar to the results of our study (14). The malnutrition risk was found to be 38.6% in another study (13).

It has been reported that the MUST is statistically significant in the estimation of prolonged hospitalization periods and high mortality rates (P = 0.02, P < 0.01, respectively) (12). In our study, although the three tests that evaluate nutritional status in hospitalized patients were similar in terms of prolonged hospitalization periods

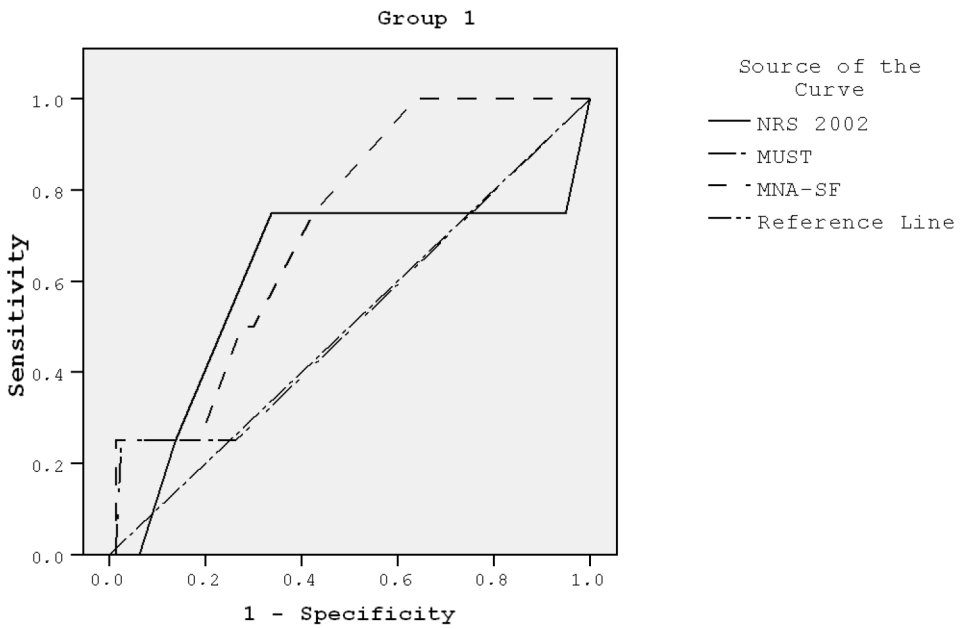

Figure 1a. Comparison of the three tests in terms of presence of sarcopenia in Group 1 patients (AUC = 0.613, P = 0.450, sensitivity 12.5%, specificity 90% for NRS 2002; AUC = 0.522, P = 0.883, sensitivity 25%, specificity 88% for MUST; AUC = 0.716, P = 0.147, sensitivity 63%, specificity 64% for MNA-SF) (AUC = area under the curve, NRS 2002 = Nutritional Risk Screening 2002, MUST = Malnutrition Universal Screening Test, MNA-SF = Mini Nutritional Assessment Short Form).

