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CLINICAL RESEARCH

Comparison of Mini Nutritional Assessment-Short and Long Form to predict all-cause mortality up to 7 years in geriatric outpatients

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Abstract

Background: We aimed to find out whether the Mini Nutritional Assessment-Short Form (MNA-SF) can predict mortality up to 7 years when compared with the Mini Nutritional Assessment-Long Form (MNA-LF) in geriatric outpatients.

Methods: This retrospective study was conducted in patients (≥65 years) who were admitted to the geriatric outpatient clinic of a university hospital. MNA-SF and MNA-LF results were available for all patients. Patients were grouped as normal nutrition status (score 12–14), at risk of malnutrition (score between 8 and 11), or malnourished (score ≤7) according to MNA-SF. Based on MNA-LF, patients had normal nutrition status (score ≥24), were at risk of malnutrition (score 17–23.5), or were malnourished (score <17). Survival of the patients was assessed retrospectively.

Results: The study included 209 patients (62.2% female). During the 7-year follow-up, 77 (36.8%) patients died. After adjusting for age, sex, and Charlson comorbidity index, MNA-SF was significantly associated with all-cause mortality during 6-month, 1-year, 3-year, 5-year, and 7-year follow-up time. MNA-LF was superior to MNA-SF to estimate 6-month ($P = 0.004$) and 1-year mortality ($P = 0.031$). There was no difference between MNA-SF and MNA-LF regarding 3-year, 5-year, and 7-year mortality.

Conclusion: MNA-SF can predict short-term and long-term mortality in geriatric outpatients as well as MNA-LF. A cut-off value of 11, indicating risk of malnutrition according to MNA-SF, may be used for the risk estimation of 1-year, 3-year, and 5-year mortality. Therefore, this study highlights the importance of screening all geriatric outpatients for malnutrition and especially the risk of malnutrition for early intervention and treatment.

KEYWORDS
geriatric assessment, malnutrition, mortality, nutrition status, outpatients

INTRODUCTION

Malnutrition is a global health problem related to the aging world population. The prevalence of malnutrition is high in the geriatric population and is one of the most important geriatric syndromes.[1] Besides causing poor clinical outcomes, including various morbidities and mortality, malnutrition plays a key factor in the pathophysiology of sarcopenia and frailty, which are interconnected.[2–4] Not only malnutrition but also the risk of malnutrition increases the risk of sarcopenia and frailty; however, nutrition screening and interventions may prevent and reverse these two important issues.[5] Therefore, recognizing and managing patients at risk of malnutrition is important.

The European Society for Clinical Nutrition and Metabolism recommends nutrition screening using any validated screening tool.[6,7] Mini Nutrition Assessment-Short Form (MNA-SF) and Long Form (MNA-LF), Nutritional Risk Score (NRS-2002), and Malnutrition Universal Screening Tool (MUST) are widely used and accepted tools for older adults. MNA-LF was first validated for geriatric outpatients, and then it was accepted and started to be widely used in various settings. Later, MNA-SF was developed as a short, easy, and quick version of MNA-LF.[8–11] It is a practical and comprehensive nutrition screening test. MNA-SF has been validated against MNA-LF in community, residential care, rehabilitation, and hospital settings so far and included older adults living with frailty as well.[12–15] Weight loss, appetite, mobility, psychological stress, neuropsychological problems, and body mass index (BMI) (calculated as weight in kilograms divided by height in meters squared, kg/m^2) are the parameters of MNA-SF and they are associated with not only malnutrition but also frailty. Supporting these data, there were studies supporting the use of MNA-SF for frailty screening in older adults.[16,17]

Although MNA-LF was proven to be associated with mortality, there have been limited data on the predictive ability of MNA-SF on short-term and long-term mortality. The primary aim of the study was to investigate whether MNA-SF can predict long-term mortality (from 6 months to 7 years) in geriatric outpatients when compared with MNA-LF. The secondary aim was to determine the cut-off points of MNA-SF and MNA-LF scores to better predict mortality risk in routine geriatric assessment.

METHODS

Study population

The present study was a retrospective analysis of a cross-sectional study that assessed the validity of MNA-SF and MNA-LF to screen malnutrition in Turkish geriatric patients.[14] A detailed description of the index study was provided elsewhere.[14] Briefly, 236 patients aged ≥65 years who applied to the geriatric outpatient clinic between January 1, 2013 and September 30, 2013 and agreed to be involved in this study were assessed. Twenty-seven patients were excluded as they did not have MNA-SF and MNA-LF scores. In the final analysis, 209 patients were included. This study was approved by the local ethics boards and commissions with the Declaration of Helsinki. Written informed consents were present for all participants.

