Original article

Being "Nutritionally At-Risk": Its Effect on Health Expenses and Length af Stay In Hospital

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Abstract. *Objective:* Hospital malnutrition is a critical, cost-increasing public health problem that is common in many countries. The study aimed to evaluate the effect of "being nutritionally at risk" on health expenses and length of stay (LOS) in hospital. *Material and Method:* Nutritional Risk Screening-2002 (NRS-2002) was used to screen 1069 adult patients on admission day. Patients' anthropometric measurements, unintentional weight loss, hand grip strength (HGS), cancer diagnosis, as well as LOS were recorded. Health expenses for each patient was obtained from hospital billing system. *Results:* Of the patients, 19.1% had NRS-2002³3 (nutritionally at risk) which was more frequent among male patients (61.8%) than female patients (38.2%) ($p<0.001$). The odds of being nutritionally at risk increased by 1.029 times with one year increase in age ($p<0.05$). The median of HGS was lower in patients with NRS-2002³3 ($p<0.05$). Patients without nutritional risk (NRS-2002<3) had a LOS of 7.65±7.61 days, while corresponding figure was 16.5±15.64 days for patients with NRS-2002³3 ($p<0.001$). Patients' health expenses with NRS-2002<3 and NRS-2002³3 were $384.19 and $873.89, respectively ($p<0.01$). One percent increase in involuntary weight loss and one unit decrease in HGS resulted in $2588 and $1066 increase in average expenses, respectively ($p<0.05$). The odds of becoming NRS-2002≥3 increased 1.566 times with 1% increase of involuntary weight loss ($p<0.001$). Cancer patients whose average LOS was 4.5 days longer had 4.93 times increased risk of developing nutritional risk during hospital stay ($p<0.001$). *Conclusion:* Nutritional status of patients should be assessed during hospitalization. Patients with nutritional risk have higher total costs and stay longer in the hospital than the patients with no risk.

Key words: Malnutrition, nutritional risk, hand grip strength, health expenses, length of stay in hospital

Introduction

Malnutrition due to starvation, disease or ageing defines a condition which results from lack of uptake or intake of nutrients leading to altered body composition (decreased fat free mass) and body cell mass Disease-related malnutrition (DRM) is an important problem in hospitalized patients (1). It is under-nutrition caused by changes of the body metabolism which increases the daily nutritional needs due to illness. DRM adversely impacts every organ system in the body with potentially serious consequences on a physical and psycho-social level that in turn contribute to increased morbidity and mortality (2). Nutritional risk of hospitalized patients

has been reported to range between 15% to 74%, depending on the hospital setting, patient population and the defining criteria used (3,4). These patients are at greater risk of comorbid complications, longer hospital stay, more frequent readmissions and mortality when compared to adequately nourished patients (1). In a multicenter study conducted in Turkey, 15% of patients was found nutritionally at risk on admission (5), and other studies in university hospital setting found this figure as 43.6% (6) and 24.7% (7).

It is important to determine the nutritional status of patients with screening tests during hospitalization (on the day of admission). The studies have shown that the initiation of appropriate nutritional therapy according to the screening test results reduced the rate of nutrition-related complications in patients, reduces in-hospital mortality and shorten the length of stay (8). The European Society of Parenteral and Enteral Nutrition (ESPEN) suggested the use of Nutrition Risk Screening-2002 (NRS-2002) to define nutritional risk in hospitalized individuals (9). Today, nutritional status screening is being performed in many countries during patients' admission to the hospital. Despite all the efforts, the rate of malnutrition in hospitalized patients has remained unchanged for years (10).

Evidence shows that disease-related malnutrition imposes high financial costs on health systems worldwide (11,12), which are closely associated with longer hospital stay, comorbid conditions and readmissions (13). It has been reported that disease-related malnutrition costs between 147-157 billion dollars annually in health expenditures in the USA (14). In a US study, hospitalized patients with malnutrition had more than a 50% higher rate of 30-day readmissions compared to those without malnutrition, and the associated cost of a readmission episode was nearly $17,000 (15). Annual costs in European Union countries were reported to be up to €120 billion (2).

