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ORIGINAL ARTICLE

Nutritional status and food intake are related to malnutrition risk and length of stay in hospitalized patients

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Summary. *Objective:* The aim was to evaluate the relationship between food intake and malnutrition risk of hospitalized patients. *Methods:* In this study 192 hospitalized patients were included. Food intake was performed on 24 h recall dietary method Nutritional Risk Screening-2002 has been used to evaluate the nutritional status of patients. Odds ratios with 95% confidence intervals were computed using a univariate and multivariate stepwise logistic regression model with malnutrition risk as the response variable. *Results:* The mean age of individuals was 50.3±16.35 years, 29.4% of males and 20.0% of females were at risk group. The patients with malign neoplasms had the highest malnutrition risk score. The overall coverage of the energy, protein, fibre, vitamin C, vitamin B12, calcium, iron and the other micronutrients of the malnutrition risk group were significantly lower than well-nourished patients ($p<0.05$). This difference was more remarkable among the patients who were younger than 65 years. Recent weight loss increased the malnutrition risk, 1.1 times in the last three and 6 months ($p=0.003$), in the last two months 1.7 times ($p=0.000$) and in the last one month was 1.5 times ($p=0.002$). *Conclusion:* The factors associated with malnutrition can be identified as food intake, recent weight loss, length of stay and anthropometric measurements. Patients who were malnourished by screening tool presented decreased food intake and had longer length of stay. A comprehensive nutritional evaluation that will allow adequate intervention and nutritional therapy is needed to avoid hospital malnutrition.

Key words: food intake, length of stay, malnutrition, NRS-2002, weight loss

Abbreviations

ASPEN: American Society of Clinical Nutrition and Metabolism, BMI: Body mass index, DRI: Dietary recommended intake, ESPEN: European Society of Clinical Nutrition and Metabolism, LOS: Length of stay in hospital, MDC: Main diagnostic categories, MUFA: Mono unsaturated fatty acids, NRS-2002: Nutritional Risk Screening-2002, PUFA: Poly unsaturated fatty acids, SFA: Saturated fatty acids, SPSS: Statistical Package for Social Sciences, WHO: World Health Organization

Introduction

Besides the impressive increase in the prevalence of obesity and its associated diseases, malnutrition is a widespread and unrecognized problem in hospitalized patients (1, 2). Malnutrition prevalence is seen between 15-70% of hospitalized patients (3, 4). It was found that one-in-three malnourished patients and one-in-five well-nourished patients consumed nothing or up to 25% of the provided food (5). Many studies have suggested that in comparison to well-nourished patients, malnourished patients exposed to worse outcomes. Malnourished patients have worse treatment response and increased rates of outcomes such as prolonged length of stay in hospital (LOS), increased readmissions and mortality (6-9).

Hospital malnutrition can be caused by disease or treatments. Physiological changes resulting from the

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disease (e.g. fever, gastrointestinal symptoms), dietary modifications (e.g. protein or fat restricted diet) and clinical examinations (e.g. colonoscopy) may increase the nutritional requirements or reduce nutrient intakes of the individuals. Hospital malnutrition can also have attributed to other causes, such as inadequate meal service in hospital and inadequate quality and flexibility of hospital catering (10).

There are limited studies evaluating how the hospital malnutrition and LOS is affected by nutritional status and nutrient intake. The main purpose of this study was to evaluate the effect of food intake, anthropometric measurements, LOS and main diagnostic categories (MDC) on the malnutrition risk of hospitalized patients.

Methods

A nonrandomized cross sectional design was used to compare malnutrition status and nutritional intake of hospitalized patients in Adult Hospital and Oncology Hospital of Hacettepe University. At least 150 participant planned to enrol the study according to the power analysis. This study was conducted among 192 adult (>18 years) volunteers between March-July 2014. Patients with cognitive impairment, oedema or dehydration, pregnant/lactating women and clinically unstable patients were excluded from the study. Ethical approval of this study has been granted by the regional ethics committee of the university (February 13, 2014; GO 14/67-02).