Baseline data collection and follow-up

Baseline characteristics of patients, including sex, age, comorbidities, and laboratory values (serum albumin level and C-reactive protein), were obtained from medical records. Charlson comorbidity index (CCI) was calculated for each patient.[18] High CCI scores presented poor prognoses. Baseline anthropometric measurements like BMI, mid-upper arm circumference (MAC), calf circumference (CC), and handgrip strength (HGS) were noted.[14] MAC was measured when elbow flexion was 90°. CC was measured when the individuals were in a sitting position with the knee at 90° flexion. A Takei digital grip strength dynamometer (Takei Scientific Instruments) was used to assess HGS while sitting with a 90° flexion of the elbow, neutrally rotated forearm, and adducted shoulder. Patients performed maximum HGS three times using their dominant hand and the highest value was taken into consideration.

A comprehensive geriatric assessment, including Lawton-Brody instrumental activities of daily living (IADL), Mini-Mental State Examination (MMSE), and Yesavage Geriatric Depression Scale (GDS) short form, was performed.[19–21] Nutrition status was assessed by MNA-SF and MNA-LF.[14,22,23] The MNA-SF values range from 0 to 14. Patients were grouped as normal nutrition status (score ≥12), at risk of malnutrition (score between 8 and 11), or malnourished (score ≤7). The MNA-LF values range from 0 to 30, and patients were grouped as normal nutrition status (score ≥24), at risk of malnutrition (score 17–23.5), or malnourished (score <17).

Survival of all participants was recorded through linkage with the Turkish national death registry from the first assessment in 2013 until they died or at the end of January 2021.

Statistical analysis

The variables were examined by using visual (histograms and probability plots) and analytical

methods (Kolmogorov-Smirnov/Shapiro-Wilk's test) to determine whether data were normally distributed. Descriptive analyses were presented using means and SDs for normally distributed MAC and CC. Medians and interquartile range (25th–75th percentile) were used for the nonnormally distributed and ordinal variables. Categorical variables were summarized in terms of counts and percentages. Kruskal-Wallis test was used to compare nonnormally distributed variables. The Mann-Whitney *U* test was performed to test the significance of pairwise differences using the Bonferroni correction to adjust for multiple comparisons. A one-way analysis of variance was used to compare normally distributed variables. Levene test was used to assess the homogeneity of the variances. When overall significance was observed, pairwise post hoc tests were performed. The chi-square test or Fisher exact test, where appropriate, was used to compare proportions between groups.

The capacities of MNA-SF and MNA-LF scores in predicting mortality were analyzed using receiver operating characteristic (ROC) curve analysis and cut-off values were presented. ROC curve comparisons of MNA-SF and MNA-LF were given as figures according to years. While evaluating the area under the curve, a 5% type 1 error level was used to accept a statistically significant predictive value of the test variables. The estimation of the cumulative survival was found by using the Kaplan-Meier method, and groups were compared with the log-rank test. The possible factors known and identified with univariate analyses were entered into the multivariable Cox regression analysis, with backward likelihood ratio (LR), to determine independent predictors of 6-month, 1-year, 3-year, 5-year, and 7-year survival. Multivariable models were generated by adjusting for age, sex, and CCI. All analyses in the Cox model were performed separately for each parameter of nutrition status because of the relationship and collinearity among them. The results were shown as hazard ratios (HRs) and corresponding 95% CI. The proportional hazards assumption and model fit was assessed using residual (Schoenfeld and Martingale) analysis. All analyses were considered statistically significant when the *P* value was <0.05 and was performed using the Statistical Package of Social Science 23.0 (SPSS).

RESULTS

Patient characteristics

In the study, 236 patients were enrolled. After excluding 27 patients without having both MNA-SF and MNA-LF scores, 209 patients were included in the final analysis. The median (minimum–maximum) age of the participants was 75 years (65–96 years), 130 of whom (62.2%) were females. The median MNA-SF score was 12 points (range, 1–14 points) and there were 31 patients (14.8%) classified as malnourished, 66 (31.6%) at risk of malnutrition, and 112 (53.6%) with normal nutrition status. The median MNA-LF score was 24.5 points (range, 6–30 points) and there were 26 patients (12.4%) classified as malnourished, 62 (29.7%) at risk of malnutrition, and 121 (57.9%) with normal nutrition status. There were significant differences in age, CCI, BMI, MAC, CC, HGS, serum albumin level, serum prealbumin level, IADL, MMSE, and GDS-15 scores in comparison with three categories of MNA-SF and MNA-LF ($P < 0.05$ for all). According to post hoc analyses; follow-up time, BMI, HGS, MAC, CC, IADL, and MMSE were significantly different between all groups. The differences in age, CCI, and GDS originated from the normal group. Serum albumin levels were significantly lower for malnutrition groups than others. Serum prealbumin levels were different only between normal and malnutrition groups. Baseline characteristics of patients according to MNA-SF and MNA-LF categories are given in Table 1.

