Poor nutritional habits are predictors of poor outcome in very old hospitalized patients[1,2]

Nadya Kagansky, Yitshal Berner, Nira Koren-Morag, Luiza Perelman, Hilla Knobler, and Shmuel Levy

ABSTRACT

Background: Malnutrition is prevalent in elderly populations. Recommended methods of nutritional screening are often too complicated and time-consuming for routine application in frail, very old, hospitalized patients.

Objective: Our aims were to identify risk factors for development of malnutrition in very old hospitalized patients and to evaluate the total Mini Nutritional Assessment (MNA) score and MNA subscores as predictors of in-hospital and long-term mortality.

Design: A prospective cohort study of patients aged ≥75 y was conducted in a geriatric hospital. Assessment included demographic, clinical, and laboratory data and cognitive, functional, and nutritional status. Follow-up was conducted for ≤2.7 y.

Results: Of the 414 patients studied, only 73 (17.6%) were well-nourished. Low serum albumin and phosphorus concentrations, dementia, and cerebrovascular accident (CVA) were significant risk factors for malnutrition. Survival was significantly lower in malnourished patients and patients at risk of malnutrition than in well-nourished patients ($P < 0.0001$). Low MNA-3 subscores (dietary habits) were significantly correlated with laboratory indexes of malnutrition and were significantly lower in patients with infections, malignancy, pressure ulcers, dementia, recent orthopedic surgery, and CVA. Multivariate analysis showed that a low MNA-3 score was an independent predictor of mortality; scores <7.5 increased the risk of death 2.05-fold.

Conclusions: The prevalence of malnutrition was high in elderly hospitalized patients. Dietary habits were significant predictors of poor hospitalization outcome. A questionnaire on dietary habits can serve as a useful tool in assessing nutritional status and prognosis in elderly patients.   *Am J Clin Nutr* 2005;82:784–91.

KEY WORDS   Nutritional habits, elderly, hospitalization, Mini Nutritional Assessment

INTRODUCTION

Malnutrition is prevalent in elderly populations, even in the developed world (1–7). Among hospitalized elderly, nutritional status is even poorer (4, 5). Protein-energy malnutrition has been reported in up to 15% of community-dwelling and home-bound elderly individuals, up to 62% of hospitalized elderly patients, and up to 85% of residents of nursing homes (1, 6, 8, 9). Many studies have shown that poor nutrition leads to complications during hospitalization and increases mortality (10–16).

Poor nutritional status in the elderly is associated with numerous factors, including decline in cognitive and functional status, chronic diseases, medications, poor dentition, isolation, and poverty (17–20). The nutritional status of elderly individuals is difficult to estimate. Recommended nutritional screening methods and questionnaires are often too complicated and time-consuming to be routinely applied in frail hospitalized elderly (21–25). Obtaining the cooperation of such patients, a prerequisite for the use of such tools, is often problematic owing to the patients' frailty and because of multiple comorbidities and treatment regimens (26). Cognitive decline frequently contributes further to difficulties in assessment because of difficulties in obtaining correct information (17, 26, 27). An additional problem is that the interpretation of biochemical markers of malnutrition is not clear-cut in the elderly (28–30). Furthermore, medical teams are often insufficiently aware of the importance of nutritional assessment in elderly patients (31, 32).

The Mini Nutritional Assessment (MNA) is a relatively new comprehensive tool that was developed for nutritional assessment in geriatric settings (33–35). The European Society of Parenteral and Enteral Nutrition, in its guidelines for nutritional screening, recommends the use of this screening tool in the elderly (36–39). Its validity, however, is still questionable (40, 41). It is time-consuming, and attempts have been made to simplify it (42). Different parts of the MNA assess different components of nutritional status: anthropometric measurements, comorbidities, dietary habits, and subjective nutritional assessment (33–35). Most studies have examined the significance of total MNA scores, and only a few have addressed its specific questions separately (43–46). The objectives of the present study were the following: to identify risk factors associated with the development of malnutrition in very old hospitalized patients and to assess the ability of the MNA total score and subscores to predict in-hospital and long-term mortality.

SUBJECTS AND METHODS

Setting

The study was conducted at Kaplan-Harzfeld Medical Center, an 880-bed community hospital with a 352-bed geriatric unit. The center serves a population of 450 000 persons in the central part of Israel. Patients' charts and laboratory data have been computerized since 1997. The study was performed according to the responsible committee on human experimentation.

