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Malnutrition risk in hospitalized patients measured with Nutrition Risk Screening 2002 tool and its association with in-hospital mortality

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Abstract. – OBJECTIVE: Malnutrition is related to increased morbidity, mortality, and costs. NRS-2002 is a practical malnutrition risk (MR) screening tool approved by the European Society for Clinical Nutrition and Metabolism (ESPEN) for inpatients. We aimed to reveal the inpatient MR using NRS-2002, and to examine the relationship between MR and in-hospital mortality.

PATIENTS AND METHODS: The results of inpatient nutritional screening in a tertiary referral center university hospital were retrospectively analyzed. The NRS-2002 test was used for defining MR. Comorbidities, initial and follow-up anthropometric data, NRS-2002 score, food intake, weight status, and laboratory analysis were examined. In-hospital mortality was noted.

RESULTS: Data from 5,999 patients were evaluated. On admission, 49.8% of the patients had MR, and 17.3% had severe MR (sMR). MR-sMR was higher in geriatric patients (62.0-28.5%). Those with dementia had the highest MR (71%), followed by stroke (66%) and malignancy (62%). Age and serum C-reactive protein (CRP) were higher, and body weight, BMI, serum albumin, and creatinine were lower in patients with MR. Multivariate analysis showed that age, albumin, CRP, congestive heart failure (CHF), malignancy, dementia, and stroke were independently associated with MR. The overall mortality rate during hospitalization was 7.9%. MR was associated with mortality regardless of serum CRP, albumin, body mass index (BMI), and age. Half of the patients received nutritional treatment (NT). NT resulted in preserved or increased body weight and albumin levels among patients and the geriatric group with MR.

CONCLUSIONS: AMR revealed that NRS-2002 is positive in approximately half of the hospitalized patients, which is associated with in-hospital mortality independent of the underlying diseases. NT is related to weight gain and increased serum albumin.

Key Words:
NRS-2002, Malnutrition, Malnutrition risk, Mortality, Inpatient, In-hospital, Geriatric, Elderly.

Introduction

According to the European Society for Clinical Nutrition and Metabolism (ESPEN), malnutrition is defined as a state of undernutrition that leads to altered body composition, diminished physical and mental function, and impaired clinical outcome from disease[1]. Previous reports[2-5] showed that 20-45% of the patients had malnutrition upon hospitalization. This frequency rises to 32.9-56.2% for the elderly[6-8]. Moreover, one-third of the inpatients developed malnutrition during their hospitalization period[5,9]. Malnutrition was associated with nosocomial infections, increased length of stay during hospitalization, higher morbidity, mortality, and costs[10-12]. Thus, it is important to diagnose and treat malnutrition[13,14].

The nutritional status of the patients must be evaluated within the first 24-72 hours of admission. This should be followed by appropriate nutritional treatment in case of malnutrition or malnutrition risk (MR). It is an appropriate approach to re-evaluate the nutritional status weekly for those who do not have malnutrition or MR[15,16]. Nutritional status can be evaluated with daily oral intake, weight status, subcutaneous edema,

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anthropometric measurements such as body mass index (BMI, kg/m^2), muscle mass and body fat, and muscle strength[17]. Easy-to-apply nutritional screening tools were developed with the aim of identifying high-risk patients for malnutrition[18]. Inflammation and malnutrition are entwined in most clinical states, as in cancer or hemodialysis patients. Thus, scores like PINI (prognostic inflammatory and nutritional index) assessing both conditions have also been developed[19]. Nutritional risk score 2002 (NRS-2002) is a malnutrition screening tool that relies on patient age, weight loss, BMI, food intake, and disease severity. It was approved by ESPEN for the inpatient population[20,21]. MR defined by NRS-2002 was associated with short and long-term mortality[22,23].

In this study, our aim was to reveal the frequency of patients with MR, using NRS-2002 in a large inpatient group including the elderly. We also aimed to identify factors associated with MR and examine the relationship between MR and in-hospital mortality in this group.