All-cause mortality according to years

MNA-LF was superior to MNA-SF estimating 6-month ($P = 0.004$) and 1-year mortality ($P = 0.031$); however, there was no difference for 3-year, 5-year, and 7-year mortality **(**Figure 1**)**. Kaplan-Meier survival curves according to MNA-SF and MNA-LF categories are shown in Figure 2.

There were significant differences between normal nutrition status, at risk of malnutrition, and malnutrition groups for both MNA-SF and MNA-LF. Cumulative survival rates according to years are given in Table 2. Cut-off values of 8 and 18.5 for 6-month mortality; 11 and 20.5 for 1-year mortality; 11 and 24 for 3-year mortality; 11 and 24 for 5-year mortality; and 10 and 25 for 7-year mortality had the best prediction for MNA-SF and MNA-LF, respectively. Cut-off values for MNA-SF and MNA-LF to predict mortality are given in detail in Table 3.

During the follow-up period, 77 (36.8%) patients died. After adjusting for age, sex, and CCI, predictive abilities of BMI, MAC, CC, HGS, serum albumin level, C-reactive protein, MNA-SF, and MNA-LF on 6-month, 1-year, 3-year, 5-year, and 7-year mortality were given in Table 4. MNA-SF was significantly associated with 6-month (HR, 0.69; 95% CI, 0.57–0.84), 1 year (HR, 0.79; 95% CI, 0.69–0.91), 3-year (HR, 0.81; 95% CI, 0.75–0.89), 5-year (HR, 0.85; 95% CI, 0.79–0.92), and 7-year (HR, 0.86; 95%

TABLE 1 Baseline characteristics of patients according to MNA-SF and MNA-LF categories

	MNA-SF ($n = 209$)				MNA-LF ($n = 209$)			
	Normal ($n = 112$)	At risk ($n = 66$)	Malnutrition ($n = 31$)	P value[a]	Normal ($n = 121$)	At risk ($n = 62$)	Malnutrition ($n = 26$)	P value[a]
Age, years (range)	73.5 (65–94)[b]	77.5 (65–96)	81 (65–89)	<0.001	74 (65–94)[b]	78 (65–96)	81.5 (65–89)	0.001
Charlson comorbidity index	4 (3–5)[b]	4 (4–5)	5 (4–6)	<0.001	4 (3–5)[b]	4 (4–5)	5 (4–6)	<0.001
Sex, female, n (%)	68 (60.7)	47 (66.2)	24 (64.9)	0.890	71 (58.7)	43 (69.4)	16 (61.5)	0.369
Follow-up time, months	94.3 (93.3–94.8)[b]	90.0 (34.7–94.0)[b]	33.3 (9.5–91.1)[b]	<0.001	94.2 (91.4–94.8)[b]	90.9 (34.9–94.1)[b]	27 (6.9–78.6)[b]	<0.001
Anthropometric measures								
BMI	28.2 (25.1–31.9)[b]	25.4 (22.4–28.8)[b]	21.2 (19.3–24.3)[b]	<0.001	28.2 (25.1–31.6)[b]	25.5 (22.4–29.6)[b]	20.9 (20.2–23.1)[b]	<0.001
Mid-arm circumference, cm	30.3 ± 4.3[b]	27.0 ± 4.2[b]	23.8 ± 4.0[b]	<0.001	30.2 ± 4.1[b]	27.0 ± 4.6[b]	22.6 ± 2.0[b]	<0.001
Calf circumference, cm	37.3 ± 4.3[b]	34.4 ± 4.2[b]	30.2 ± 4.1[b]	<0.001	37.2 ± 4.1[b]	34.2 ± 4.8[b]	29.4 ± 2.9[b]	<0.001
Handgrip strength, kg	24.1 (19.3–29.1)[b]	16.8 (13.6–23.6)[b]	13.5 (9.3–17.7)[b]	<0.001	23.3 (18.9–29.4)[b]	17.0 (13.9–21.6)[b]	12.5 (8.5–16.3)[b]	<0.001
Laboratory values								
Serum albumin level, g/dl	4.4 (4.2–4.6)	4.3 (4.0–4.6)	3.9 (3.6–4.3)[b]	<0.001	4.4 (4.2–4.6)	4.3 (3.9–4.6)	3.8 (3.6–4.3)[b]	<0.001
Serum prealbumin level, mg/dl	22.7 (19.9–25.7)	21.4 (18.3–24.5)	19.4 (13.6–24.9)	0.018*	22.6 (19.9–25.6)	21.7 (18.4–25.5)	17.9 (12.2–21.9)	0.002*
CRP, mg/dl	0.5 (0.3–1.0)	0.8 (0.2–1.6)	0.8 (0.4–2.6)	0.115	0.5 (0.3–1.1)	0.8 (0.2–1.6)	0.9 (0.6–2.5)	0.053
White blood cell, $\times 10^{b}$ U/L	6.4 (5.6–7.6)	6.8 (5.5–8.0)	7.8 (6.0–10.5)	0.014*	6.5 (5.7–7.7)	6.8 (5.5–8.0)	7.6 (5.9–10.3)	0.129
Geriatric assessments								
IADL	24 (24–24)[b]	15.5 (6.7–24)[b]	5 (0–18)[b]	<0.001	24 (23.5–24)[b]	16 (7–24)[b]	1.5 (0–16.2)[b]	<0.001
MMSE scores	28 (27–29)[b]	26 (22.5–28)[b]	20 (10.7–27)[b]	<0.001	28 (27–29)[b]	27 (23–28)[b]	20 (6.5–27)[b]	<0.001
GDS-15 scores	0 (0–1)[b]	3 (0–5)	5 (2.5–6)	<0.001	0 (0–2)[b]	3 (0–5.5)	5 (2.5–6)	<0.001