Study design and patients

During the study period, 520 patients aged ≥75 y were admitted to the hospital's geriatric wards and were enrolled in this prospective study. Of these, 106 patients were excluded from the study: 52 were excluded because of severe cognitive impairment that interfered with MNA administration, 20 because of severe hearing loss, 3 because of speech disturbances, and 31 patients with no particular complaint. The 414 patients who were finally included in the study were followed up during hospitalization and for up to 2.7 y from the time of admission. The duration of hospitalization and mortality were recorded.

A single well-trained research geriatrician was responsible for collecting demographic (age, sex) and clinical data (causes of hospitalization, previously known illnesses, and detailed information on drug treatment). All of the basic data were collected within 3 days of admission.

Nutritional assessment

Nutritional status was assessed by using the MNA (33), a questionnaire in which nutritional status is classified on the following 30-point scale: 24–30, well-nourished; 17–23.5, at risk of malnutrition; and <17; malnourished. The MNA score incorporates 4 component subscores: MNA-1 (4 items), anthropometric measurement (0–8 points); MNA-2 (6 items), global evaluation (0–9 points); MNA-3 (6 items), assessment of dietetic habits (0–9 points); and MNA-4 (2 items), subjective assessment of self-perceived quality of health and nutrition (0–4 points). Nutritional assessment with the MNA is part of routine geriatric assessment in our hospital.

The MNA-3 component comprises questions relating to the number of full meals the patient eats daily; the consumption of dairy products, protein, fruit, and vegetables; the reasons for any decline in food intake over the previous 3 mo (such as loss of appetite, digestive problems, or chewing or swallowing difficulties); daily fluid consumption; and mode of feeding. Mobility and cognitive status are assessed as part of the MNA-2 subscore (global evaluation). In addition to the MNA assessment, we obtained patients' scores on the short-form MNA (MNA-SF), a 6-item variant of the MNA screening test (47).

Laboratory methods

Blood samples were obtained at admission and were examined in the hospital's clinical chemistry laboratory. In addition to total blood count, samples were tested for renal function, thyroid function, vitamin B-12 concentration, transferrin, cholesterol, triacylglycerol, electrolytes, albumin, and C-reactive protein. The laboratory data were converted from conventional units to SI units by using conversion factors of 10 for albumin and 0.323 for phosphorus. For biochemical assays, we used a Roche-Hitachi analyzer (Mannheim, Germany).

Statistical analysis

Data are expressed as means ± SDs for continuous variables and as frequencies and percentages for categorical variables. Differences in nutritional status were analyzed by ANOVA for continuous variables and by the chi-square test for categorical variables. Pearson correlation coefficients were calculated for linear relations between total MNA scores or MNA subscores and the laboratory measures. MNA subscores were analyzed by Student's t tests for continuous variables and by the chi-square test for categorical variables. Multivariate analyses with forward logistic regression were used to estimate the probabilities of malnutrition and death. Odds ratios (ORs) and their 95% CIs were computed for all variables in the model.

Patients' total MNA scores were classified into 3 groups (MNA < 17, 17 < MNA ≤ 23.5, and MNA > 23.5) and were compared by assessment of survival curves. The model's goodness-of-fit was assessed by the Hosmer-Lemeshow test. A receiver operating characteristic (ROC) curve was created for each of the 2 models (with MNA and with MNA-3) by using the computed probabilities from the logistic regression models. The ROC curve plots the 1 minus specificity (the proportion of false positives) versus the sensitivity of each possible cutoff on the continuum of the predictor variable (estimated probability from the model). An area under the curve of ≥0.5 shows the ability of the model to predict the hard event (in this case, mortality). All statistical computations were 2-tailed. Data were analyzed by using SPSS software version 12.0 (SPSS Inc, Chicago, IL).

RESULTS

Patients' demographic and clinical characteristics

The mean age of the patients included in the study was 84.8 ± 6.1 y (range: 75–103 y). Females were preponderant (65.7%). Most of the patients (71.7%) had lived at home before hospitalization; one-half of them (52.4%) were bed- or chair-bound, and 25.4% had a diagnosis of moderate to severe cognitive decline. Diabetes mellitus, congestive heart failure, and cardiovascular diseases were prevalent. As many as 69.3% reported moderate to severe loss of appetite, and 16.7% reported a loss in weight of >3 kg during the previous 3 mo. Most of the patients (72.5%) ate 3 meals per day. Mean body mass index (in kg/m^2) was 23.6 ± 4.5 (range: 10.5–38.8), and the mean MNA score was 17.4 ± 5.6 (range: 4.5–28.0). Patients were receiving an average of 4.8 ± 2.7 different medications.