Patients and Methods

Study and the Population

In this retrospective descriptive study, the results of inpatient nutritional screening performed in a tertiary referral center university hospital over a six-year period were evaluated. The nutritional status of hospitalized adult patients (from both medical and the surgical wards, n=5,999), their treatments, and follow-up were evaluated using hospital records, including consultations with the Clinical Nutrition Team (CNT). This study was approved by the local Ethics Committee (Istanbul University Ethics Committee, acceptance: 17-132) and followed the Helsinki Declaration guidelines.

Evaluation of the Nutritional Status

All patients were evaluated within the first 48 hours of their hospitalization by the same two nurses working in the CNT. Nurses were supervised by the same physicians from the CNT who were experienced in the field of clinical nutrition. Medical history, treatments, physical examination, anthropometric data, NRS-2002 scores, food intake and weight loss status, gastrointestinal functions, and laboratory analysis were examined. In-hospital mortality was noted.

The NRS-2002 test was used for the screening of malnutrition risk24. The test consisted of two parts. In the first part, the nutritional status of the patient was evaluated (score 0-3), and in the second part, current diseases and severity were asked (score 0-3). A total score was determined from both parts (min-max: 0-7). Then, 1 point was added to the total score for those aged 70 or over. MR was defined as a total score ≥3, and severe MR (sMR) as a total score ≥5.

Nutrition Treatment and Follow-Up

Basal energy expenditure (BEE) was calculated using the Harris-Benedict formula[25]. Daily energy expenditure (DEE) was calculated by the sum of BEE, activity factor, stress factor, and thermogenic factor. Daily protein needs were assumed according to clinical conditions ranging from 1-2 g/kg. Serum albumin, CRP, creatinine, electrolytes, and complete blood counts of the patients during admission and follow-up were noted.

Nutrition treatment (NT) included personalized diet, enteral and/or parenteral nutrition, planned according to daily energy and protein needs. Follow-up nutritional status, anthropometric data, laboratory analysis, and clinical condition were noted.

Statistical Analysis

The SPSS v. 29 (IBM Corp., Armonk, NY, USA) program was used for statistical analysis. As descriptive statistics, the mean and standard deviation for parametric data, median and 25-75th percentiles for non-parametric data, and ratio and frequency values for categorical data were used. Categorical variables were compared with the Chi-square test, and parametric and non-parametric data were compared with Mann-Whitney U, Student's *t*-test or Wilcoxon tests, accordingly. Any variable that was associated with MR and/or in-hospital mortality was evaluated in multiple logistic regression analysis. For statistical significance, the *p*-value was accepted as significant when ≤0.05.

Results

Patient Characteristics

The study group consisted of 5,999 patients. 47.3% were female, and 38.6% were in the geriatric age group (≥65 years old). Demographic characteristics, DEE, serum albumin and C-reactive protein (CRP) of the whole group and those in the geriatric age are summarized in Table I. 64% of the patients were from medical wards, 18% were from emergency ward and 18% were from surgery wards. The comorbidities of the patients are shown in Figure 1. Malignancy (38%) was the

Table I. Demographic characteristics and laboratory analysis.

Parameter		Whole group median (IQR)	Age<65 (61.4%)	Age≥65 (38.6%)	p
Sex (female)	(%)	47.3%	46.3%	48.8%	0.07
Age	(years)	60 (25)	50 (23)	74 (10)	-
Height	(cm)	165 (12)	166 (13)	165 (13)	<0.001
Weight	(kg)	69.1 (21)	69.3(22)	69(19)	0.78
BMI	(kg/m^2)	24.9 (7.3)	24.6 (7.4)	25.4 (7)	<0.001
DEE	(kcal/day)	1,950 (511)	2,070 (540)	1,750 (410)	<0.001
Albumin	(g/dL)	3.4 (1)	3.5 (1.1)	3.3 (1)	<0.001
CRP	(mg/L)	27 (78.3)	24.6 (80.6)	31 (74.1)	0.005

IQR: Interquartile range, BMI: Body mass index, DEE: Daily energy expenditure, CRP: C reactive protein.

most frequent comorbidity, followed by diabetes (25%) and chronic kidney disease (CKD) (12%).