Notes: As appropriate, numbers are means ± SD, medians (25th–75th percentiles), or frequencies (%). BMI is calculated as weight in kilograms divided by height in meters squared.

Abbreviations: BMI, body mass index; CRP, C-reactive protein; GDS, Geriatric Depression Scale; IADL, instrumental activities of daily living; MMSE, Mini-Mental State Examination; MNA-LF, Mini Nutritional Assessment-Long Form; MNA-SF, Mini Nutritional Assessment-Short Form.

[a]P values were for the comparison across the three subgroups.

[b]The groups which the differences were originated from according to post hoc analyses.

*Statistically different between normal and malnutrition groups.

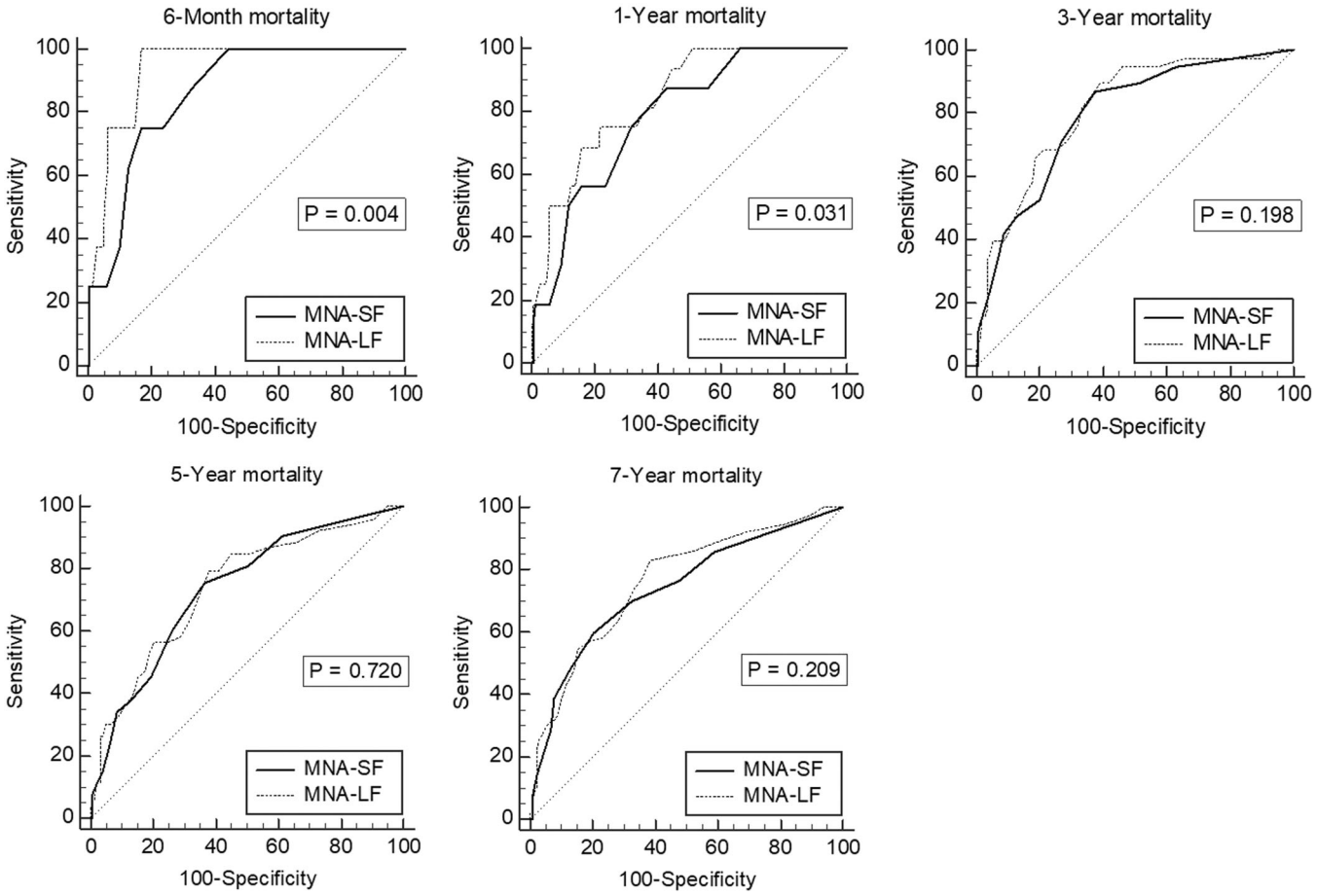

FIGURE 1 Comparisons of receiver operating characteristic curves for MNA-SF and MNA-LF according to years. MNA-LF, Mini Nutritional Assessment-Long Form; MNA-SF, Mini Nutritional Assessment-Short Form

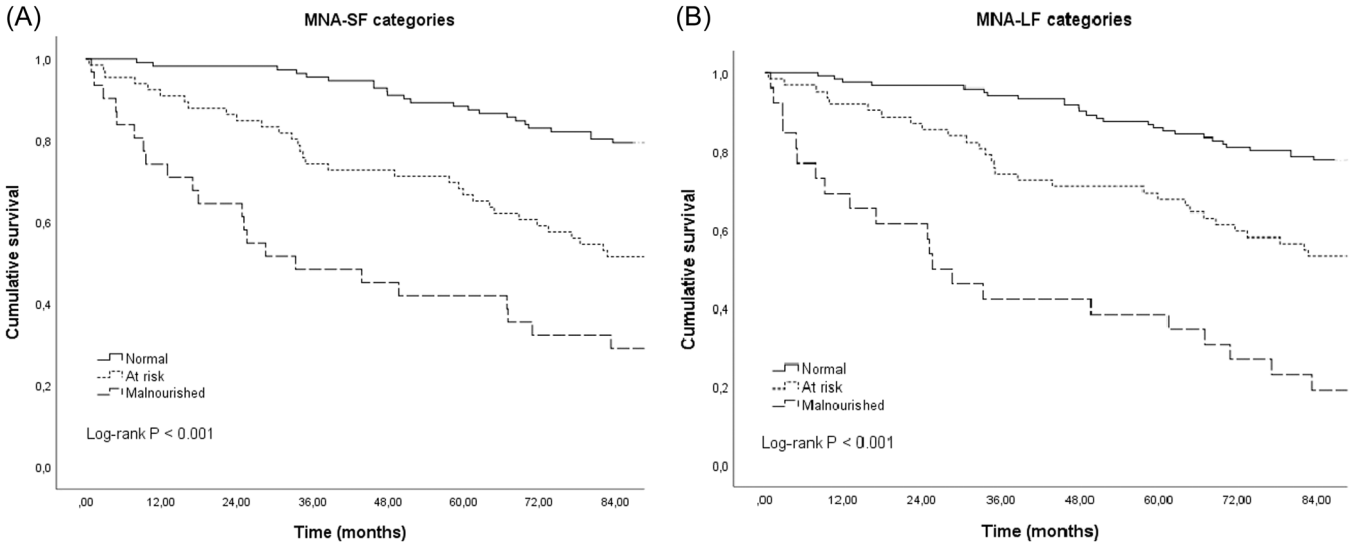