The mean age of the 106 excluded patients was 84.2 ± 7.3 y, their mean body mass index was 22.9 ± 4.2, and 64.9% were females. None of these characteristics differed significantly from those of the included patients.

Recorded in **Table 1** are the demographic, clinical, and laboratory characteristics of the patients in the different nutritional status groups as defined by their total MNA scores (*see* Subjects and Methods). Only 73 (17.6%) of the patients were well-nourished, 137 (33.2%) were at risk of malnutrition, and 204 (49.4%) were malnourished. ANOVA (for continuous variables) and chi-square test (for categorical variables) showed that patients who were malnourished or at risk of malnutrition were significantly older than the well-nourished patients. Compared with the numbers of well-nourished patients, there were ≈10 times as many who were malnourished in the subgroups of patients with cerebrovascular accident (CVA) or dementia and

TABLE 1
Clinical and laboratory variables in patients with different nutritional status according to Mini Nutritional Assessment (MNA) score

	MNA > 23.5 (n = 21 M, 51 F)	17 ≤ MNA ≤ 23.5 (n = 46 M, 91 F)	MNA < 17 (n = 75 M, 129 F)	P^1
Age (y)	83.5 ± 5.42^2	84.2 ± 6.2	85.6 ± 6.2	0.020
Sex (% M/% F)	(29.2/70.8)	(33.6/66.4)	(36.8/63.2)	
Cerebrovascular accident, n = 103 (%)	7 (6.8)	28 (27.2)	68 (66.1)	< 0.0001
Dementia, n = 107 (%)	6 (5.6)	22 (20.6)	79 (73.8)	< 0.0001
Infection, n = 101 (%)	9 (8.9)	30 (29.7)	62 (61.4)	0.007
Malignancy, n = 73 (%)	7 (9.6)	18 (24.7)	48 (65.8)	0.002
Postorthopedic rehabilitation, n = 159 (%)	51 (32.1)	52 (32.7)	56 (35.2)	< 0.0001
Pressure ulcers, n = 61 (%)	9 (14.8)	12 (19.7)	40 (66.5)	0.018
Cholesterol (mmol/L)	4.6 ± 1.3	4.4 ± 1.1	4.2 ± 1.3	0.019
Albumin (g/L)	33.1 ± 4.2	31.3 ± 5.1	28.1 ± 5.2	< 0.0001
Hemoglobin (g/L)	120.1 ± 15.4	113.2 ± 16.1	111.5 ± 16.2	< 0.0001
Transferrin (g/L)	2.3 ± 0.6	1.94 ± 0.5	1.6 ± 0.50	< 0.0001
Phosphorus (mmol/L)	1.1 ± 0.1	1.0 ± 0.2	0.9 ± 0.2	< 0.0001
Total lymphocyte count (×10⁹/L)	2.3 ± 5.9	1.6 ± 0.9	1.9 ± 5.1	0.525

[1] ANOVA test for continuous variables and chi-square test for categorical variables.
[2] $\bar{x} \pm$ SD (all such values).

almost 7 times as many in the subgroups with infections or malignancy. Serum concentrations of laboratory indexes known to reflect the nutritional state (cholesterol, albumin, hemoglobin, transferrin, and phosphorus) showed significant differences among the 3 nutritional-status groups but no significant differences with respect to the following laboratory data: white blood cell count (10.4 ± 8.1, 10.6 ± 10.1, and 11.3 ± 9.2 cells ×10⁹/L in the well-nourished, at risk, and malnourished groups, respectively; $P = 0.756$), serum concentration of ferritin (324 ± 363, 312 ± 293, and 309 ± 402 μg/L, respectively; $P = 0.944$), and creatinine (87.5 ± 55.7, 105.2 ± 83.9, and 1.01 ± 0.39 μmol/L, respectively; $P = 0.083$).

Relations between laboratory indexes and MNA total score or subscores

Relations between the laboratory and clinical indexes and the total MNA score or subscores were determined by Pearson's correlations (**Table 2**). MNA subscores were significantly correlated with the total MNA score. Serum concentrations of transferrin, albumin, and phosphorus were highly correlated with the total MNA score ($r = 0.42$, 0.43, and 0.33, respectively) and with the MNA-3 subscore ($r = 0.40$, 0.41, and 0.34, respectively).

Cholesterol, hemoglobin, and C-reactive protein were significantly correlated with the total MNA score and with the MNA-3 subscore (C-reactive protein inversely), but correlations with the other MNA subscores were less consistent. Total lymphocyte counts showed no correlation with the total MNA score or any of the subscores.