Nutritional Status of the Patients

Recent weight loss was reported in 55.3% of the patients, which was more prevalent in men (58.6 *vs.* 51.7%; $p<0.001$). The initial evaluation showed that 49.8% of the patients had MR and 17.3% had severe MR (sMR; NRS-2002 score ≥5) (Table II). MR was higher in men (51.5 *vs.* 47.9%; $p=0.005$), whereas sMR rates were similar in both gender (M-F: 18 *vs.* 16.5%; $p=0.132$). In the geriatric group, the frequency of patients with MRI or SMR was higher (62.0% and 28.5%, Table II). The MR and sMR rates in patients with different comorbidities were summarized in Figure 2. Patients with dementia had the highest MR, and sMR (71% and 57%). This group was followed by patients with stroke, and then by patients with malignancy, in terms of MR, and sMR (Figure 2). Malnutrition risk (and sMR) among patients hospitalized in the medical, emergency and surgery wards were 50.8% (15.2%), 44% (19%), and 51.8% (23.5%), respectively.

Factors Related to MR

In patients with MR, compared to those with normal nutritional status age, DEE and serum CRP were significantly higher, body weight, BMI, serum albumin, and creatinine were significantly

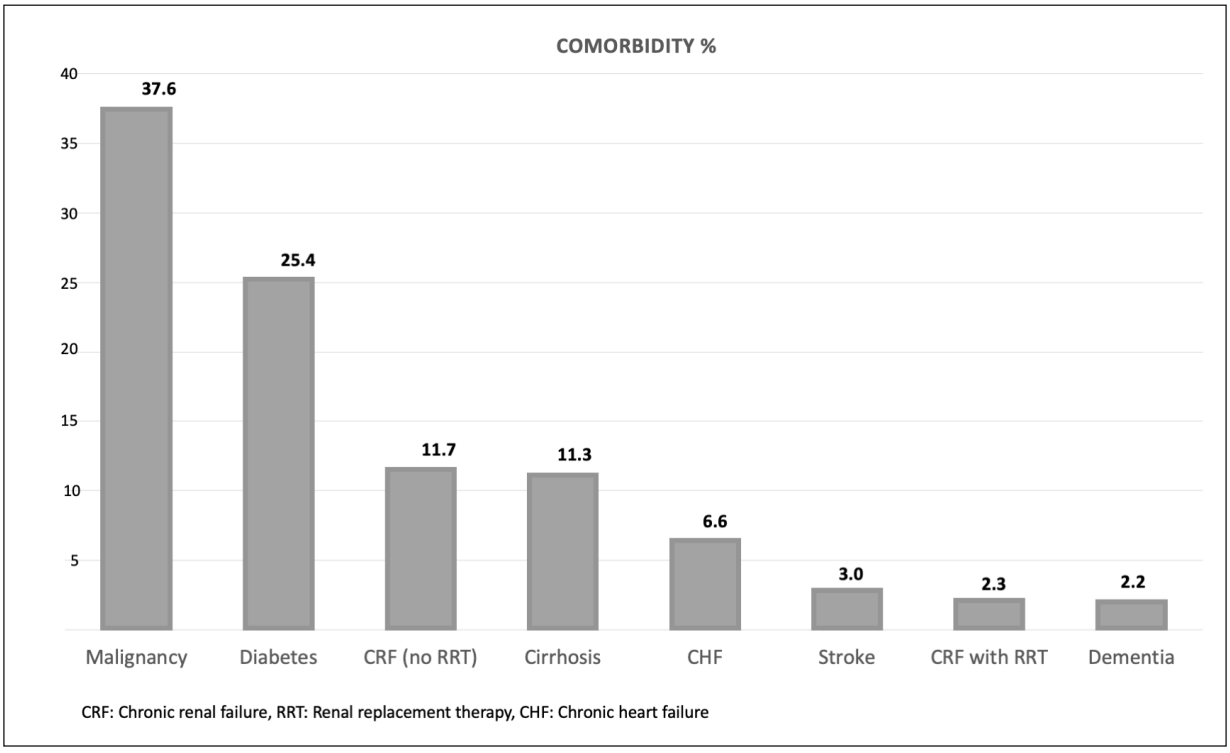

Figure 1. Frequency of certain comorbidities in the patient group.

Table II. MR and sMR among all patients and geriatric age group.

All patients	%	Age<65	≥65	65-69	≥70	p^{δ}	p^{Φ}
MR							
NRS-2002 ≥3	49.8	42%	62%	53%	65.6%	<0.001	<0.001
sMR							
NRS-2002 ≥5	17.3	10%	28.5%	18.1%	32.5%	<0.001	<0.001

p^{Φ}<65 *vs.* 65-69, p^{δ}<65 *vs.* ≥65. MR: Malnutrition risk, sMR: severe MR.