Data were collected by face to face interviews using a standard questionnaire. Food intake was performed on 24 h recall dietary method. BEBIS program (Pasifik Company, İstanbul, Turkey) were used to determine average daily energy and nutrient intake. Nutritional status of patients were evaluated by Nutritional Risk Screening-2002 (NRS-2002). NRS-2002 classifies patients' nutritional status based on body mass index (BMI), percentage of recent weight loss and recent change in food intake and severity of disease. Being nutritionally "at risk" was defined as a NRS-2002 score ≥3. This tool is recommended by the European Society of Clinical Nutrition and Metabolism (ESPEN) for hospital nutritional screening (11, 12). Dietary types were classified as regular diet, specific diet (diabetic, low salt, lipid and cholesterol diets etc.), restricted (protein, potassium or phosphorus restricted diets, test diets etc.) and enteral nutrition.

The body weights of individuals with minimal clothing without shoes were measured with a body analyser (Tanita HA622). Height was measured with a stable stadiometer. BMI was calculated for each individual. BMI was calculated as weight (kg)/height (m^2) and all participants were classified into four BMI categories according to the World Health Organization (WHO) as; underweight (<18.5 kg/m^2), normal weight (≥18.5-24.9 kg/m^2), overweight (≥25.0-29·9 kg/m^2) and obesity (≥30.0 kg/m^2) (13). The mid arm circumferences were measured with a fiber-glass tape which was sensitive to 0.1 cm. All measurements were obtained as described above (14).

SPSS (Statistical Package for Social Sciences Inc., Chicago, IL, United States) for Windows 15.0 program was used to analyse the data. The results were presented as the mean and standard deviation ($\bar{\chi}$±S) values. The table of percentage points was given for qualitative data. Mann Whitney-U test was used to compare the differences between two groups. Pearson chi-square test was performed to evaluate the categorical variables. Odds ratios with 95% confidence intervals were computed using a univariate and multivariate stepwise logistic regression model with malnutrition risk as the response variable. For all statistical procedures, a-*P* value of less than 0.05 was considered significant.

Results

A total of 192 hospitalized patients were enrolled in the study. Gender and nutritional risk specific distributions of BMI, LOS, weight loss and mid arm circumference are described in Table 1. The male to female ratio of our sample was 1.1 (102/90) while mean age and BMI were 50.3±16.35 years and 27.0±5.92 kg/m^2. According to malnutrition risk evaluated with NRS 2002; 29.4% of males and 20.0% of females were at risk group. Also one in every four screened patients (25%) had risk of having malnutrition.

Malnutrition risk by age, MDC, appetite status and dietary type were shown in Figure 1. The age de-

Table 1. Malnutrition risk by anthropometric measurements and length of stay (LOS) by main diagnostic categories