FIGURE 2 Kaplan-Meier survival curves according to (A) MNA-SF categories and (B) MNA-LF categories. MNA-LF, Mini Nutritional Assessment-Long Form; MNA-SF, Mini Nutritional Assessment-Short Form

TABLE 2 Survival rates according to years for MNA-SF and MNA-LF categories

	MNA-SF ($n = 209$)			MNA-LF ($n = 209$)		
Survival	Normal ($n = 112$)	At risk ($n = 66$)	Malnutrition ($n = 31$)	Normal ($n = 121$)	At risk ($n = 62$)	Malnutrition ($n = 26$)
6-Month, *n* (%)	112 (100)	63 (95.5)	26 (83.9)	121 (100)	60 (96.8)	20 (96.2)
1-Year, *n* (%)	110 (98.2)	60 (90.9)	23 (74.2)	118 (97.5)	57 (91.9)	18 (69.2)
3-Year, *n* (%)	107 (95.5)	49 (74.2)	15 (48.4)	114 (94.2)	46 (74.2)	11 (42.3)
5-Year, *n* (%)	99 (88.4)	44 (66.7)	13 (41.9)	104 (86.0)	42 (67.7)	10 (38.5)
7-Year, *n* (%)	89 (79.5)	34 (51.5)	9 (29.0)	94 (77.7)	33 (53.2)	5 (19.2)

Abbreviations: MNA-LF, Mini Nutritional Assessment-Long Form; MNA-SF, Mini Nutritional Assessment-Short Form.