While there are studies investigating the nutritional risk of patients during hospital admission, no study has been conducted to evaluate the effects of nutritional risk on health expenses and length of stay in hospital (LOS) in Turkey. Therefore, the present study was carried out to determine the nutritional risk of patients during hospital admission and its effect on health expenses and LOS.

Materials and Methods

Participants and Study Design:

The study protocol and the consent form were approved by the Institutional Human Subject Review Committee of Ankara University Faculty of Medicine (December 23, 2014; No: 15-575-13). The present study was carried out in Ankara University Hospitals in Ankara, Turkey between May 2015 and December 2016. The hospitals have 1200 beds and provide tertiary healthcare services in two separate campuses.

This cross-sectional causality analysis study used previously obtained malnutrition data by the nutrition support team of the same hospitals to determine the sample size. The total number of patients was estimated by assuming that the malnutrition rate during hospitalization was 45%, confidence interval was 95% with a sensitivity of ±2.5%. The prior year's hospitalization numbers of each clinic was used to for the number of patients to be included from each clinic. The patients who were between 18-65 years of age and volunteered to participate were included in the study. The patients from the emergency services, maternity clinics and intensive care units were excluded. Additionally, the patients from the clinics whose prior year's hospitalizations were less than 263, malnutrition expectation was low, average day of hospitalization was less than three were not included. The distribution of number of patients included from each clinic were shown in Table 1.

Nutritional Assesment and Anthropometric Measurements

The patient population (n=1069) comprised individuals between 18 to 65 years old and without end term illnesses. Patients' nutritional status were determined by Turkish version of NRS-2002 within of 24 hours of their admission to the hospital (9). The Turkish reliability and validity of NRS-2002 has been studied (16). It is comprised of two parts. The first part uses four questions to analyze the body mass index (BMI), lowered intake during the previous week, weight loss, and the severity of the patient's disease. In the event of

Table 1. The distribution of number of patients included from the clinics

Clinics	n	%
Cardiology	105	9.8
Neurology	28	2.6
Infectious Diseases	21	2.0
Transplantation Unit	14	1.3
Rheumatology	26	2.4
Cardio-thoracic surgery	33	3.1
Ear Nose Throat	78	7.3
Neurosurgery	54	5.1
Orthopaedics	65	6.1
Urology	77	7.2
Dermatology	40	3.7
Endocrinology	29	2.7
Gastroenterology	21	2.0
Nephrology	22	2.1
Medical Oncology	55	5.1
General Surgery	171	16.0
Surgical Oncology	25	2.3
Hematology	23	2.2
Bone Marrow Transplantation	12	1.1
Cardiovascular Surgery	36	3.4
Chest Diseases	72	6.7
Plastic Surgery	46	4.3
Gynecologic Oncology	16	1.5
Total	**1069**	**100.0**

an affirmative answer, the second part of the screening tool is applied, yielding a score (<3 points) according to weight loss, dietary intake and BMI, and another score (<3 points) according to the severity of the disease. When a score of ≥3 was obtained, the patient was classified as "nutritionally at risk". Then a nutritional management and monitoring plan were established accordingly (9). The information of disease(s) in NRS-2002 screening was recorded by consulting the patient's primary physician.

The following anthropometric measures were obtained: weight, height, and BMI. Height was measured at baseline with a stadiometer (Holtain Limited, Crymych, U.K.) and patients were weighed by a scale adjusted to 0.1 kg (SECA 665, Hamburg, Germany). After calculation of BMI, <18.5 kg/m^2 was used to define malnutrition as suggested by Cederholm *et al.* (17). Hand grip strength (HGS) was measured in the non-dominant hand with a Jamar dynamometer (Takei Scientific Instruments Co. Ltd, Japan). This was accomplished while the patients were sitting comfortably with shoulder adducted, forearm neutrally rotated, elbow flexed to 90°, and forearm and wrist were in a neutral position. They were told to perform three consecutive contractions one minute apart from each other, and the mean value was calculated (18).