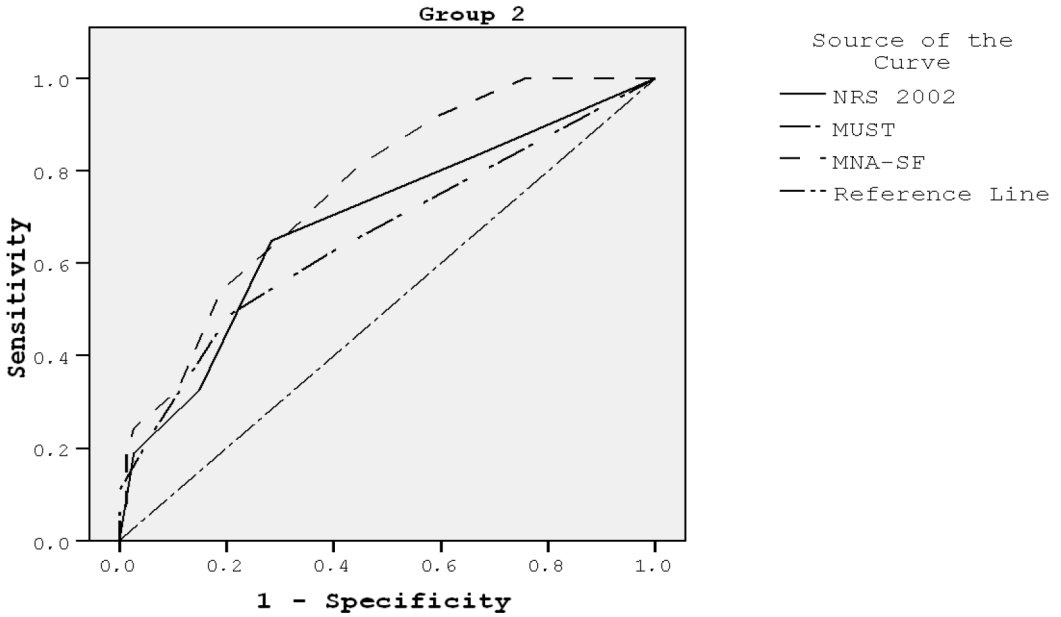

Figure 1b. Comparison of the three tests in terms of presence of sarcopenia in Group 2 patients (AUC = 0.689, P = 0.001, sensitivity 44%, specificity 78% for NRS 2002; AUC = 0.659, P = 0.006, sensitivity 36%, specificity 86% for MUST; AUC = 0.762, P < 0.001, sensitivity 86%, specificity 48% for MNA-SF) (AUC = area under the curve, NRS 2002 = Nutritional Risk Screening 2002, MUST = Malnutrition Universal Screening Test, MNA-SF = Mini Nutritional Assessment Short Form).

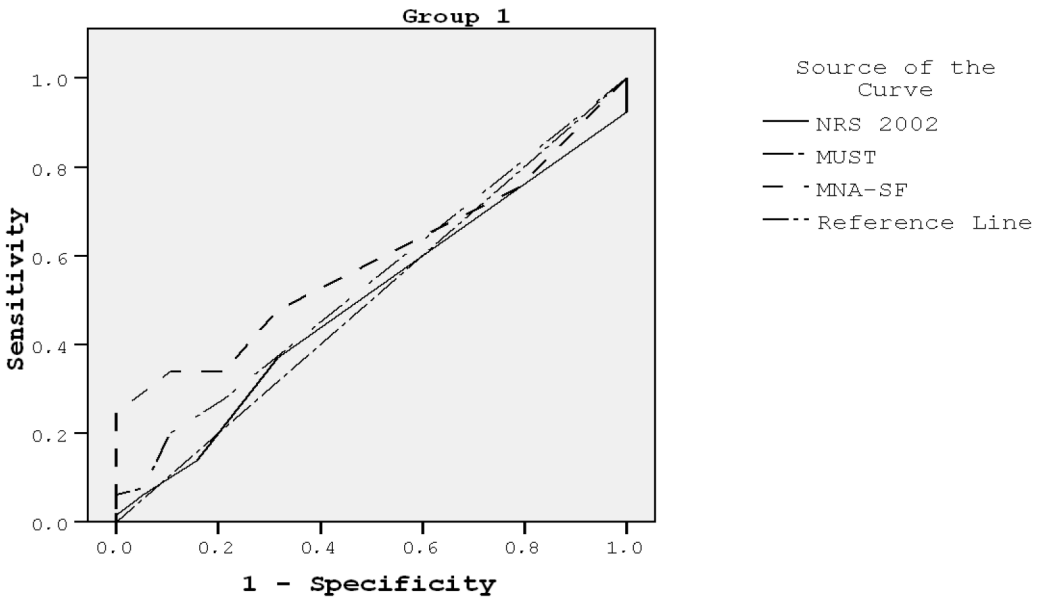

Figure 2a. Comparison of the three tests in terms of prolonged hospitalization periods (≥15 days) in Group 1 (AUC = 0.495, P = 0.945, sensitivity 10%, specificity 89% for NRS 2002; AUC = 0.540, P = 0.597, sensitivity 14%, specificity 92% for MUST; AUC = 0.585, P = 0.259, sensitivity 41%, specificity 47% for MNA-SF) (AUC = area under the curve, NRS 2002 = Nutritional Risk Screening 2002, MUST = Malnutrition Universal Screening Test, MNA-SF = Mini Nutritional Assessment Short Form).