lower (p<0.001) (Table III). In the geriatric subgroup, NRS-2002 scores were negatively associated with body weight, BMI, and serum albumin (p<0.001). Serum CRP was also significantly higher in geriatric patients with MR or sMR (p<0.001). Malignancy and dementia were strongly associated with MR.

Logistic regression analysis showed that lower BMI, lower serum albumin, and higher CRP were independently associated with MR in patients with normal renal functions (Table IV). In patients younger than 70 years, age (p=0.005) and lower serum creatinine (p=0.009) were independently associated with MR in addition to BMI, serum albumin, and CRP. Demographic characteristics, comorbidities, and the laboratory analysis of the whole group were evaluated together in multivariate regression analysis. Lower serum albumin, higher CRP, concomitant congestive heart failure (CHF), malignancy, dementia, and stroke were independently associated with MR (Table IV). Additionally, in the subgroup of patients with age <70 years, increasing age or being in the geriatric group (65-69) were also associated with MR, independent of the laboratory parameters or concomitant diseases (p=0.013 and p=0.002 respectively).

In-Hospital Mortality Data

The overall mortality rate during hospitalization was 7.9%. In-hospital mortality was 7% in the medical wards, 5.4% in emergency ward, and 10% in surgery wards. The highest mortality was seen in patients with malignancy (14%) and in patients receiving renal replacement therapy (RRT, 13%). These were followed by CHF (10%), CKD (9%), dementia (8%), and stroke (7.6%).