CI, 0.81–0.92) mortality. MNA-LF was significantly associated with 6-month (HR, 0.72; 95% CI, 0.62–0.83), 1-year (HR, 0.82; 95% CI, 0.75–0.90), 3-year (HR, 0.86; 95% CI, 0.82–0.91), 5-year (HR, 0.90; 95% CI, 0.85–0.94), and 7-year (HR, 0.90; 95% CI, 0.87–0.94) mortality as well.

DISCUSSION

In the present study, MNA-SF was shown to predict the risk of mortality from 6 months to 7 years. As MNA-LF was known to predict long-term mortality, estimating capacities of both MNA-SF and MNA-LF to predict mortality were compared. MNA-LF was superior to MNA-SF only for predicting 6-month and 1-year mortality. To the best of our knowledge, this is the first study investigating the predictive ability of both MNA-SF and MNA-LF in comparison with short-term and long-term mortality risk among geriatric outpatients. A cut-off value of 11, indicating malnutrition risk according to MNA-SF, was found to be associated with long-term mortality as well.

MNA-LF was developed in 1994 specifically for nutrition screening and assessment of geriatric patients, and it has large acceptance worldwide in various settings. MNA-LF provides a multidimensional approach for assessing older people and takes about 15 min to perform.[11] It was proven to predict short-term and long-term mortality in numerous studies,[24–29] and it was used as a reference method for the validation of other nutrition screening tools.[8,12,30] Subsequently, MNA-SF was developed as a quick and practical method.[22,23] It takes <5 min and does not require any special training or laboratory values. Currently, MNA-SF, MUST, and NRS-2002 are the most accepted tools for malnutrition screening of older adults. However, MNA-SF was superior to others at some points. It contains questions about mobility, psychological stress or acute disease, and neuropsychological problems, and these parameters are related to sarcopenia and frailty, which are important geriatric syndromes. Moreover, it is well known that these three common geriatric syndromes—malnutrition, sarcopenia, and frailty—share common pathophysiological mechanisms and interact with each other.[4,31,32] In line with these data, preventing and screening malnutrition as well as finding and following individuals at risk of malnutrition are crucial. In addition, there were studies supporting the use of MNA-SF for frailty screening in older adults.[16,17]

There are few and insufficient data about the effect of MNA-SF on all-cause mortality, especially in geriatric outpatients. On the other hand, the comparison of the MNA-SF with MNA-LF is not well studied. Kiesswetter et al compared MNA-SF and MNA-LF to predict 1-year mortality among 309 community-dwelling older adults and found that MNA-LF was superior to MNA-SF (at risk of malnutrition: HR = 2.21; 95% CI = 1.02–4.75 vs HR = 5.05; 95% CI = 1.53–16.58; malnourished: HR = 3.27, 95% CI = 1.34–8.02 vs HR = 8.75; 95% CI = 2.45–31.18 by MNA-SF and MN-LF, respectively). Nevertheless, patients at risk of malnutrition had a 2.21-fold and 5.05-fold higher risk for mortality according to MNA-SF and MNA-LF, respectively. As they discussed in their paper, a longer observation period was needed.[33] In our study, both MNA-SF and MNA-LF predicted short- and long-term mortality, and MNA-LF was superior to MNA-SF for 6-month and 1-year mortality similar to the study by Kiesswetter et al; however, there was no difference between these two tools regarding 3-year, 5-year, and 7-year mortality risk estimation. In this study, a cut-off point of 11 for MNA-SF best-predicted 1-year, 3-year, and 5-year mortality, and a cut-off point of 10 for MNA-SF best-predicted 7-year mortality. These findings mean that patients at risk of malnutrition are also at risk of long-term mortality (from 1 year to 7 years) according to

TABLE 3 Receiver operating characteristic analysis of MNA-SF and MNA-LF scores for mortality prediction according to years

	MNA-SF				MNA-LF			
Mortality prediction	**Cut-off**	**AUC (95% CI)**	**Sensitivity**	**Specificity**	**Cut-off**	**AUC (95% CI)**	**Sensitivity**	**Specificity**
6-Month	≤8	0.858 (0.803–0.902)	75.0	83.0	≤18.5	0.935 (0.893–0.965)	100.0	83.0
1-Year	≤11	0.786 (0.724–0.840)	87.5	57.0	≤20.5	0.841 (0.784–0.888)	75.0	78.2
3-Year	≤11	0.791 (0.730–0.844)	86.8	62.6	≤24	0.813 (0.754–0.864)	89.5	60.8
5-Year	≤11	0.734 (0.669–0.793)	75.5	63.5	≤24	0.740 (0.675–0.798)	79.2	62.2
7-Year	≤10	0.740 (0.675–0.798)	59.7	79.5	≤25	0.764 (0.700–0.819)	83.1	61.4

Abbreviations: AUC, area under the curve; MNA-LF, Mini Nutritional Assessment-Long Form; MNA-SF, Mini Nutritional Assessment-Short Form.