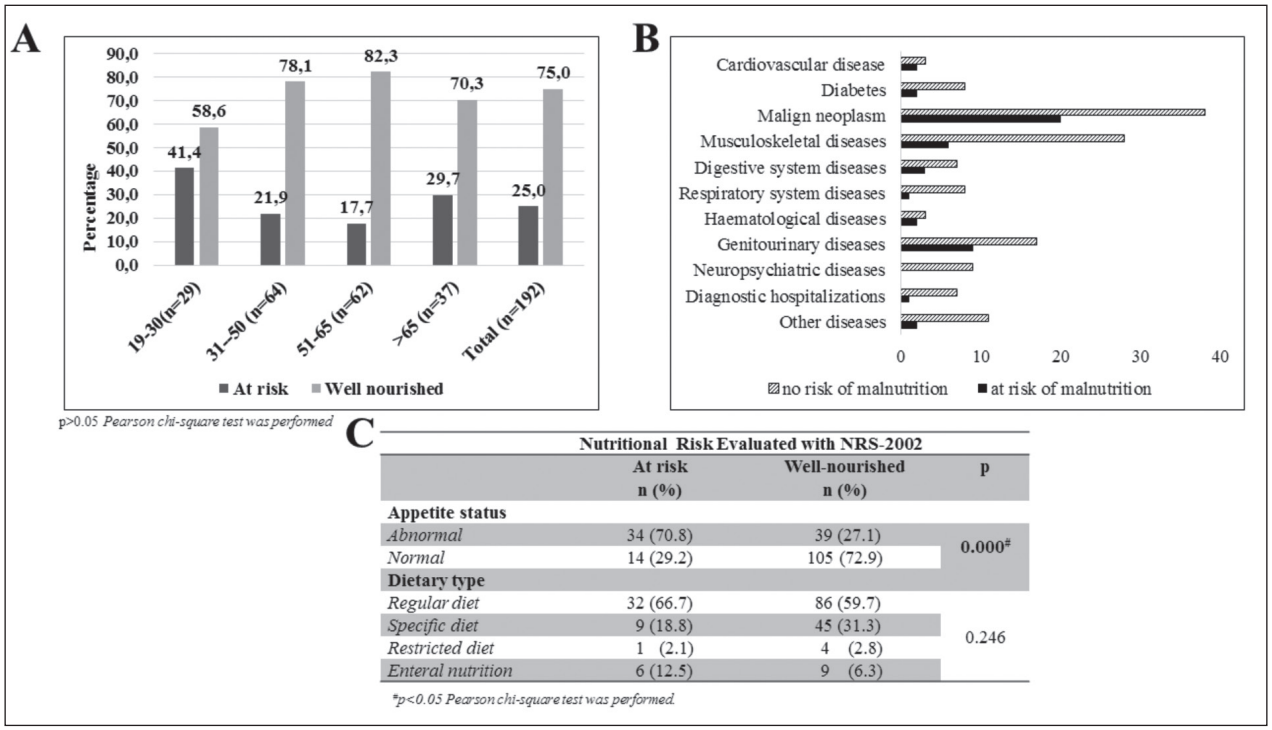
Anthropometric measurements and LOS ($\bar{\chi}$±S)	Nutritional Risk Evaluated with NRS-2002		Total (n=192)	p-value
	At risk (n=48)	Well-nourished (n=144)		
BMI (kg/m²)				
Female	27.9±7.58	28.9±6.74	28.7±6.88	0.313
Male	23.0±3.80	26.5±4.29	25.5±4.42	**0.000#**
Total	24.9±5.95	27.7±5.95	27.0±5.92	**0.000#**
Mid arm circumference (cm)				
Female	28.7±4.39	30.6±4.62	30.3±4.12	0.208
Male	27.0±3.63	29.6±3.51	28.8±3.72	**0.003***
Total	28.7±4.39	30.6±4.62	29.5±4.22	**0.001#**
Weight Loss (%)				
Last six months	11.1±6.57	6.6±5.05	8.6±6.16	**0.001#**
Last three months	9.6±5.89	5.8±4.99	7.7±5.74	**0.001#**
Last two months	8.1±5.16	3.7±1.80	5.9±4.43	**0.000#**
Last one month	6.1±3.37	3.5±1.90	4.8±2.98	**0.000#**
Mean LOS (days) by MDC				
Other diseases	2.5±2.12	3.4±2.54	3.3±2.43	0.641
Diagnostic hospitalizations	4.0±0.00	9.7±7.23	9.0±6.99	0.500
Neuropsychiatric diseases	--	6.2±4.41	6.2±4.41	--
Genitourinary diseases	13.2±22.40	3.5±2.55	6.9±13.67	0.107
Haematological diseases	8.5±0.71	8.7±3.51	8.6±2.51	0.800
Respiratory system diseases	9.0±0.00	8.0±12.01	8.1±11.24	0.667
Digestive system diseases	22.0±11.26	4.1±4.60	9.5±10.80	**0.033***
Musculoskeletal diseases	3.3±1.97	7.6±9.20	6.9±8.53	0.494
Malign neoplasm	10.8±14.45	4.4±4.78	6.6±9.68	**0.036***
Diabetes	2.0±2.83	12.5±20.60	10.4±18.72	0.237
Cardiovascular disease	11.0±00	7.7±11.55	8.5±9.57	1.000
Total	10.0±14.26	6.22±8.20	7.2±10.13	**0.040***

**p<0.05, #p≤0.001 Mann Whitney U test was performed. BMI: body mass index, MDC: main diagnostic categories*

pendent distribution of the NRS-2002 score did not differed significantly among the age groups (p=0.083) as it is shown in figure 1A. According to MDC, the patients with malign neoplasms had the highest malnutrition risk score (Figure 1B). According to NRS-2002 scores, the loss of appetite was 70.8% of the patients at risk of malnutrition while 27.1% of well-nourished patient reported loss of appetite (p=0.000) (Figure 1C). There was no significant difference between dietary type and malnutrition status (p=0.246).