All patients with total MNA scores >23.5 ($n = 73$) had MNA-3 subscores >7.5 (range: 7.7–9.0). By contrast, all patients whose total MNA scores were <17 ($n = 204$) had MNA-3 subscores <7.5 (range: 0–7.5). In patients whose total MNA scores ranged between 17 and 23.5, the MNA-3 subscores were >4 and <9.

MNA total score and subscores in patients with different medical conditions

Student's *t* tests were used to compare the MNA total score and subscores in patients with and without CVA, rehabilitation after orthopedic surgery, infections, pressure ulcers, dementia, and malignancy (**Table 3**). Both the total MNA score and the MNA-3 subscore were significantly lower in patients with any of these medical conditions than in patients without them. The MNA-1 subscore did not differ significantly between patients with and

TABLE 2
Pearson correlations between the total Mini Nutritional Assessment (MNA) score or subscores and laboratory indexes[1]

	MNA	MNA-1	MNA-2	MNA-3	MNA-4
MNA score	1	0.74^2	0.72^2	0.87^2	0.71^2
Age (y)	-0.16^2	-0.15^2	-0.12	-0.14	-0.04
Transferrin (g/L)	0.42^2	0.10^2	0.24^2	0.40^2	0.30^2
Albumin (g/L)	0.43^2	0.28^2	0.29^2	0.41^2	0.33^2
Phosphorus (mmol/L)	0.33^2	0.15^2	0.29^2	0.34^2	0.19^2
Cholesterol (mmol/L)	0.18^2	0.10^2	0.12^2	0.17^2	0.17^2
Hb (g/L)	0.22^2	0.18^2	0.08	0.20^2	0.22^2
CRP (g/L)	-0.11^2	-0.10	-0.02	-0.12^2	-0.08
Urea:creatinine [(mmol/L)/(μmol/L)]	-0.17^2	-0.04	-0.16^2	-0.19^2	-0.10^2
TLC (×10⁹/L)	0.01	-0.01	0.01	0.01	0.02

[1] n = 414. CRP, C-reactive protein; Hb, hemoglobin; MNA-1 subscore, anthropometric measurements; MNA-2 subscore, global assessment; MNA-3 subscore, dietary questionnaire; MNA-4 subscore, subjective assessment; TLC, total lymphocyte count.
[2] Pearson correlation significant at the 0.05 level (2-tailed).

TABLE 3
Mini Nutritional Assessment (MNA) total score and subscores in patients with and without different medical conditions[1]

	MNA (range: 0–30)	MNA-1 (range: 0–8)	MNA-2 (range: 0–9)	MNA-3 (range: 0–9)	MNA-4 (range: 0–4)
CVA					
Yes (n = 103)	15.2 ± 5.3[2]	4.6 ± 2.2	4.1 ± 1.9	5.1 ± 2.2	1.4 ± 0.8
No (n = 311)	18.1 ± 5.5	5.1 ± 2.2	5.2 ± 1.8	6.2 ± 2.2	1.7 ± 0.9
P[3]	< 0.0001	0.084	< 0.0001	< 0.0001	0.009
Rehabilitation after orthopedic surgery					
Yes (n = 159)	19.4 ± 5.6	5.5 ± 2.2	5.1 ± 1.8	6.8 ± 2.1	1.9 ± 0.9
No (n = 255)	16.1 ± 5.2	4.6 ± 2.1	4.7 ± 1.9	5.4 ± 2.1	1.4 ± 0.9
P	< 0.0001	< 0.0001	0.044	< 0.0001	< 0.0001
Infections					
Yes (n = 101)	16.2 ± 5.2	5.1 ± 1.9	4.2 ± 2.0	5.2 ± 2.3	1.5 ± 0.8
No (n = 313)	17.7 ± 5.6	4.9 ± 2.2	5.1 ± 1.8	6.1 ± 2.1	1.7 ± 0.9
P	0.011	0.408	< 0.0001	0.001	0.145
Pressure ulcers					
Yes (n = 61)	15.3 ± 5.9	4.4 ± 2.4	4.2 ± 2.1	5.2 ± 2.3	1.4 ± 0.8
No (n = 353)	17.8 ± 5.5	5.1 ± 2.1	5.0 ± 1.8	6.0 ± 2.2	1.6 ± 0.9
P	0.001	0.030	0.002	0.013	0.077
Dementia					
Yes (n = 107)	14.5 ± 5.2	4.2 ± 2.3	3.9 ± 1.6	5.0 ± 2.2	1.4 ± 0.8
No (n = 307)	18.4 ± 5.4	5.2 ± 2.1	5.2 ± 1.8	6.2 ± 2.1	1.7 ± 0.9
P	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.001
Malignancy					
Yes (n = 73)	15.6 ± 5.1	4.5 ± 2.2	4.4 ± 1.9	5.4 ± 2.2	1.3 ± 0.7
No (n = 341)	17.8 ± 5.7	5.1 ± 2.2	5.0 ± 1.9	6.0 ± 2.2	1.7 ± 0.9
P	0.002	0.066	0.07	0.021	0.002
Death					
Yes (n = 122)	14.9 ± 5.2	4.6 ± 2.2	4.1 ± 1.9	4.8 ± 2.2	1.3 ± 0.8
No (n = 292)	18.5 ± 5.5	5.1 ± 2.2	5.2 ± 1.8	6.3 ± 2.1	1.8 ± 0.9
P	< 0.0001	0.041	< 0.0001	< 0.0001	< 0.0001