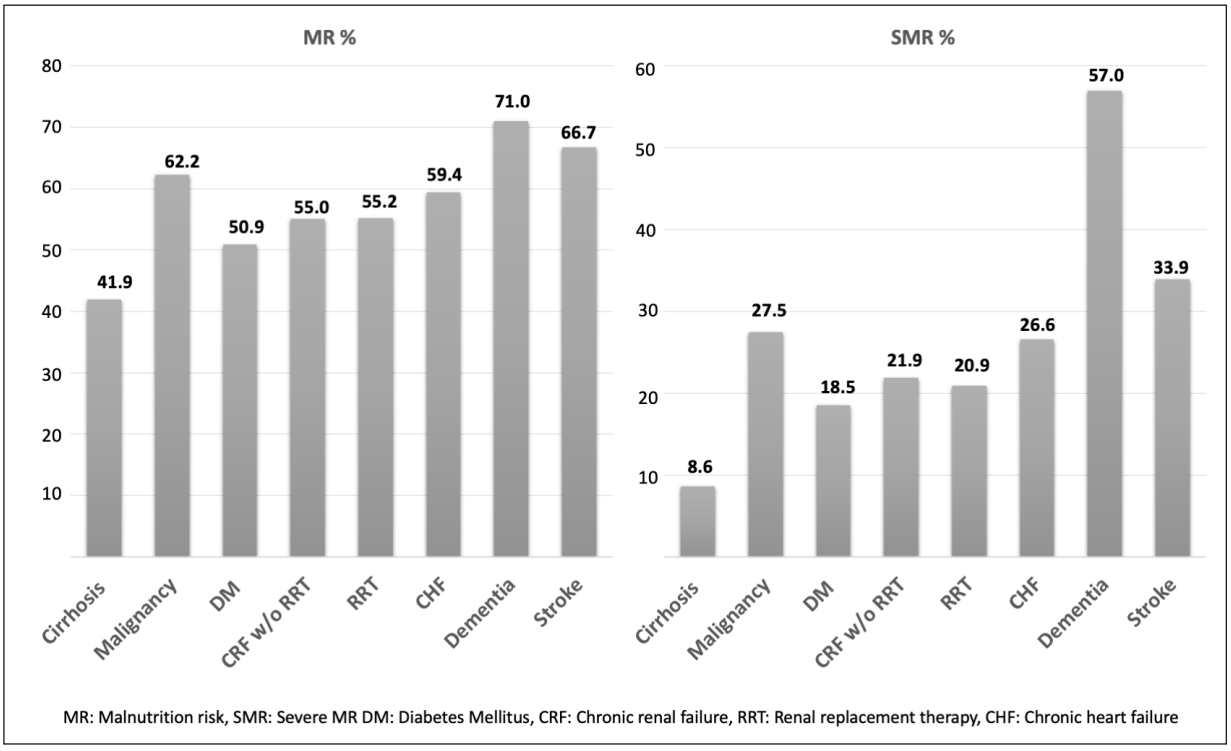

Figure 2. Frequency of Malnutrition Risk (MR) and Severe Malnutrition Risk (SMR) among disease groups.

Table III. Univariate analysis of demographic and laboratory parameters related to MR and sMR.

		All patients			p		
	Median (IQR)	NRS-2002 <3	NRS-2002 ≥3	NRS-2002 ≥5	<3 *vs.* ≥3	<3 *vs.* ≥5	3-4 *vs.* ≥5
Age	(years)	57 (25)	64 (24)	70 (22)	<0.001	<0.001	<0.001
Weight	(kg)	72 (21.2)	66 (20)	65 (20.4)	<0.001	<0.001	0.09
BMI	(kg/m^2)	25.9 (7.4)	23.8 (6.9)	23.5 (6.7)	<0.001	<0.001	0.04
CRP	(mg/L)	14.5 (55)	42.6 (89)	61 (106)	<0.001	<0.001	<0.001
Albumin	(g/dL)	3.6 (1.1)	3.2 (0.9)	3.1 (0.8)	<0.001	<0.001	<0.001
Cre.$^{\Phi}$	(mg/dL)	0.8 (0.4)	0.7 (0.5)	0.7 (0.5)	0.01	0.02	0.4
Cre.$^{\delta}$	(mg/dL)	2 (2)	2.2 (1.7)	2.3 (1.6)	0.1	0.08	0.5
Cre.$^{\lambda}$	(mg/dL)	3.1 (2.5)	3.1 (2.5)	2.8 (1.3)	1	1	1

MR: Malnutrition risk, sMR: severe MR, Cre: Creatinine, BMI: Body mass index, CRP: C reactive protein. ($^{\Phi}$) Normal renal function, ($^{\delta}$) Chronic Renal Failure w/o Renal Replacement Therapy, ($^{\lambda}$) Renal Replacement Therapy.

Table IV. Multivariate regression analysis of demographic and laboratory parameters, and comorbidities, for MR.