TABLE 4 Cox regression for the association between nutrition parameters and all-cause mortality according to years

Variables	**6-Month mortality**		**1-Year mortality**		**3-Year mortality**		**5-Year mortality**		**7-Year mortality**	
Model[a]	**HR (95% CI)**	***P* value**	**HR (95% CI)**	***P* value**	**HR (95% CI)**	***P* value**	**HR (95% CI)**	***P* value**	**HR (95% CI)**	***P* value**
BMI	0.85 (0.72–0.99)	0.045*	0.90 (0.81–1.00)	0.073	0.91 (0.84–0.98)	0.024*	0.93 (0.88–0.99)	0.043*	0.93 (0.89–0.98)	0.016*
MAC, cm	0.63 (0.49–0.81)	<0.001*	0.73 (0.61–0.88)	0.001*	0.76 (0.68–0.86)	<0.001*	0.80 (0.74–0.87)	<0.001*	0.86 (0.80–0.92)	<0.001*
CC, cm	0.80 (0.69–0.94)	0.008*	0.93 (0.84–1.06)	0.209	0.89 (0.82–0.97)	0.010*	0.93 (0.87–1.00)	0.056	0.95 (0.89–1.00)	0.070
HGS, kg	0.71 (0.59-.086)	<0.001*	0.86 (0.78–0.96)	0.006*	0.88 (0.82–0.94)	<0.001*	0.87 (0.83–0.91)	<0.001*	0.91 (0.88–0.95)	<0.001*
Serum albumin level, g/dl	0.18 (0.06–0.47)	0.001*	0.20 (0.07–0.58)	0.003*	0.21 (0.10–0.47)	<0.001*	0.20 (0.11–0.39)	<0.001*	0.34 (0.16–0.68)	0.003*
CRP, mg/dl	1.04 (0.95–1.13)	0.347	0.20 (0.02–1.61)	0.132	1.03 (1.00–1.06)	0.031*	1.04 (1.01–1.06)	0.007*	1.03 (1.00–1.06)	0.044*
MNA-SF score	0.69 (0.57–0.84)	<0.001*	0.79 (0.69–0.91)	0.001*	0.81 (0.75–0.89)	<0.001*	0.85 (0.79–0.92)	<0.001*	0.86 (0.81–0.92)	<0.001*
MNA-LF score	0.72 (0.62–0.83)	<0.001*	0.82 (0.75–0.90)	<0.001*	0.86 (0.82–0.91)	<0.001*	0.90 (0.85–0.94)	<0.001*	0.90 (0.87–0.94)	<0.001*

Note: BMI is calculated as weight in kilograms divided by height in meters squared.

Abbreviations: BMI, body mass index; CC, calf circumference; CRP, C-reactive protein; HGS, handgrip strength; HR, hazard ratio; MAC, mid-upper arm circumference; MNA-LF, Mini Nutritional Assessment-Long Form; MNA-SF, Mini Nutritional Assessment-Short Form.

[a]Model: Each variable was adjusted for sex (categorical), age, and Charlson comorbidity index.

*$P < 0.05$.

MNA-SF. These data highlight the importance of finding patients at risk of malnutrition.

To the best of our knowledge, there is only one study comparing MNA-SF and MNA-LF for mortality prediction for up to 4 years.[34] Wang et al performed this study by using datasets of the Taiwan Longitudinal Survey on aging, including 2872 older patients, and compared MNA-SF (Taiwanese-specific version containing CC instead of BMI) and MNA-LF. MNA-SF was found to be at least as effective as MNA-LF for mortality prediction, similar to our study. However, whereas most participants in this study were community-living, there were participants from long-term care settings. Independent analysis for different settings was not available. On the other hand, they used the modified version of MNA-SF by using CC. Our study population included only geriatric outpatients, and we used the first version of MNA-SF (using BMI) and followed patients for 7 years presenting short- and long-term mortality predictions. In another study, the MNA-SF score was found to be independently associated with 2-year mortality in patients on dialysis when compared with MNA-LF (HR, 0.86; 95% CI, 0.75–0.98 per point).[35] This study was in line with our study. However, 75 (34.7%) of 216 patients were aged <65 years and the study included a specific disease group.

There were two published studies including outpatients with heart failure but not specific to geriatric patients.[36,37] The first study evaluated the association of MNA and subjective global assessment with 2-year mortality and only MNA was found to be an independent predictor of 2-year mortality.[36] They also evaluated the diagnostic evaluation of MNA-SF, Malnutrition Screening Tool (MST), and MUST for detecting malnutrition or the risk of malnutrition by using MNA-LF as the reference method, and MNA-SF was found to be a better screening method than MST or MUST. But, they did not assess the MNA-SF for mortality prediction and this study was not specific to older adults and did not include geriatric assessment.[36] In the second study (aged 69 ± 11.5 years), MNA-SF was effective in predicting mortality (mean follow up, 23.8 ± 6.6 months) for heart failure with mid-range left ventricular ejection fraction but not for heart failure with reduced/preserved left ventricular ejection fraction in the multivariable analysis in outpatients.[37] However, it supported the strong ability of MNA-SF to predict long-term mortality like ours, but for a specific group.