[1] CVA, cerebrovascular accident; MNA-1 subscore, anthropometric measurements; MNA-2 subscore, global assessment; MNA-3 subscore, dietary questionnaire; MNA-4 subscore, subjective assessment.

[2] $\bar{x} \pm SD$ (all such values).

[3] Student's t tests of differences in MNA score or subscores between patients with and without disease (all such values).

without CVA, infections, or malignancy; the MNA-2 subscore did not differ significantly in patients with and without malignancy; and the MNA-4 subscore did not differ significantly in patients with and without infections and pressure ulcers.

Risk factors for malnutrition

Risk factors for malnutrition (MNA ≤ 23.5) were identified by the use of a multivariate logistic regression model (**Table 4**). The results showed that low serum albumin, dementia, CVA, and low serum phosphorus were significant risk factors for malnutrition.

TABLE 4
Risk factors for malnutrition (Mini Nutritional Assessment score ≤ 23.4)[1]

	OR (95% CI)	P
Albumin[2]	4.76 (2.56, 9.09)	< 0.001
Dementia	3.85 (1.55, 9.59)	0.004
CVA	3.73 (1.54, 8.99)	0.003
Phosphorus[3]	1.49 (1.07, 2.04)	0.017

[1] CVA, cerebrovascular accident; OR, odds ratio. Multivariate logistic regression analysis included the following variables: age, sex, CVA, rehabilitation after surgery, infections, pressure ulcers, dementia, malignancy, hemoglobin, cholesterol, transferrin, phosphorus, and albumin.

[2] Decreased by 10 g/L.

[3] Decreased by 0.323 mmol/L.

MNA and outcome of hospitalization

The median duration of hospitalization for the whole study group was 47.3 ± 62.1 d (range: 1–566 d). Duration was significantly associated with nutritional status as reflected by the MNA score and the MNA-3 subscore. It increased from 28.3 ± 27.6 d in the well-nourished group (MNA ≥ 24) to 59.9 ± 77.0 d in the malnourished group (MNA < 17) (Student's t test, $P < 0.001$) and from 27.0 ± 25.7 d in patients with MNA-3 subscores > 7.5 to 53.8 ± 70.8 d in those with MNA-3 subscores < 7.5 (Student's t test, $P < 0.001$).

During hospitalization, 122 (29.2%) of the patients died. Comparison of the test scores of patients who died during hospitalization with those of patients who survived, with use of the Student's t test (**Table 5**), showed that the total MNA score and all MNA subscores were significantly lower in those who died. Moreover, the death rate in malnourished patients (MNA < 17) was 3-fold that in the well-nourished patients (MNA > 23.5) (38.7% compared with 12.5%; chi-square test, $P < 0.001$).

Risk factors for death were identified by the use of a multivariate logistic regression analysis of the study population (**Table 6**). Low serum albumin concentration, diabetes mellitus, infections, and malignancy were found to be independent risk factors for death. A 6-point decrease in the MNA total score increased the risk of death by 1.64-fold (model 1). Replacement

TABLE 5
Mean Mini Nutritional Assessment (MNA) total score and subscores in patients who died and patients who were discharged from the hospital[1]

	Died (n = 122)	Survived (n = 292)	P[2]
MNA (range: 0–30)	14.9 ± 5.2[3]	18.5 ± 5.5	< 0.001
MNA-1 (range: 0–8)	4.6 ± 2.2	5.1 ± 2.2	0.041
MNA-2 (range: 0–9)	4.1 ± 2.0	5.2 ± 1.8	< 0.001
MNA-3 (range: 0–9)	4.8 ± 2.2	6.3 ± 2.1	< 0.001
MNA-4 (range: 0–4)	1.3 ± 0.8	1.8 ± 0.9	< 0.001

[1] n = 414. MNA-1 subscore, anthropometric measurements; MNA-2 subscore, global assessment; MNA-3 subscore, dietary questionnaire; MNA-4 subscore, subjective assessment.

