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Original article

Malnutrition rate among hospitalized patients with type 2 diabetes mellitus

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Summary. *Aim:* Rate of obesity is high among patients with type 2 diabetes thus assessment of the nutritional status is often ignored in these patients. This study aimed to evaluate nutritional status of patients with type 2 diabetes mellitus who were hospitalized forpoor glycemic control and to define the risk factors related to malnutrition. *Methods:* Study included a total of 104 patients (67 female, 37 male, mean age: 65.08±12.57) who were hospitalized in the Internal Medicine Clinics for poor glycemic control. Patients' nutritional status was evaluated on the first day of admission. Demographic, anthropometric and biochemical data of the cases were evaluated. Nutritional status was assessed with Mini Nutritional Assessment(MNA) test. *Results:* Malnutrition rate was 7.7%, rate of the patients with malnutrition risk was 18.3% and rate of the patients with normal nutritional status was found as 74%. Body mass index was 25 kg/m^{2}or higher in 37.5% of the patients with malnutrition and 63.2% in patients with malnutrition risk. In logistic regression analysis, duration of diabetes [(between 15-20 years OR: 5.535 (95% CI:1.15-26.61), >20 years OR: 7.147 (95% CI:1.59-31.96)] and BMI[<25 kg/m2 OR: 4.565 (95% CI:1.47-14.13)] were the independent risk factors correlated with malnutrition. *Conclusions:* One in every four patients with type 2 diabetes hospitalized due to poor glycemic control was observed to have malnutrition or have malnutrition risk indicating nutritional assessment should be performed in hospitalized patients with type 2 diabetes even if they are overweight or obese.

Key words: type 2 diabetes; malnutrition

Introduction

Malnutrition is a nutritional condition which emerges with the decrease or increase (or imbalance) of energy, protein and other nutrients, and poses effects in the form (shape, size and composition) and function of tissues/body that are measurable in clinics (1). It's risk profile is often associated with lower body mass index, but studies have shown that patients with normal or high BMI can also be at malnutrition risk (2).

Type 2 diabetes is a worldwide epidemic associated with obesity (3). Patients often have high BMI and weight loss is the center of diabetes treatment (4). Due to patients' obese appearance, malnutrition risk of these patients is often not evaluated by the health practitioners in clinical settings (5).

Objective of this study was to assess nutritional status of patients with type 2 diabetes mellitus who were hospitalized due to poor glycemic control and to define the risk factors related to malnutrition.

Methods

All the patients with type 2 diabetes mellitus who were hospitalized in the internal medicine clinics of [removed for blind peer review] for poor glycemic

control (high glucose levels) between September 2014 and January 2015 were recruited. Patients with severe renal, cardiac or liver dysfunction, malignancy, requirement of intensive care unit, diabetic decompensation and patients with confused consciousness and unconscious patients were excluded. The study was approved by [removed for blind peer review] (Date: 09.09.2014, No: 2014/0139) and written consents of the patients were received. Helsinki Declaration principles were followed during the study.

Sample size was calculated with G*Power (v3.1.7) program. Malnutrition rate of patients with type 2 diabetes was presumed to be 27-30% according to literature. Therefore, to achieve 28%, 104 cases were recruited (7% error, α=0.10).

Detailed medical history was obtained and physical examination was performed to all the patients who met the inclusion criteria and who accepted to be enrolled. Age, gender, history, duration of diabetes, treatment characteristics, comorbidities, smoking and alcohol consumption were questioned. Blood pressure, height, weight, waist circumference, calf circumference and upper arm circumference were measured. Fasting blood glucose, hemoglobin A1c (HbA1c), urea, creatinine, total cholesterol, low density lipoprotein cholesterol (LDL), high density lipoprotein cholesterol (HDL), triglyceride, alanine transferase and aspartate transferase values were recorded from the patients' files. Nutritional status of the patients was assessed on the first day of hospitalization with Mini Nutritional Assessment (MNA). Demographic, anthropometric and biochemical data of the patients having malnutrition, risk for malnutrition and normal nutritional status defined with MNA were compared and logistic analysis was performed to assess the correlation between nutritional status and clinical features. Nutritional status of the patients was further assessed with the Nutritional Risk Screening (NRS-2002) (6).