Patients were also asked whether any unintentional weight loss had occured in the past three months. It was not possible to measure body weight and height in two and twelve of the patients, respectively. In forty two of them arm muscle strength was not obtained due to different reasons. Those patients were excluded from the study.

Health Expenses and Length of Hospital Stay

The health expenses were calculated based on LOS (i.e. the number of days between the first day of hospitalization and the day of discharge). The invoice total was separately calculated from each patient's hospital expense invoices. In the calculation, costs expenses were used. Cost is the amount of all production factors, expressed in money, spent for service production in healthcare institutions (19). It covers all factors that are directly or indirectly related to service production, such as medical supplies and general administrative expenses (20). The expense, on the other hand, is the monetary amount of the portion of the stock that is purchased in advance and used in the production of services in the institution's warehouse (21). Therefore, the concept of expense was used in the present study because the patient bills included the amount and monetary equivalent of the materials used in service production.

Statistical Analysis

Descriptive statistics were used for situations where patients were classified as "nutritionally at risk"

or not. Data were interpreted by frequency and percentage for categorical analyses, while mean, standard deviation, median, minimum and maximum values were used to interpret quantitative measurements. Cross tables and chi-square analyses were obtained for categorical situations, and for significant variables odds ratios of established logistic regression models were interpreted. For quantitative measurements, distribution assumptions were examined using the Kolmogorov-Smirnov test. When assumptions were met, independent Student's t-test was used for paired group examinations, and comparisons were made using Mann Whitney-U test for cases where it was not provided. For comparisons involving more than two groups, the necessary interpretations were made using one-way ANOVA for cases where the assumption was met, and the Kruskal Wallis test for cases where it was not provided. Logistic regression was applied for the NRS-2002 classification of the obtained significant variables and odds ratios were interpreted. ROC curves were plotted from the obtained probability outputs. Likewise, linear regression was used to examine hospitalization days and costs. In regression methods, all variables were included in the model and the cases where only significant variables were in the model were examined with the forward selection method. For all statistical analyses, SPSS 26.0 (SPSS, Chicago, IL, USA) was used. The level of significance was set as $\alpha=0.05$. The charts drawn for the relevant tests were drawn with MS Excel application and interpreted.

Results

The present study was carried out on 1069 patients whose descriptive information are shown in Table 2.

The highest number of patients with NRS-2002≥3 were in the oncology clinic (n=33) which was followed by general surgery (n=32) and cardio-thoracic surgery (n=14) (Figure 1).

The percentage of patients who were "nutritionally at risk" (NRS-2002≥3) was 19.1% (n=204). Significantly more male patients were with NRS-2002≥3 than female patients (p=0.003). Patients with NRS-2002≥3 had significantly lower BMI (p<0.001). Of the patients with BMI≤20, 16.8% were not nutritionally at risk (p <0.001). It was observed that 53.9% of the patients with NRS-2002≥3 had cancer diagnosis. This figure was significantly higher than patients with no diagnosis of cancer (p<0.001). Percentage of weight loss in the last three months was higher, and the median value

Table 2. Descriptive information of the patients in the study

	All (n=1096)	**NRS-2002<3 (n=865)**	**NRS-2002≥3 (n=204)**	**P**
Gender M (%) / F (%)	52.3 / 47.7	50.1 / 49.9	61.8 / 38.2	0.003
Age (years)	46.59±12.84	46.22±12.76	48.16±13.08	0.022
BMI	27.90±6.13	28.57±5.96	25.03±6.01	<0.001
BMI<18.5	6.8%	4.4%	16.8%	<0.001
Cancer diagnosis	21.9%	14.3%	53.9%	<0,001
Weight loss (last 3 months, kg)	1.88±4.51	0.54±2.02	7.67±7.08	<0.001
Hand grip strength (kg) (min-max)	23.0 (5.2-74.00)	23.50 (5.97-74.00)	21.27 (5.2-52.50)	0.022
Length of hospital stay (day) (min-max)	9.34±10.27	7.65±7.61	16.5±15.64	<0.001
Invoice total ($) (min-max)	447.27 (5.86-4802)	384.19 (5.86-47.886)	873.89 (27.28-48.022)	<0.001