[2] Student's t tests of differences in MNA scores or subscores between patients who died and patients who survived.

[3] $\bar{x}$ ± SD (all such values).

of the total MNA score in the model by each of the 4 MNA subscores and the MNA-SF score (model 2) showed that only the MNA-3 subscore was an independent predictor of mortality. An MNA-3 subscore <7.5 increased the risk of death 2.05-fold.

We stratified the analyses by sex, age (< and >85 y), and body mass index (< and >20). These variables did not show any significant interaction with other variables in the model, nor were they significant independent predictors of malnutrition or mortality.

During a follow-up period of up to 2.7 y, we compared the survival curves of the patients in the 3 nutritional groups (**Figure 1**). Survival rates in malnourished patients and in patients at risk of malnutrition were significantly lower than in the group of well-nourished patients (log-rank test, P = 0.003).

TABLE 6
Risk factors for mortality, including total Mini Nutritional Assessment (MNA) score (model 1) and subscores (model 2)[1]

Risk factor	OR (95% CI)	P
Model 1		
Albumin[2]	2.32 (1.41, 3.85)	0.001
DM	2.29 (1.33, 3.97)	0.003
Infections	1.93 (1.14, 3.27)	0.014
Malignancy	1.80 (1.02, 3.19)	0.043
MNA[3]	1.64 (1.23, 2.17)	0.001
Model 2		
Albumin[2]	3.01 (1.89, 4.76)	0.0001
DM	2.06 (1.22, 3.49)	0.007
MNA-3[4]	2.05 (1.08, 3.91)	0.028

[1] DM, diabetes mellitus; MNA-1 subscore, anthropometric measurements; MNA-2 subscore, global assessment; MNA-3 subscore, dietary questionnaire; MNA-4 subscore, subjective assessment; OR, odds ratio. Multiple logistic regression analysis included the following variables: For model 1, age, sex, cerebrovascular accident, DM, rehabilitation after surgery, infections, pressure ulcers, dementia, malignancy, hemoglobin, cholesterol, phosphorus, albumin, and MNA score. For model 2, age; sex; cerebrovascular accident; DM; rehabilitation after surgery; infections; pressure ulcers; dementia; malignancy; hemoglobin; cholesterol; phosphorus; albumin; subscores for MNA-1, MNA-2, MNA-3, and MNA-4; and short-form MNA score.

[2] Decreased by 10 g/L.
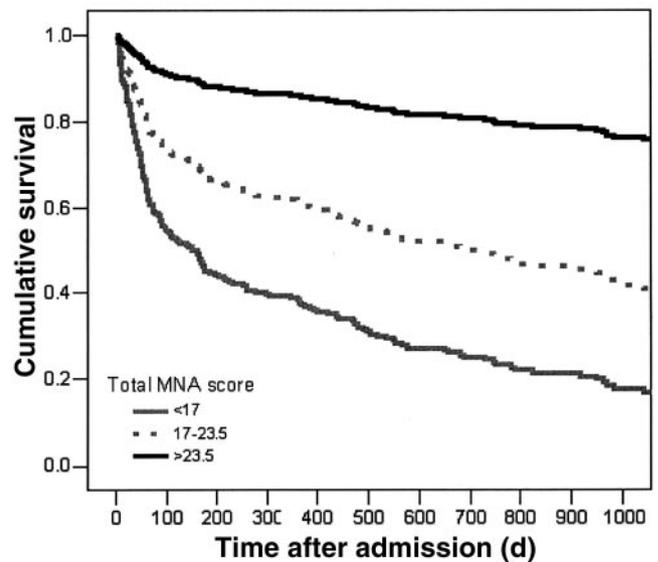
[3] Decreased by 6 points.

[4] <7.5 units.

FIGURE 1. Long-term survival curves in the study population according to nutritional status as assessed by total Mini Nutritional Assessment (MNA) score. Range: <17, malnourished (n = 204); 17–23.5, at risk of malnutrition (n = 137); 24–30, well-nourished (n = 73). Log-rank test, P = 0.003.