In physical examination of the patients; blood pressure, height, weight, waist circumference, calf circumference and upper arm circumference were measured with standard measuring instruments by the same person. Measuring of the waist circumference was performed from the narrowest part of the waist in the plane crossing between spina iliaca anterior superior in the patients standing with mild expiration. Calf circumference was measured from the widest part with the legs bending 90 degrees from the knee and sole pressing to a firm and flat ground. Measurement of the upper arm circumference was performed with marking the mid-point between the shoulder and elbow. Patients were weighed in an upright position looking ahead with room clothes worn and without shoes. Height was measured with the feet joined together and without shoes. The BMI was calculated as the body mass in kilograms divided by the square of the body height in meters (kg/m^2).

Glucose, total cholesterol, HDL, LDL, triglyceride, alanine transferase, aspartate transferase measurements were carried out with enzymatic method using COBAS 8000 (Roche Diagnostics, Switzerland), while HbA1c measurement was carried out with boronate affinity high liquid pressure chromatography method using Primus Ultra 2 (Trinity Biotech, ABD) device.

A total of 6 questions were asked to the patients in MNA screening test. As a result; patients were categorized as having a normal nutritional status, risk for malnutrition and those with malnutrition. MNA assessment test which consisted of 12 questions was applied to the patients with risk for malnutrition. According to the results of this test, patients were categorized again. Data obtained were added to the patient groups which were categorized in the screening testing (7). Patients were categorized and scored according to malnutrition and severity of disease. Patients with a total score ≥3 were under risk for malnutrition (8).

Number Cruncher Statistical System 2007 and Power Analysis and Sample Size 2008 Statistical Software (Utah, USA) were used. Student T test was used for comparison of two group in parameters showing normal distribution and Mann Whitney U test for comparison of two group in parameters with non-normal distribution. Kruskal Wallis test was used for comparison of 3 and more groups which did not show normal distribution, while Mann Whitney U test was used for determination of the group causing the difference. Pearson Chi-square and Fisher-Freeman-Halton tests were used for comparison of the qualitative data. Logistic Regression analysis was carried out in multivariate analysis of the risk factors affecting malnutrition. The level of statistical significance was set at $p<0.05$.

Results

Study included 104 patients with type 2 diabetes (67 female, 37 male, mean age: 65.08±12.57). Comorbidities and treatment characteristics of the patients are given in Table 1. The most common comorbidities were hypertension, hyperlipidemia and coronary artery disease (67.3%, 48.1% and 26.9%). Mean diabetes duration was 10.01±9.12 years.

MNA screening and assessment results of the patients are shown in Table 2. According to results of MNA; 4.8% of the patients had malnutrition, 24% had malnutrition risk and 71.2% had normal nutritional status. MNA assessment test was performed to 25 patients who had malnutrition risk. Among these patients, 12% had malnutrition, 76% had malnutrition risk and 12% had normal nutritional status. According to the results of MNA screening and assessment tests; 7.7% of all the patients had malnutrition, 18.3% had malnutrition risk and 74% had normal nutritional status. Whereas according to the assessment with NRS-2002; frequency of patients under risk for malnutrition was 21.1% and incidence of those with normal nutritional status was 78.9%.

Table 1 - Incidence of comorbidities and treatment characteristics

Comorbidities	**n**	**%**
Incidence of coronary artery disease	28	26.9
Incidence of hyperlipidemia	50	48.1
Incidence of hypertension	70	67.3
Incidence of chronic kidney disease	26	25.0
Incidence of heart failure	25	24.0
Incidence of Dementia-Alzheimer	9	8.7
Incidence of peripheral artery	4	3.8
Frequency of patients using oral anti-diabetics	43	41.3
Frequency of patients using insulin	80	76.9
Frequency of patients using oral anti-diabetics + insulin	20	19.2
Frequency of patients using anti-hypertensive drugs	65	62.5
Frequency of patients using other drugs	73	70.2

Table 2 - Distributions according to MNA Testing

Nutritional Assessment	**n**	**N(%)**
MNA screening (n=104); n (%)		
Patients with malnutrition	5	4.8
Patients with risk for malnutrition	25	24.0
Patients with normal nutritional status	74	71.2
Assessment outcome in the patients having risk for malnutrition (n=25); n (%)		
Malnutrition	3	12.0
Risk for malnutrition	19	76.0
Normal nutritional status	3	12.0
MNA screening and assessment outcome; (n:104); n (%)		
Malnutrition	8	7.7
Risk for malnutrition	19	18.3
Normal nutritional status	77	74.0