Continuous variables with normal distribution were presented as mean±SD and skewed distributed variables were presented as median and interquartile range (IQR). Categorical variables were given numbers and percentages. BMI=Body Mass Index (kg/m^2), NRS-2002=Nutritional Risk Screening-2002

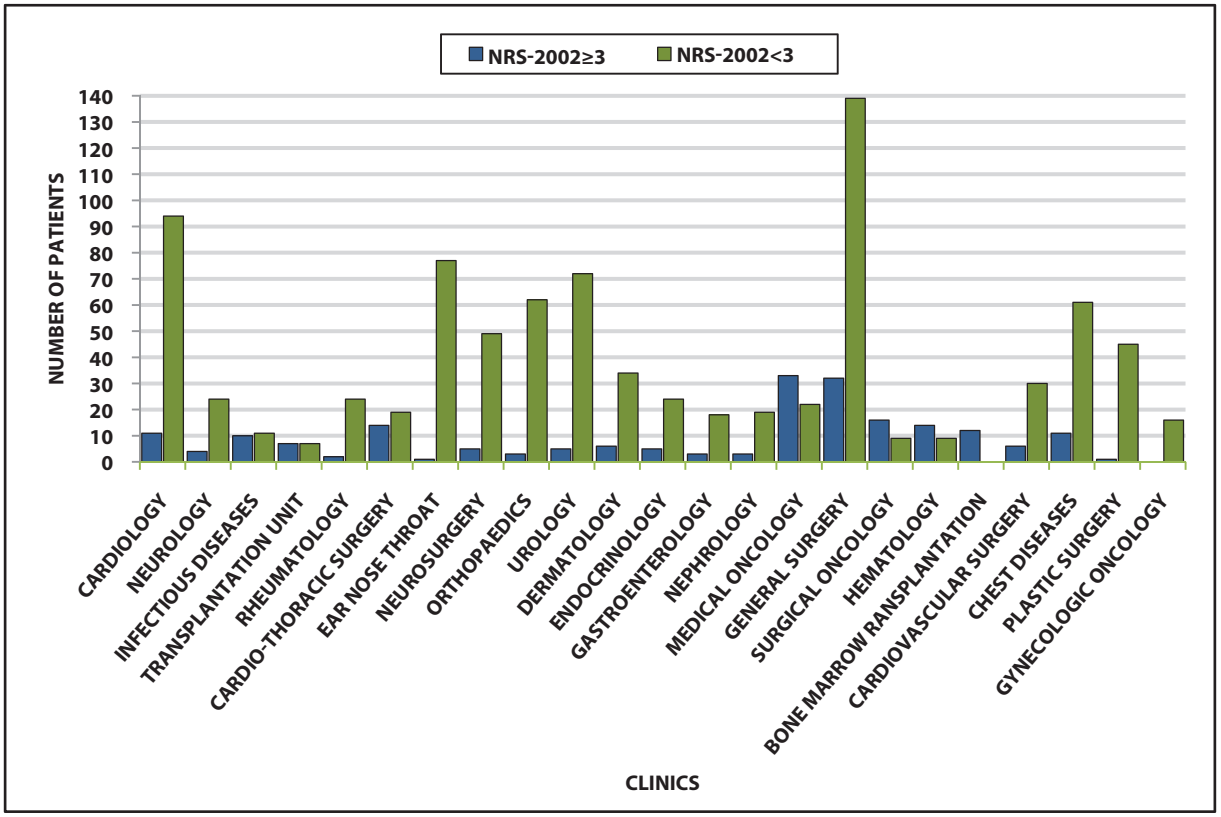

Figure 1. Distribution of patients according to NRS-2002 scores and clinics

of muscle strength was lower in patients with NRS-2002≥3 ($p<0.001$ and $p<0.05$, respectively). The mean hospitalization period was 9.34±10.27 days and patients with NRS-2002≥3 stayed longer in the hospital than those with NRS-2002<3 (16.50±15.64 vs. 7.65±7.61 days; $p<0.001$). The hospital expenses were significantly higher in patients with NRS-2002≥3 ($p<0.001$) (Table 2).