BMI and mid arm circumference of men who were at risk of malnutrition was lower than well-nourished group while there were no differences in women (Table 1). At malnutrition risk group the mean percentage of weight loss in the last six, three, two and one months were significantly higher than well-nourished group (p<0.005). Participants who were at malnutrition risk group had longer LOS compared to well-nourished participants (p=0.040). Similarly, the LOS was significantly higher in malign neoplasm and digestive system disease patients at risk of malnutrition (p<0.05).

Energy and protein consumption percentage were 79.9% and 75.9%, respectively. According to Table 2, the overall coverage of the energy, protein, fibre and micronutrients of the malnutrition risk group were significantly lower than well-nourished patients (p<0.005). This difference was more remarkable among the patients who were younger than 65



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Nutritional Risk Evaluated with NRS-2002			
	At risk n (%)	Well-nourished n (%)	p
Appetite status			
Abnormal	34 (70.8)	39 (27.1)	0.000#
Normal	14 (29.2)	105 (72.9)	
Dietary type			
Regular diet	32 (66.7)	86 (59.7)	
Specific diet	9 (18.8)	45 (31.3)	0.246
Restricted diet	1 (2.1)	4 (2.8)	
Enteral nutrition	6 (12.5)	9 (6.3)	

*p<0.05 Pearson chi-square test was performed.

Figure 1. Participants' malnutrition risk according to NRS-2002. A. Malnutrition risk by age, B. Malnutrition risk by main diagnostic categories, C. Malnutrition risk by appetite status and dietary type

years (p<0.005). In the malnutrition risk group saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA) and cholesterol coverage of patients older than 65 years were higher but this difference was not statistically significant (p>0.05). In contrast, patients under the age of 65 in the malnutrition risk group had a lower percentage of SFA, MUFA, PUFA and cholesterol but only SFA coverage was statistically significant (p=0.016).

Seventy-one patients (n=71, 39%) did not meet their energy needs while 149 patients (57.3%) consumed less protein depending on the Dietary Recommended Intake (DRI) threshold (Figure 2). Both energy and protein intakes of 68 patients (35.4%) were below their nutritional needs. Also one in every five screened patients (20.8%) consumed both energy and protein over their needs.

When the variables tested as determinants of nutritional status were assessed by univariate logistic regression model as predictors of malnutrition risk; LOS, weight loss and some anthropometric measurements including BMI, mid-arm and calf circumferences were identified as important determinants but not dietary types (Table 3). Malnutrition risk was increased 1.032 fold by the increase of LOS (p=0.039). Similarly, malnutrition risk was significantly associated with weight loss in the last six (p=0.003), three (p=0.009), two (p=0.000) and one months (p=0.002). Malnutrition risk did not differ according to dietary type. When malnutrition risk evaluated by BMI; being underweight increased the risk of malnutrition up to 6 fold (p=0.035) compared to normal weight. In contrast, malnutrition risk decreased by the increase of BMI but this was statistically significant only in obese individuals (OR: *0.307, 0.113-0.838, p=0.021)*. There was a protective effect of increased mid arm circumference up to 15% (p=0.001) while calf circumference was 11% protective against malnutrition risk (p=0.004).