There are emerging studies supporting the strong ability of MNA-SF to predict mortality in hospital settings, nursing homes, and emergency departments.[38–45] For example, Hakim et al compared nutrition tools MNA-SF, NRS-2002, and MUST in older patients who were operated on due to hip fracture, and showed the superiority of MNA-SF for 36-month mortality and there were significant differences between MNA-SF categories.[39] Similar to that study, Helminen et al supported the superiority of MNA-SF on NRS-2002 in older patients with hip fracture on 4-month mortality.[38] MNA-SF was shown as an effective tool to predict 30-month mortality in a nursing home in Japan.[40] Also in another study in 13 French nursing homes ($n = 773$), MNA-SF was found to be independently associated with 1-year mortality.[41] A 9-year retrospective study in a nursing home showed MNA-SF (both the risk of malnutrition and malnutrition) to be related to 9-year mortality.[42] MNA-SF was shown to predict short-term mortality in emergency departments for up to three months.[43,44] However, MNA-SF was not compared with MNA-LF in all these studies, and all of them included specific groups. These patient groups usually have acute illnesses and are more prone to have common geriatrics syndromes. The patients who applied to outpatient clinics are the most important group, which can be detected at the time of malnutrition risk before overt malnutrition develops and can be intervened. In this study, we showed the ability of MNA-SF to predict all-cause mortality, especially for patients with a risk of malnutrition.

In our study, whereas there were 66 (31.6%) and 62 (29.7%) patients at risk of malnutrition, the number of patients with malnutrition were 31 (14.8%) and 26 (12.4%) according to MNA-SF and MNA-LF, respectively. In a large meta-analysis, including 240 studies using MNA-LF mainly from Europe ($n = 159$) and Asia ($n = 40$), the prevalence of malnutrition was 6.0%, and malnutrition risk was 30.9% for outpatients.[46] The rate of patients at risk of malnutrition in our study was similar to that prevalence study. Nutrition screening is getting more crucial in the aging world not only to find malnourished patients but also for patients at risk of malnutrition (~30% for outpatients) because of its relation to long-term mortality, independently. Finding and following patients with risk of malnutrition are targeted to prevent and reverse sarcopenia and frailty, recently.

In this study, we also showed that not only MNA-LF and MNA-SF but also MAC, HGS, and serum albumin level were significantly and independently associated with mortality from 6 months to 7 years in geriatric outpatients. Helminen et al showed serum albumin level as the strong prognostic indicator of mortality (1-year mortality) in patients with hip fracture.[47] In a nursing home study including 144 newly admitted patients; low CC, low serum albumin levels, MNA-SF, and BMI had a relation to 18-month mortality.[48] MAC and HGS are

parameters associated with both malnutrition and sarcopenia. Therefore, their association with long-term mortality is not surprising.

Strengths and limitations

There are some strengths of this study. First, it provided data about the association between MNA-SF and long-term (7-year) mortality based on MNA-LF as a reference in geriatric outpatients with comprehensive geriatric assessment. Moreover, it provided data about the effect of other nutrition-related parameters on mortality prediction.

There were some limitations of this study. First, it had a retrospective design and data were obtained from a previous index study, and only the survival of the patients during the 7 years was available. Second, we had no data about the frailty status. Therefore, studies assessing frailty and sarcopenia besides nutrition status are needed for the future.

In conclusion, this study found the independent capacity of MNA-SF to predict short-term and long-term mortality up to 7 years in geriatric outpatients compared with MNA-LF. A cut-off value of 11, indicating malnutrition risk according to MNA-SF, may be used for the risk estimation of 1-year, 3-year, and 5-year mortality. On the other hand, the findings of the study emphasize the importance of screening all geriatric outpatients for malnutrition and especially for risk of malnutrition using MNA-SF and encourage healthcare workers for effective intervention and targeting modifiable factors.

AUTHOR CONTRIBUTIONS

Yelda Ozturk and Meltem Halil equally contributed to the conception and design of the research; Mehmet Emin Kuyumcu and Fatih Yesil contributed to the design of the research; Meltem Koca and Cafer Balci contributed to the acquisition and analysis of the data; Pelin Unsal and Merve Guner Oytun contributed to the analysis of the data; Burcu Balam Dogu and Mustafa Cankurtaran contributed to the acquisition, analysis, and interpretation of the data. All authors drafted the manuscript, critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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