The patients' variables according to NRS-2002 scores are presented in Table 3.

Length of stay in hospital stay increased from 5 days to 21 days, in parallel to the increase in NRS-2002 scores. All pairwise comparisons between NRS-2002 scores and LOS and resulted in significant differences except for patient groups with scores 4 and 5 ($p<0.001$). In the comparisons of NRS-2002 scores and mean age, the patient group with score 0 was statistically different from all other groups ($p<0.001$). The mean ages of patient groups with scores 3 and 4 were lower than other groups but were similar to each other. The comparisons between NRS-2002 score groups and mean unintentional weight loss resulted in significant differences in all groups except for the comparisons between patient groups with scores 2 and 3, and 4 and 5 ($p<0.001$). In the comparisons between NRS-2002 scores and BMI, the patient groups with scores 0 and 2, and 4 and 5 did not differ significantly, while the patient group with score 1 had the highest BMI score ($p<0.001$). BMI decreased in contrast to the increase in NRS-2002 score. When mean hand grip strength measurements and NRS-2002 scores were evaluated, pairwise comparisons found significant differences between NRS-2002 scores 0 and 1, 0 and 2 and 0 and 4 ($p<0.001$, each). With regard to the comparisons for NRS-2002 scores and the invoice total, except for the patient groups with scores 4 and 5, all groups significantly differed ($p<0.001$) The median value of the invoice total was found to increase to $304.4 and $1613, when the patients' NRS-2002 scores were as 0 and 5, respectively.

Table 3. Patient variables according to NRS-2002 scores

	NRS-2002 Score							
	0	**1**	**2**	**3**	**4**	**≥5**	**p**	**Significantly different subsets*** **
Length of stay (day)	5.36±4.02	8.39±8.48	11.34±9.75	14.49±13.59	17.60±17.34	21.17±17.53	<0.001	a, b, c, d, e, f, g, h, i, k, l, m, n
Age (years)	41.69±13.08	49.44±11.26	47.93±12.99	47.82±13.25	47.63±13.57	50.69±11.23	<0.001	a, b, c, d, e
Weight loss (%)	0.06±0.64	0.49±1.93	2.06±3.54	5.40±4.95	8.51±7.12	13.74 ±9.36	<0.001	a, b, c, d, e, f, g, h, i, j, k, l, m, n, o
BMI	27.55±5.50	29.75±6.31	27.54±5.34	26.40±6.01	23.70±5.64	23.11±5.90	<0.001	a, c, d, e, f, g, h, i, j, k, l, m, n
Hand grip strength	26.63±11.39	24.71±10.52	23.96±8.80	24.34±9.47	21.65±10.60	23.05±8.21	<0.001	a, b, d
Invoice total ($) (min-max)	304.41 (32.97-8069)	454.04 (5.86-17816)	702.5 (5.86-47886)	750.7 (45.45-110183)	1112.13 (27.2-4802.2)	1613.7 (60.64-25514)	<0.001	a, b, c, d, e, f, g, h, i, k, l m, n

Continuous variable with normal distribution were presented as mean ± SD, and non-normally distributed variable were presented as median and minimum, maximum. BMI=Body Mass Index (kg/m^2), NRS-2002=Nutritional Risk Screening-2002

*** a: 0-1; b: 0-2; c: 0-3; d: 0-4; e: 0-5; f: 1-2; g :1-3; h: 1-4; i: 1-5; j: 2-3; k: 2-4; l: 2-5; m: 3-4; n: 3-5; o: 4-5

A multiple logistic regression model was established for patients with (NRS-2002≥3) and without risk (NRS-2002<3) by taking all significant variables into the model (Model 1) (Table 4).