Discussion

Malnutrition is a major global health concern and mostly affects hospitalized patients. Impaired appetite,

Table 2: Percentage of patients' coverage of the nutritional needs according to malnutrition status

Energy and Nutrients	Age groups (years)						
	≤ 65 years			> 65 years			Total
	At risk ($\bar{\chi}$±S)	Well-nourished ($\bar{\chi}$±S)	p	At risk ($\bar{\chi}$±S)	Well-nourished ($\bar{\chi}$±S)	p	p value
Energy (kcal)	68.9±28.24	77.8±21.53	0.057	87.4±26.02	102.4±30.36	0.150	**0.050***
Protein (g)	98.0±49.71	113.4±35.68	0.066	107.3±49.54	121.4±46.46	0.242	**0.039***
SFA (g)	197.2±89.20	234.1±122.57	**0.016***	234.7±122.07	209.9±49.32	0.635	0.052
MUFA (g)	123.3±77.25	137.2±59.83	0.089	147.1±59.60	121.6±36.17	0.170	0.339
PUFA (g)	117.7±63.29	130.1±57.40	0.265	139.3±70.29	115.5±49.79	0.270	0.691
Cholesterol(mg)	111.8±74.09	129.9±63.90	0.129	136.2±77.76	128.4±60.86	0.883	0.230
Fibre (g)	56.7±31.11	76.5±28.68	**0.001#**	75.4±43.33	88.3±40.34	0.384	**0.001#**
Vitamin C (mg)	72.4±58.03	119.7±75.15	**0.000#**	93.8±80.22	142.4±99.85	0.108	**0.000#**
Vitamin B1 (mg)	64.2±31.67	81.2±25.96	**0.002***	76.9±35.58	87.2±31.20	0.300	**0.002***
Vitamin B2 (mg)	105.2±48.30	128.8±42.08	**0.006***	112.9±56.94	144.0±58.31	0.108	**0.001#**
Niacine (mg)	149.4±87.82	175.8±68.57	0.070	164.3±84.05	193.5±88.14	0.270	**0.033***
Vitamin B6 (mg)	84.5±47.24	109.4±44.10	**0.004***	84.7±38.99	101.4±45.12	0.216	**0.001#**
Folate (mcg)	56.9±23.36	78.9±2.99	**0.000#**	69.8±32.14	80.0±34.45	0.316	**0.000#**
Vitamin B12 (mcg)	163.1±122.30	205.1±100.55	**0.008***	216.7±134.44	234.5±124.66	0.832	**0.018***
Calcium (mg)	60.9±23.60	73.3±29.24	**0.047***	55.7±25.21	78.4±34.91	0.055	**0.007***
Phosphorus (mg)	137.4±60.31	165.7±51.17	**0.012***	157.1±67.73	186.1±63.40	0.181	**0.005***
Iron(mg)	73.8±46.24	94.3±43.89	**0.009***	99.5±40.96	109.4±54.81	0.635	**0.019***
Magnesium (mg)	52.7±26.78	69.1±22.87	**0.001#**	63.7±33.94	72.0±30.46	0.300	**0.000#**

**p<0.05, #p≤0.001 Mann Whitney U test was performed. MUFA: Mono unsaturated fatty acids, PUFA: Poly unsaturated fatty acids, SFA: Saturated fatty acids*

inadequate food intake, recent weight loss and reduction in anthropometric measurements were identified as major contributors of malnutrition (15). This study evaluates the association between malnutrition risk and anthropometric data, nutrition related parameters, LOS and MDC in hospitalized patients. Weight loss, LOS and anthropometric measurements were found as major contributors to malnutrition risk while dietary type was not related to malnutrition. Additionally, it was found that energy and nutrient intake of patients who were at risk of malnutrition were significantly lower than well-nourished patients. In the study population one in every four screened patients (25%) had risk of having malnutrition. Also 29.4% of males and 20.0% of females were nutritionally at risk group. Other studies reported similar results (16,17). This may be because of men demand healthcare services later than women. Thus, men may have more probability of being malnourished than women.

In the present study the loss of appetite was significantly lower in at risk group versus well-nourished group. It is known that in appetence is an important variable related to malnutrition (18, 19).