The ROC curve analysis of the sensitivities and specificities of the different logistic models for predicting mortality are shown in **Figure 2**. The curves are based on the total MNA score and the MNA-3 subscore and overlapped.

DISCUSSION

In this study of very old hospitalized patients, the prevalence of malnutrition was extremely high: <20% of the patients were
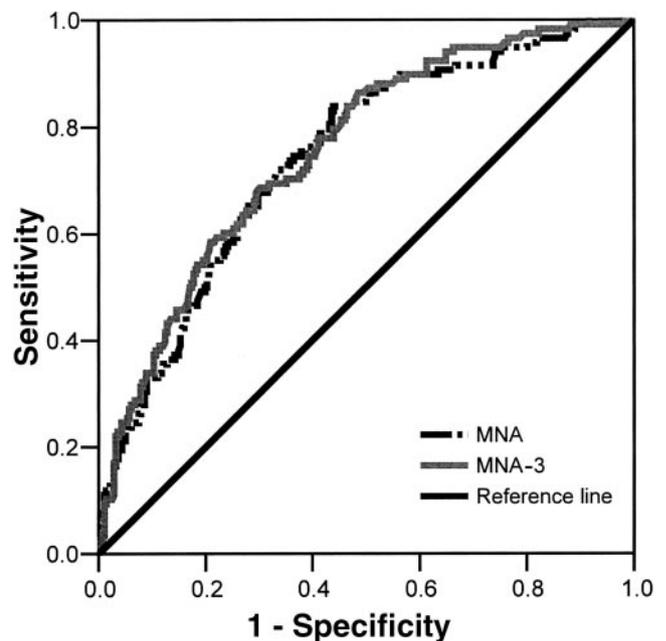

FIGURE 2. Receiver operating characteristics of the sensitivity and specificity of predicted probabilities for the logistic mortality model incorporating the total Mini Nutritional Assessment (MNA) score or the MNA-3 (dietary questionnaire) subscore (n = 414). The area under the curve is 0.744 for the MNA score and 0.755 for the MNA-3 subscore.

well-nourished. In patients who were malnourished or at risk of malnutrition, the hospitalization period was longer and in-hospital and long-term mortality were higher than in well-nourished patients. Our data confirm studies (1, 2) in which nutritional status was found to be normal in fewer than one-third of newly admitted geriatric patients (7, 48–50).

Morley and Thomas (6) attribute the "anorexia of aging" to disturbances in the ability to regulate food intake. Poor nutritional status of the elderly is attributable to multiple factors. With age, the appetite is reduced, physical activity diminishes, and fat-free body mass decreases even in the absence of overt catabolic illness (1, 5–7). Hospitalization; a deteriorated medical, functional, or cognitive state; and social problems can further contribute to malnutrition (11, 17–20). We found cognitive impairment to be a significant risk factor for malnutrition. Cognitive impairment results in decline in social and economic status, difficulties in swallowing and functioning, and decline in weight (51, 52). In addition, assessment of nutritional status in cognitively impaired patients is more complicated and less accurate; for that reason, busy medical staff frequently do not perform it (27, 53). Low serum concentrations of albumin were found in this and other studies to be an important marker of malnutrition (54, 55). However, many acute and chronic inflammatory conditions, such as chronic liver and kidney disease, cancer, and surgery, are also associated with low serum albumin (56–59), and the frequent coexistence of these medical conditions in hospitalized elderly patients reduces the specificity of hypoalbuminemia in assessing malnutrition. Interpretation of other known biochemical markers of nutritional status (serum concentrations of transferrin, hemoglobin, and cholesterol) in the elderly is also equivocal (28). A method of nutritional status assessment that is reliable and easy to perform is needed both for predicting outcome (43, 60) and for planning an intervention program.

Despite the high prevalence of malnutrition in the elderly and the known association between malnutrition and poor outcome, malnutrition often goes unrecognized and untreated during hospitalization (8, 31). This is partly because the routine nutritional tests in current use are often not done because of time limits and, in part, because of the frailty of geriatric patients (21, 26, 31). Many studies have shown a high correlation between the MNA and other clinical and laboratory indexes of malnutrition (33, 37–39). Moreover, several authors have reported that reduced MNA scores are predictors of poor prognosis (60, 61), a finding confirmed by the present study of very old hospitalized patients. However, administration of the MNA is relatively time consuming and needs the patient's cooperation (40, 41). Some attempts have been made to simplify it, for example the MNA-SF (42). In very old hospitalized patients, however, we did not find this test to have prognostic significance.