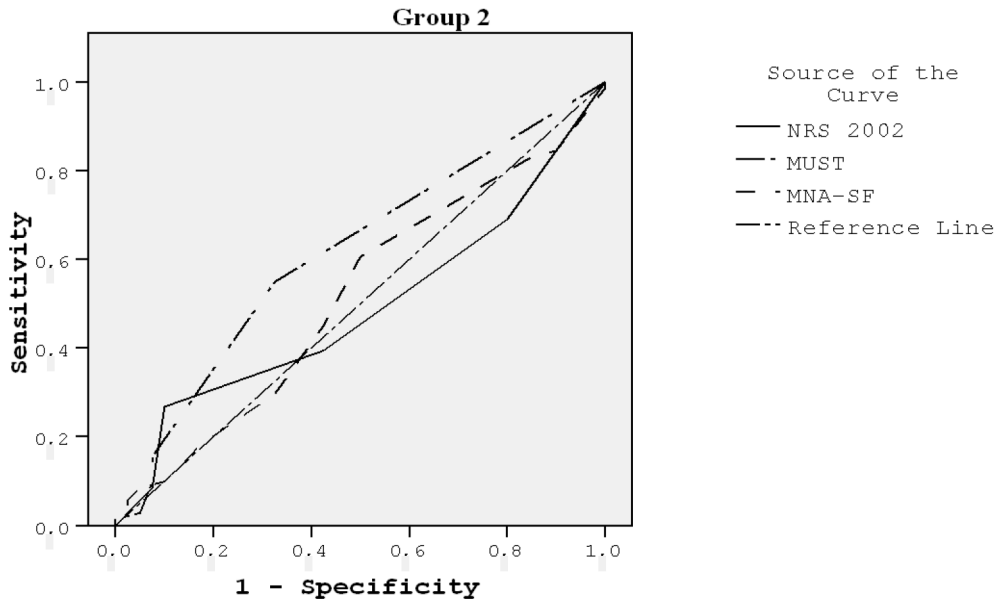

Figure 2b. Comparison of the three tests in terms of prolonged hospitalization periods (≥15 days) in Group 2 (AUC = 0.488, P = 0.827, sensitivity 33%, specificity 74% for NRS 2002; AUC = 0.614, P = 0.048, sensitivity 25%, specificity 86% for MUST; AUC = 0.514, P = 0.789, sensitivity 66%, specificity 41% for MNA-SF) (AUC = area under the curve, NRS 2002 = Nutritional Risk Screening 2002, MUST = Malnutrition Universal Screening Test, MNA-SF = Mini Nutritional Assessment Short Form).

in patients under the age of 65, the MUST was better at estimating prolonged hospitalization periods in patients over the age of 65. However, the MUST has high specificity but low sensitivity with respect to the cutoff points (≥2 points) of malnutrition risk. In a comprehensive study of 705 patients admitted to hospitals in a Brazilian population that aimed to compare the three tests (NRS 2002, MUST, and MNA-SF), malnutrition risks were found to be 27.9%, 39.6%, and 73.2%, respectively. In that study, ROC curve analysis found that the NRS 2002 (complications: 0.6531 (AUC); prolonged hospitalization period: 0.6508; mortality: 0.7948) and the MNA-SF (complications: 0.6495; prolonged hospitalization period: 0.6197; mortality: 0.7583) were similar in terms of evaluating negative results, such as complications, prolonged hospitalization periods, and mortality. However, the NRS 2002 seemed to be more predictable. Furthermore, there was no statistical significance in patients under the age of 65 (P > 0.05) (15). However, our study showed that compared with the other tests, the MUST was significantly better in the evaluation of prolonged hospitalization in elderly patients. We were not able to compare the three tests in terms of mortality in our study because the mortality rate was only 1% (two patients).

We compared all three tests using ROC curve analysis to predict the presence of sarcopenia due to the easy applicability of the tests and because of the malnutrition–sarcopenia relationship. We found that although the three tests were significantly effective in representing sarcopenia in patients over the age of 65, the MNA-SF seemed to be more effective than the other tests (MNA-SF, P < 0.001; NRS 2002, P = 0.001; MUST, P = 0.006). None of the three tests are highly sensitive or specific in terms of detecting the presence of sarcopenia and sarcopenia parameters. However, the MNA-SF does well in patients over the age of 65 with low LMMI and who have a slow walking speed. The study results showed that the tests are similar in low hand grip strength in the two age groups.

The limitations of our study are as follows: the study is local and cross-sectional. The "timed get up and go" test to assess walking speed in hospitalized patients could not be performed by some patients because of their poor physical condition. Thus, mean walking speed might actually be lower than expected. Patients hospitalized in the oncology, hematology, and rheumatology clinics were excluded from the study due to their poor performance status and difficulty performing the tests. This factor might affect conditions such as malnutrition, sarcopenia, mortality, and a prolonged hospitalization period. The number of patients, especially in G1 (n = 4), was low for evaluating sarcopenia and differences between the tests. Finally, the tools used to detect sarcopenia have no cutoff points assigned for the Turkish population. For this reason, we presented our results by comparing a smaller number of controls (30 females and 30 males).

In conclusion, nutritional risk screening tools can indicate the negative consequences of hospitalized patients. The MNA-SF test is better at predicting sarcopenia

and sarcopenia parameters in patients over the age of 65, whereas the MUST seems to be better at reflecting prolonged hospitalization periods. However, while some tests are shown to be effective according to the literature and our study, it should be noted that these tests are not as highly selective and specific as expected. Our study is important in that it is the first study in the literature to compare the three tests in terms of sarcopenia and sarcopenia parameters. However, comprehensive studies with a higher number of patients conducted at more than one center need to be performed in the future.

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