BMI is a simple and objective measurements for determining the nutritional status and is an important component of several malnutrition screening tools (19). Malnutrition can be underestimated when assessed by BMI alone (20, 21). Because clinical signifi-

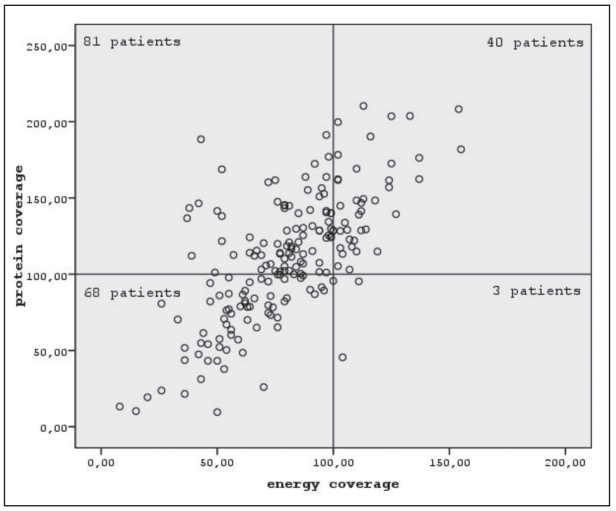

Figure 2. Coverage of the recommended nutritional needs. Needs were calculated according to Dietary Guidelines

Table 3. Bivariate logistic regression analysis of the association between factors related to nutritional status and malnutrition risk

	Odds ratio (95%CI)	p
LOS (days)	1.032 (1.002-1.064)	**0.039***
Weight loss (%)		
Last six months	1.142 (1.046-1.247)	**0.003***
Last three months	1.147 (1.035-1.271)	**0.009***
Last two months	1.685 (1.258-2.256)	**0.000#**
Last one month	1.507 (1.166-1.948)	**0.002***
Dietary type		
Regular diet	1	Reference
Specific diet	0.538 (0.236-1.224)	0.139
Enteral nutrition	0.672 (0.072-6.239)	0.727
Restricted diet	1.792 (0.591-5.436)	0.303
Anthropometric measurements		
BMI (kg/m²)		
<18.5	*6.143 (1.141-33.066)*	***0.035****
18.5-24.9	1	Reference
25.0-29.9	*0.521 (0.241-1.125)*	*0.097*
>30	*0.307 (0.113-0.838)*	***0.021****
Mid arm circumference (cm)	0.850 (0.775-0.933)	**0.001#**
Calf circumference (cm)	0.890 (0.822-0.963)	**0.004***

**p<0.05, #p≤0.001 Odds ratios were computed using a bivariate logistic regression model BMI: body mass index, LOS: length of stay*

cant weight changes and the reduction of oral intake that occur before removal to the hospital are ignored in the BMI calculation. In addition, a patient may have a high BMI and might be malnourished depending on reduced food intake caused by an underlying disease. On the other hand, decreased BMI does not indicate the individuals are malnourished. Furthermore, it was shown that BMI alone is insufficient in assessing an obesity risk factor for individuals (20). In our study the BMI of men who were at risk of malnutrition was lower than well-nourished group (p=0.000). On the other hand, there was no difference on BMI of women between two groups. In parallel with dos Santos et al. (22), being underweight increased the risk of malnutrition up to 6 fold (OR: 6.143, *1.141-33.066,* p=0.035) compared to normal BMI. In contrast, there is a reverse association between obesity and malnutrition risk. Similarly, other studies reported that obesity is inversely associated with clinical outcome (23, 24). It is likely that there is a wide variation in body composition and nutritional status in the overweight and obese populations (25). All these findings support the concepts that greater body stores confer survival advantages in catabolic conditions.

Similar to BMI; other anthropometric measurements such as mean handgrip strength, mid arm and calf circumferences may be related to malnutrition risk. Mean handgrip measurements of females and males were respectively 18.9±6.39 kg and 31.1±8.99 kg. Vanitha et al. (26) reported that the mid arm circumference was higher in well-nourished group. In our study, mid arm circumference of females and males were respectively 30.3±4.12 cm and 28.8±3.72 cm. Mid arm circumference was significantly higher in well-nourished men while there was no difference among women. There was a protective effect of increased mid arm circumference up to 15% while calf circumference was 11% protective against malnutrition risk by the bivariate logistic regression analysis.