For many years, anthropometric measurements (MNA-1) were the cornerstone of nutritional assessment and were considered to be the most significant part of the MNA (43, 62). In our study, MNA-1 scores showed lower correlations than the other subscores with laboratory indexes of malnutrition and coexisting diseases. In a small study of 41 female orthopedic patients who were younger, on average, than our patients (43), anthropometric assessment was found to have the best predictive value. Saletti et al (62) reported a high correlation between anthropometric assessment and total MNA scores in a selected population of institutionalized elderly patients with similar dietary provision. As opposed to these 2 studies, our study evaluated a large cohort of very old patients with a wide range of medical conditions and no previous dietary interventions. The results of our study might be explained by the changes in height and body composition and the decrease in fat-free mass that occur in the elderly, especially in the very old, and that can alter anthropometric measurements.

Two smaller studies, in examining the significance of the MNA subscores, found the MNA-4 subscore (subjective nutritional assessment) to be useful in assessing malnutrition (21, 46). In our study of very old patients, the MNA-4 score was the least significant subscore. This subscore includes 2 questions addressing patients' self-perception of health and nutritional status compared with that of other elderly people with whom they are in contact. The usefulness of the MNA-4 in the very old is sometimes limited as a result of the anxiety, depression, and decline in cognitive functions that are common in this age group (63). Because self-perception is largely dependent on mood state, it is often difficult to distinguish between malnutrition and depressive symptoms on the basis of the MNA-4 subscore alone.

In our study, the MNA-3 subscore (dietary habits) was highly correlated with the total MNA score, with most of the laboratory indexes known to reflect malnutrition, and with many cormorbid illnesses. Because the MNA-3 subscore relates specifically to the number of meals consumed, food ingredients, and problems with swallowing and digestion, answers to these types of questions are less liable to be influenced by the individual's psychological state. The accuracy of assessments based on self-reports has been questioned by some authors (64, 65), but others have found a significant correlation between such assessment and anthropometric and energy expenditure measurements (66-68). Our finding that dietary habits correlate significantly with the assessment of nutritional state agrees with data from a recent study of 178 patients aged between 75 and 94 y, a population in whom eating problems and decline in food intake were found to be common and to correlate significantly with the MNA score (44).

Reduced food intake in the elderly has often been reported. Jalali (69) found that most of the elderly subjects studied ate fewer than 2 meals a day, only one-half ate fruit and vegetables, and one-half were unable to eat properly because of oral problems. In another study, the intake of vitamins and trace elements by elderly patients was less than two-thirds of the US recommended dietary allowances, mainly because of chewing difficulties, reduced appetite, and social problems (31). It thus seems that problems related to eating habits become more important with age. During periods of high energy requirement, such as acute hospitalization, the nutritional deficit becomes more apparent.

The major finding of the present study is that the MNA-3 subscore is a strong predictor of in-hospital and 3-y mortality. In patients with MNA-3 subscores <7.5, mortality was increased by 2-fold. Our finding that the total MNA score is a predictor of long-term outcome agrees with the results of some other studies (35, 60, 61), However, as far as we are aware, the predictive potential of the MNA-3 subscore has been investigated in only one study (70). Moreover, in previous studies aimed at evaluating the predictive potential of the total MNA subscores, long-term follow-up was not performed. Our finding that the MNA-3 subscore can replace the total MNA score in assessing nutritional state and as a predictor of outcome might have an important clinical advantage. The items included in this component are short and simple, making nutritional assessment in this population easier for the medical staff.

A limitation of our study is the possibility that the multiple comorbidities and treatment regimens of the patients might have influenced their outcome. In addition, the results obtained in this population of very old patients might not apply to younger patients.

In summary, the results of the present study show a high prevalence of malnutrition in very old hospitalized patients. Malnutrition, or even risk of malnutrition, as defined by low MNA scores, was a predictor of long hospital stay and high mortality. The MNA-3 subscore (questionnaire on dietary habits) was significantly correlated with the total MNA score and with laboratory indexes of malnutrition and was also significantly low in patients with the most coexisting medical conditions. Moreover, this subscore was a significant predictor of hospitalization outcome and long-term mortality. Screening for dietary habits is a quick and easy tool for nutritional assessment. We suggest that this is the most important component of screening for malnutrition, and that the MNS-3 might thus be a useful tool in planning programs of preventive nutrition in frail, very old patients.

NK, YB, and SL designed the experiment. LP collected data. NK and NK-M analyzed data. YB, NK-M, LP, HK, and SL provided significant advice. NK, HK, and SL wrote the manuscript. None of the authors had any conflicts of interest.

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