	Demographic and laboratory parameters$^{\Phi}$			All parameters$^{\Omega}$		
	p	OR	CI	p	OR	CI
BMI (kg/m^2) (-)	<0.001	1.06	1.04-1.07	<0.001	1.06	1.05-1.07
Male sex	0.85			-		
CRP (mg/L)	0.016	1.002	1.001-1.003	<0.001	1.002	1.001-1.003
Albumin (g/dL) (-)	<0.001	1.54	1.35-1.75	<0.001	1.66	1.51-1.84
Creatinine (mg/dL) (-)	0.09			-		
	Commodity					
Malignancy	<0.001	2.42	2.17-2.70	<0.001	2.18	1.81-2.56
CRF	0.016	1.24	1.04-1.48	0.47		
CHF	<0.001	1.61	1.29-2.02	<0.001	1.92	1.47-2.52
Dementia	<0.001	2.47	1.66-3.67	0.006	1.91	1.20-2.51
Stroke	<0.001	1.95	1.40-2.71	0.007	1.72	1.16-2.57
DM	0.672			-		
RRT	0.961			-		

MR: Malnutrition risk, BMI: Body mass index, CRP: C reactive protein; CRF: Chronic renal failure, DM: Diabetes Mellitus, CHF: Chronic heart failure; RRT: Renal replacement therapy, OR: Odds ratio, CI: Confidence interval. $^{\Phi}$: calculated for patients with normal renal function, $^{\Omega}$: calculated for all patients, (-): decreasing values.

The univariate and multivariate analyzes of in-hospital mortality-related factors are summarized in Table V. Presence of MR on admission was associated with mortality during hospitalization. This association was independent of serum CRP, serum albumin, BMI and age. Similarly, sMR was an independent risk factor for in-hospital mortality (OR: 3.11, p<0.001). In the geriatric population, <70 and ≥70 years old groups were further evaluated separately. The presence of MR or sMR was associated with in-hospital mortality for both groups (MR-sMR: p=0.02, p=0.03 in the age 65-69 group, p=0.002, p<0.001 in the age ≥70 group). In multivariate regression analysis, MR (OR: 2.18, p=0.004), lower albumin (OR: 2.0, p<0.001), higher CRP (p<0.001), lower BMI (p=0.008), malignancy (OR: 3.4, p<0.001), and CHF (OR: 3.0, p<0.001), were independently associated with in-hospital mortality.

Nutrition Treatment (NT)

NT was given to 54% of the patients (n=3,240): 34% enteral nutrition, 5% parenteral nutrition (PN), and 15% EN and PN together (Table VI). 79.6% and 90.5% of the patients with MR and sMR received NT, respectively. 28.6% of the patients with an initial NRS score <3 received nutrition treatment during their follow-up, due to in-hospital undernutrition. NT frequency was highest in patients with dementia, and stroke (75.6 and 84.7%, respectively). 37.2% of malignancy patients received EN during hospitalization. PN (alone or in combination with EN) use was highest among patients with stroke (50%), malignancy (31.1%), and dementia (30.5%).

NT resulted in a preserved or increased body weight in 14% and 20.3%, respectively, of the patients with MR (p<0.001). NT was also related to increased serum albumin levels in 42% of the

Table V. Univariate and multivariate analysis of factors related to in-hospital mortality.

	Univariate *p*	Multivariate *p*	OR (CI)
High CRP (mg/L)	<0.001	<0.001	1.005 (1.003-1.007)
Low serum albumin (g/dL)	<0.001	<0.001	1.760 (1.340-2.320)
Ageing	0.11		
Lower BMI (kg/m^2)	<0.001	0.04	1.030 (1.010-1.060)
Age >70$^{\theta}$	0.7	0.34	-
Higher NRS$^{\omega}$	<0.001	- -	
NRS-2002 ≥3$^{\omega}$	<0.001	0.027	1.883 (1.076-2.397)

CRP: C reactive protein, BMI: Body mass index, OR: Odds ratio, CI: Confidence interval. $^{\theta}$: Age>70 was evaluated in regression analyses, because it is also a parameter used in calculating NRS; $^{\omega}$: NRS≥3 was evaluated in regression analyses as an indicator of MR.