For the case where significant variables were in the model, forward selection method was applied. In that case, variables that were significant at 95% confidence level were entered into the model. The obtained model has 91.6% correct classification rate, 97.3% sensitivity and 66.7% specificity. With every unit increase of hospital stay (day), age (year) and weight loss (%), the odds ratios of being "nutritionally at risk" (NRS-2002≥3) increased by 1.04 (p=0.007), 1.029 (p=0.011) and 1.566 (p<0.001), respectively.

All significant variables were taken into the model and a model was established for the length of hospital stay (Model 2). The necessary assumptions were examined and the model was found to be correct (Table 5).

In the model with a 20% explanation rate, it was found that nutritionally at risk patients stayed an average of 6 more days in the hospital (p<0.001). When patients who did not receive cancer treatment were compared, they stayed in the hospital for an average of 4.5 days longer (p<0.001). It was seen from the model that male patients had an average of 1.5 more days of hospitalization than female patients (p=0.038). Nutritionally at risk patients, on average, had a total expense of $55,923 more than patients with no nutritional risk (p<0.001). The minimum difference was $23,000. It was seen that 1% increase in weight loss resulted in $2588 increase in the average expense, while one unit decrease in muscle strength led to $1066 increase (p<0.05).

Table 4. Factors affecting patients' nutritional risk

Model 1	p	Odds	Odds Confidence Interval	
			Minimum	Maximum
LOS (days)	0.007	1.040	1.011	1.071
Age (year)	0.011	1.029	1.007	1.052
BMI (<18.5)	<0.001			
BMI (18.5-24.99)	0.024	0.238	0.069	0.828
BMI (25.0-29.99)	<0.001	0.084	0.023	0.310
BMI (≥30.0)	0.001	0.102	0.028	0.381
Weight loss (%)	<0.001	1.566	1.450	1.692
No cancer diagnosis	<0.001	0.203	0.117	0.354
Invoice total	0.007	1.000	1.000	1.000

The logical regression model among the significant variables, p<0.001. LOS=Length of hospital stay, BMI=Body Mass Index (kg/m^2)

Table 5. The effect of being nutritionally at risk on health expenses and length of hospital stay

Model 2: Length of hospital stay	**β**	**P**	**Minimum**	**Maximum**
NRS-2002≥3	6.208	<0.001	4.551	7.8
Cancer diagnosis	4.527	<0.001	3.006	6.05
Gender	1.533	0.038	0.087	2.98
Model 3: Health expense	**β**	**P**	**Minimum**	**Maximum**
NRS-2002≥3	55923	0.001	23024.41	91196.32
Weight loss (%)	-2588.25	0.027	-6763.15	-47.09
Hand grip strength	1.066,58	0.039	55.69	2077.48

Linear regression model among all significant variables. NRS-2002=Nutritional Risk Screening-2002

Discussion

Hospital malnutrition is a prevalent and critical public health problem. Due to increases in complication rates, morbidity, mortality, hospital readmission, and the length of hospital stay it creates economical burden both on the patients and the health care system (22). In the present study, by using NRS-2002, 19.1% of the patients were found to be nutritionally at risk during admission to the hospital. Patients from the clinics of cardio-thoracic and general surgery, oncology, hematology and chest diseases were significantly at more risk.

These findings were in line with Korfalı *et al.* (5) study who reported 15% of 29139 patients had nutritional risk. In an another study by Zhou *et al.* (23) among 810 general surgery patients 42.6% were nutritionally at risk. Sauer *et al.* (24) whose analysis included data of 9959 adults estimated that malnutrition risk was approximately 1 in 3 of the hospitalized patients. Despite many studies presenting its consequences, it is observed that hospital malnutrition rates do not change.