Weight loss is one of the main nutritional assessment indicators associated with long-term mortality in numerous studies (6, 21, 27). BMI cut off points, the amount and duration of weight loss are related to malnutrition. Clinically significant weight loss has previously been found to be associated with morbidity and mortality (21, 25). American Society of Clinical

Nutrition and Metabolism (ASPEN) recommends a weight loss below 10% in the last six months, 7.5% in the last three months and 5% in the last month to avoid malnutrition (28). In our study the weight loss was higher than ASPEN recommendations at malnutrition risk group (respectively 11.1±6.57%; 9.6±5.89%; 6.1±3.37%). Also, recent weight loss of malnourished group was significantly higher in at risk group versus well-nourished group. Recent weight loss increased the malnutrition risk 1.1 times in the last 3 and 6 months and in the last 1 month was 1.5 times.

LOS has been thought as a factor that effects patients' well-being during hospital treatment (29). In general patients with malnutrition have longer LOS associated with prolonged duration of treatment and increased morbidity (25, 29). Lim et al. (8) demonstrated that malnutrition was an independent risk factor for longer LOS. We found that being at risk group significantly increased mean LOS compared to well-nourished group. In parallel, one study conducted in Switzerland reported higher LOS among undernourished patients compared to well-nourished patients (30). Also our results showed that malnutrition risk was increased 1.032 fold by the increase of LOS.

The relationship between malnutrition and LOS was reported in many studies (31-34) and can be considered an independent risk factor related to other complications and mortality (35). Reducing the LOS, therefore, has the potential to improve patients' quality of life by decreasing the risk of infections and other hospital-acquired diseases (29).

In our study, the LOS was significantly higher in malign neoplasm and digestive system disease patients at risk of malnutrition ($p<0.05$). According to MDC the patients with malign neoplasms had the highest malnutrition risk score. Similarly, other studies have found that cancer patients had higher malnutrition rates than non-oncologic patients (2, 36, 37). Cancer patients are particularly vulnerable to nutritional deficiencies due to the combined effects of malignancy and its treatments (38, 39). It is known that many treatment methods including chemotherapy, radiotherapy and surgery negatively affect the nutritional status related to commonly experienced side effects such as nausea, vomiting, anorexia, lethargy, diarrhea, esophagitis and dysphagia (40,41). These are strong reasons to avoid malnutrition by monitoring the nutritional status of all cancer patients throughout their illness.

Although many hospital diets provide sufficient energy and nutrients, previous studies showed that patients failed to meet their energy and protein needs in parallel with our study (15, 34, 42). However, studies evaluating only energy and protein intake may be inadequate to assess patients' nutrient intake. A study reported no significant differences for energy and nutrients and for intakes below 1/3 of dietary recommendations from nutritionally-at-risk and well-nourished patients (42) but in our study malnutrition risk group had significantly lower intake and this difference was more remarkable among the patients who were younger than 65 years.

DRI is used to evaluate nutritional requirements of healthy individuals, but the needs of hospitalized patients may be increased because of their clinical outcomes. So patients' food intake should be monitored even they cover their needs according to DRI, not to underestimate malnutrition risk.

Our single-center study population was heterogeneous by age group and MDC. Although its overall big sample size it involves a rather small sample in different age groups. 24 h recall dietary method may have variable outcomes in terms of hospital menu, LOS, stage of medical investigations, disease and treatment to evaluate nutritional intakes.

Although these limitations, our study has some strengths. First of all, energy and nutrient requirements were calculated individually by age group and gender. Moreover, there was no notification about the study which could have influence the behavior of patients. Patients were evaluated by their dietary type. So malnutrition risk was not overestimated because of less energy and nutrient intakes provided by restricted diets. The nutritional screening was performed in different departments of hospital and this lead to evaluate malnutrition rates of several diagnostic categories in different departments.

Conclusion

In conclusion, malnutrition prevention and treatment is a major challenge. A proper diagnosis is es-

sential for the nutritional therapy to be started as soon as possible, allowing an efficient dietetic-therapeutic intervention. Early intervention with additional nutritive treatment can lower malnourished associated complications and LOS. So, malnutrition should be adequately screened and documented. Nutritional intervention in patients at risk of malnutrition leads to a better prognosis, reducing the morbidity and mortality, improving quality of life. In conclusion, not only the physicians and dietitians but also the hospital managers, nurses and food service staff have to understand that good nutrition is a prerequisite for preventing hospital malnutrition.

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