Table VI. Nutrition treatment of patients

	All patients % (n)	NRS-2002 NRS-2002 ≥5	NRS-2002 NRS-2002 ≥3	NRS-2002 <3
No treatment	46 (2,759)	9.5%	20.4%	71.4%
EN	34 (2,043)	37.7%	46.5%	21.7%
PN	5 (300)	12.1%	7.3%	2.7%
EN+PN	15 (897)	40.7%	25.8%	4.2%

EN: Enteral nutrition, PN: Parenteral nutrition.

patients with MR (p<0.001). Similarly, NT resulted in preserved or increased body weight in 16%, and 17.5% of the patients with MR in the geriatric group (p<0.001). The frequency of patients with weight gain was significantly higher in younger patients (age <65 years) when compared to geriatric patients (22.1 *vs.* 17.5%, p<0.001). NT was associated with body weight gain in patients with malignancy, dementia, and stroke (p=0.001; p=0.04; p=0.03, respectively). In patients with malignancy during NT, serum albumin increase was achieved independent from CRP change (p=0.01).

Discussion

Malnutrition is prevalent among hospitalized patients and is associated with increased morbidity, mortality, costs, and longer hospital stays[3,10,11]. In this study, we presented the MR, sMR rates, and associated in-hospital mortality at a university hospital in Istanbul/Turkey, which is one of the biggest in the country with over 1,000 beds. The association between MR and mortality indicated that monitoring, diagnosing, and treating malnutrition during hospitalization is important.

MR prevalence in hospitalized patients varies according to the screening method and the target population. The clinical use of NRS-2002 is widely accepted, especially for inpatients. Studies[3,26] reported that the frequency of MR among hospitalized patients in Europe is between 18-45%. Higher prevalence of inpatient MR and sMR (49.8% and 17.3%) in our data could be related to our study being conducted in a tertiary referral center. Malignancy-related anorexia-cachexia is an important factor for MR. Dysphagia caused by dementia and stroke contributes to MR in hospitalized patients[27-31]. The geriatric age is also an MR factor. The prevalence of MR or sMR in the elderly was found to be higher compared to younger patients with similar characteristics[32-34], and thus age ≥70 years contributes an additional score in NRS-2002 tool. Similarly, our results showed that MR rates were higher in patients with malignancy, dementia, and stroke. Also, the elderly group had higher MR. In the young geriatric group (65-69 age) MR, sMR were higher than in non-geriatric patients. Regardless of the comorbidities, the association of geriatric age with MR, clearly shows the relationship between MR and being elderly.

NRS-2002 can predict short- and long-term prognosis in hospitalized patients[22,23,35]. Secondary analyses of the EFFORT study pointed out the effect of MR on 30- and 180-day mortality[35]. A higher

NRS score was associated with a higher mortality rate, with an HR of 1.2235. Another retrospective observational study[22] reported a doubled mortality rate in those with MR (NRS≥3) defined at hospital admission. Similarly, we showed that MR and sMR were closely related to in-hospital mortality, which was also true for the geriatric population. The latter is particularly important because the validity of NRS 2022 for predicting MR in elderly patients was reported to be lower[36]. In addition, the association of MR with in-hospital mortality, independent of age, reveals the importance of screening for nutritional status in all hospitalized patients.

According to our data, the highest in-hospital mortality rate was in the malignancy patient group. In a large series in the literature, in-patient mortality in cancer patients has been reported as 5.7%[37]. Our study was conducted in a tertiary referral center, which might explain the higher mortality rate of 14%. In another study[38], malnutrition prevalence was higher in hospitalized patients, especially in those with advanced malignancy, and malnutrition was associated with an increased 6-month mortality rate (OR:2.7). For these reasons, this independent relationship that we have shown between MR, malignancy, and in-hospital mortality is important.