The European Society of Parenteral and Enteral Nutrition (ESPEN) has proposed BMI<18.5 to be accepted as cut-off value for malnutrition (17). In several studies, the decrease in the percent of malnutrition based on weight change trends and BMI during hospitalization has been reported (25,26). The present

study was able to determine that 16.5% of the patients with nutritional risk had a BMI of <18.5. Therefore, screening patients' nutritional status during hospital admission not only with BMI but with other methods will increase the effectiveveness of efforts to prevent hospital malnutrition.

Unintentional weight loss is perhaps the best validated nutritional assessment parameter (17,27). One of the diagnostic criteria of malnutrition suggested by the ESPEN is unintentional loss of body weight of more than 5% that has occurred over 3 months (17). The Global Leadership Initiative on Malnutrition (GLIM) has established a strong consensus for the inclusion of involuntary weight loss as a phenotypic criterion (28). According to Turkish NutritionDay 2006 data (5), 54% of the patients had weight loss before admission, and 24% of them had lost more than 8 kg in the past 3 months. In a study by Klek *et al.* (29) those data for 2011 were reported as 48% and 29%, respectively. In the present study, the amount of weight loss was higher (approximately 8 kg) in nutritionally at risk group compared to not-at-risk group. It was also observed that involuntary weight loss increased in parallel to NRS-2002 score increase. When weight loss (%) increased by 1%, the probability of individuals becoming nutritionally at risk (NRS≥3) increased 1.566 times. Therefore, it is important to question the unintentional weight loss in patients during assessment of nutritional risk on admission to the hospital (17).

Nutritional status is one of the important factors affecting the duration of hospital stay (4,30). Hiller *et al.* (31) and Guerra *et al.* (32) reported 7 more days longer hospital stay in patients with malnutrition. Hudson *et al.* (33) in their study on 3907 patients, reported that the hospitalization period was 3 days longer (15 vs 12 days) in patients with malnutrition. The present study also found that patients with nutritional risk were hospitalized for an average of 6 more days than those who were not. In addition, one day increase in hospitalization period increased the probability of being at risk (NRS-2002≥3) by 1.04 times.

In the present study higher percentage of male patients had NRS-2002≥3 when compared to female patients (61.8% vs 38.2%). Furthermore, it was also found that male patients with nutritional risk stayed more than a day longer in the hospital as compared to at risk female patients. Another multicenter study reported increased nutritional risk and length of hospital stay in women than men (55.84% vs 44.16%) (34). A study with 2906 hospitalized patients found that women had a lower rate of malnutrition than men and the highest increase in length of stay was observed in male patients with malnutrition aged 60 years or older (35). De Santiago *et al.* (36) stated gender as a protective factor for malnutrition in their patient population where 65.3% of patients without nutritional risk were women. Despite the statistically insignificant difference between gender and malnutrition in their study, Hudson *et al.* (33) reported the rate of malnutrition to be higher in men than women (53.85% vs 46.15%). Although being male was found to be a risk factor in terms of malnutrition in the present study, it is clear that the literature is lacking a consensus on this issue.

Age is another important risk factor for malnutrition risk. In a study by Hudson *et al.* (33) older patients (61 vs 58 years of age) were found to be significantly malnourished, and fewer patients who were not malnourished were <50 years old (22.35% vs 31.07%). In the present study, it was found that the average age of nutritionally at risk patients was higher than those who were not. Being one year older increased the chance of being nutritionally at risk by one-fold. Nutritional treatment of the patient should be planned with this point of view in mind, since together with the age of patient, the disease stress will lead to increased risk on the patient's nutritional status. Properly planned nutritional therapy is an important factor in preventing the development of many complications for patients who are nutritionally at risk (4).

One of the important parameters used in determining the nutritional status of patients is hand grip strength (37). Muscle function reacts early to nutritional deprivation (38), which makes HGS particularly useful for evaluating acute changes in nutritional status and predicting specific outcomes (i.e. mortality, hospitalization cost) (39,40). It is also an independent factor that was associated with longer hospital stay (38). In this study, the median value of HGS was lower in nutritionally at-risk patients. It was observed that by 10-unit increase in muscle strength, the duration of hospital stay decreased by one day on average.