Previous studies[39,40] reported a 6-25% in-hospital mortality rate in CHF patients, which depends on clinical severity and concurrent diseases. In a meta-analysis[41] examining CHF patients, the prevalence of malnutrition was 46%, and malnutrition was associated with all-cause mortality (HR 2.15). In our patient group, the in-hospital mortality rate of the CHF patients was 10%, and MR was found to be independently associated with mortality. Therefore, similar to malignancy patients, the assessment and treatment of malnutrition are important in this group, especially in terms of in-hospital mortality.

The risks of malnutrition and further cachexia in CKD patients (+/- RRT) are known. A relationship between malnutrition and mortality has been shown in patients receiving RRT, and CKD patients (HR 3.03-1.4)[42]. In our study, we showed that MR, sMR were associated with RRT and CKD. Also, in-hospital mortality was quite high in these patients.

In-hospital mortality for patients with dementia and stroke in our group were in parallel with the literature (reported 10%, 7.9% respectively)[43,44]. These problems are encountered more frequently in geriatric age. The fact that the highest MR, and sMR rates were in these patients is a point that should be emphasized in terms of in-hospital mortality.

MR is associated with lower serum albumin and higher serum CRP, which was also similar to our data. Moreover, serum albumin and CRP show a negative correlation independent of the nutrition treatment[45,46]. This indicates the relationship between inflammation and nutritional risk. As previously reported[47,] lower albumin, and higher CRP were associated with in-hospital mortality also in our study. The significant relationship between NT, weight gain, and increase in serum albumin, in our malignancy patients might be due to multimodal NT (combinations of enriched diet, enteral and parenteral nutrition, according to the needs of the patients). This may also indicate more prominent nutritional deficiencies that affect albumin levels, apart from the effect of underlying inflammation. Considering the high in-hospital mortality, early detection of MR, and initiation of NT seem important, especially in this patient group. Accordingly, better nutritional status was associated with lesser side effects and more successful medical treatment in cancer patients[48].

NT was related to significant weight gain in our patients, especially in those with malignancy, dementia, and stroke. Most of the patients received combined NT, including personalized diet and enteral nutrition, parallel to the suggestion of ESPEN. As expected, PN was used less in patients with CRF, CHF, and RRT, with high volume overload risk. It should be emphasized that the geriatric group gained less weight with NT compared to younger patients. This might be related to frailty, the severity of malnutrition, other comorbidities, polypharmacy, dysphagia, constipation, and anorexia of aging. Another important point to be emphasized is that nearly one-third of the patients who did not receive NT because MR was not seen initially, needed treatment during follow-up. In our study, we neither evaluated parameters that distinguish this patient group nor analyzed their prognosis. This issue, and the adequacy of NT in geriatric inpatients, as we emphasized above, should be evaluated in further studies.

Our study showed MR prevalence and its relationship with in-hospital mortality, in a relatively high number of inpatients of a university hospital in Istanbul, Turkey. Its retrospective design and lack of data on long-term mortality were the study's main limitations.

Conclusions

MR revealed with NRS-2002, is positive in approximately half of the hospitalized patients, which is associated with in-hospital mortality independent of the underlying diseases (also in geriatric patients). During the follow-up of patients who do not have MR initially, nutritional treatment needs may arise. NT done using every aspect of the nutrition support is related to weight gain, and increased serum albumin independent from CRP.

Ethics Approval

This study was approved by the local Ethics Committee (Istanbul University Ethics Committee, acceptance: 17-132) and followed the Helsinki Declaration guidelines.

Informed Consent

The study design is retrospective and informed consent is not applicable..

Authors' Contributions

OKB: conceptualization, methodology, data curation, writing - original draft; MB: data curation; BI: data curation; SA: data curation; YBT: data curation; MA: investigation; YG: investigation; BO: investigation, resources; SB: investigation, resources; SNE: Supervision; TSA: Supervision, writing-review, and editing; BS: conceptualization, supervision, writing-review, and editing.

Availability of Data and Materials

Data will be available upon reasonable request from the authors.

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