Malnutrition is a frequent medical problem in cancer patients who are particularly at high risk (41). Numerous studies have highlighted the consequences of malnutrition in patients with cancer, including adverse impact on health, survival and increased healthcare costs (41,42). Patients with colorectal cancer who were found to be nutritionally at risk on admission stayed 7 days more in the hospital (43). According to PREDyCES study, mean duration of hospitalization and healthcare costs were greater in nutritionally at risk patients (12.1 days) than in well-nourished patients (8.6 days) (42). In this study, approximately one out of every four patients admitted to the hospital had a type of cancer diagnosis (27.9%). Of the patients with cancer diagnosis, 53% was found to be nutritionally at risk. Cancer patients had 4.93 times increased risk of developing nutritional risk during hospital stay which was 4.5 days longer on average. This period was shorter in patients with poor nutritional status but with no cancer diagnosis. Therefore, it becomes very important to determine the nutritional status of patients and to make an appropriate nutrition plan during hospitalization (1).

In this study, the median of total health expenses of patients was $447.27. This amount was as twice as high for nutritionally at-risk patients. Invoice total increased in parallel to the increase in NRS-2002 scores. One unit reduction in muscle strength and 1% increase in weight loss had significant effects on the expenses. In numerous studies it was shown that mmalnourished patients incurred higher costs than non-malnourished ones (13,44-46). According to Curtis *et al.* (13) cost increase for malnourished patients has ranged between 45% and 102%. However, Amaral *et al.* (44) demonstrated an average of 19.3% higher costs in the malnourished group. Other research groups reported higher cost increases ranging between 31% to 50% (45).

Malnutrition is a financial burden on healthcare institutions and it is gradually increasing. The results of a Canadian study indicated that approximately 40% of patients were malnourished on admission and they cost between $1500 and $2000 more per hospital stay than well-nourished patients (13). In a European study, after excluding extreme expenditures, being nutritionally at-risk was associated with approximately €5085 higher actual healthcare costs (46). According to the authors the finding was consistent with the results of a previous review where being undernourished led to an additional cost ranging between €1640 and €5829 (12). In a study conducted in Germany, it was predicted that the cost of malnutrition was €9 billion in 2013, and that would increase to €11 billion in 2020 (47).

This was the first study investigating the effect of nutritional risk on health expenses in Turkey. One of its limitations was related to the cost calculation which was not carried out in accordance with the disease related group (DRG) costs (48). However, at the time of study, DRG costs were not employed in the hospitals where the study was conducted. Hence, the cost calculation was based on the concept of expense. To this end, invoices of all expenses of the patient during hospitalization were added up and calculated as expense. With this method of calculation, the expenditures made on nutritionally at risk patients were found to be much higher than those who were not. It is plausible to suggest that even more remarkable results could be reached with a full cost calculation as observed in the literature (13,48).

Another limitation of the study might be related to its sample size. Due to the method used to choose the sample size, only a proportion of patients in the clinics who were at nutritional risk was included. Hence, a general ratio of nutritionally at-risk patients during hospitalization has been reached. It is obvious that in order to determine the nutritionally at risk patients in respective clinics and be more effective in raising the awareness for preventing possible complications related to hospital malnutrition, research with a larger patient population is warranted.

Conclusions

The nutritional risk of the hospitalized patient should be determined by assessing the nutritional status. The presence of malnutrition in hospitalized patients increases the cost, which brings additional economic burden to the health system. In the present study, 19.1% of hospitalized patients were nutritionally at risk to which status being old and male, unintentional weight loss and the presence of cancer diagnosis significantly contributed. Reduced HGS

was found as a determining factor for increased health expenditures and length of stay. Patients with nutritional risk stayed longer in the hospital and total health expenditures were higher than patients with no nutritional risk. Assessing the nutritional status of the patients following hospitalization and implementation of an appropriate nutrition plan may contribute to reducing the hospitalization period and the health expenditures.

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