Clinical characteristics of the cases according to the outcomes of MNA screening and assessment tests are given in Table 3. There were no smokers in malnutrition group whereas smoking frequency was similar in malnutrition risk group and normal nutritional group (15.8% vs. 14.3%). BMI of the patients with malnutrition was lower patients with malnutrition risk and patients with normal nutritional status (p=0.009; p<0.01). In 37.5% of the cases with malnutrition and in 63.2% with malnutrition risk BMI was >25 kg/m^2 and higher. Diastolic blood pressure was significantly lower in the patients with malnutrition compared to those with malnutrition risk and normal nutritional status (p=0.013). Although not statistically significant most of the patients with malnutrition were in the first five years of diabetes diagnosis whereas patients with malnutrition risk was mostly had the disease for more than 20 years.

Mean BMI and waist circumference of the male patients were 28±5 and 105±14 cm, respectively whereas female patients' mean BMI was 29±5 and mean waist circumference was 104±14 cm. Mean MNA screening

Table 3 - Clinical characteristics of the groups according to the outcome of MNA screening and assessment

Characteristics		**Total (n=104)**	**Malnutrition group (n=8)**	**Malnutrition risk group (n=19)**	**Normal nutritional group (n=77)**	***p***
Age (year)		65.09±12.58	70.75±10.74	65.53±13.17	64.39±12.60	***0.320***
Gender; *n (%)*	Female	67(64.4)	5(62.5)	10(52.6)	52(67.5)	***0.469***
	Male	37 (35.6)	3 (37.5)	9 (47.4)	25 (32.5)	
Smoking frequency; *n(%)*		14 (13.5)	0 (0)	3 (15.8)	11 (14.3)	***0.541***
Alcohol frequency; *n (%)*		3 (2.9)	0 (0)	1 (5.3)	2 (2.6)	***0.339***
Duration of disease; *n (%)*	0-5 years	47 (45.2)	3 (37.5)	5 (26.3)	39 (50.6)	***0.156***
	5-10 years	22 (21.2)	2 (2.0)	3 (15.8)	17 (22.1)	
	10-15 years	8 (7.7)	0 (0)	2 (10.5)	6 (7.8)	
	15-20 years	14 (13.5)	2 (25.0)	3 (15.8)	9 (11.7)	
	>20 years	13 (12.5)	1 (12.5)	6 (31.6)	6 (7.8)	
DM duration (year);		10.00±9.12	11.75±10.38	13.68±9.62	8.92±8.71 (5)	***0,092***
BMI (kg/m^2);		28.75±5.55	24.66±4.74	26.99±5.86	29.62±5.30	***0.014****
	<25 kg/m^2	29 (27.9)	5 (62.5)	7 (36.8)	17 (22.1)	***0.480***
BMI	≥25 kg/m^2	75 (72.1)	3 (37.5)	12 (63.2)	60 (77.9)	
Waist circumference (cm)		104.92±14.24	98.75±13.91	102.47±15.85	106.17±13.79	***0.256***
SBP (mmHg)		123.63±16.24	126.25±15.98	127.21±18.62	122.48±15.70	***0.474***
DBP (mmHg)		71.49±8.21	63.75±5.17	72.10±8.38	72.14±8.09	***0.013****
FPG (mg/dl)		227.64±102.09	197.00±110.68	246.53±110.29	226.17±99.63	***0.564***
HbA1c (%)		9.15±2.78	7.49±2.87	9.55±2.61	9.23±2.79	***0.163***
Total cholesterol (mg/dl)		190.03±80.21	155.13±47.66	170.63±35.85	198.44±88.95	***0.148***
HDL cholesterol (mg/dl)		35.27±13.79	32.50±8.94	37.05±14.80	35.12±14.03	***0.915***
LDL cholesterol (mg/dl)		108.70±40.85	95.38±37.60	101.06±28.63	112.19±43.64	***0.342***
Triglyceride (mg/dl)		218.61±242.07	136.00±58.22	183.89±126.60	235.75±272.01	***0.424***
AST (IU/L)		28.83±32.79	27.88±12.89	26.05±22.57	29.61±36.32	***0.507***
ALT (IU/L)		30.84±54.80	19.38±10.73	32.47±61.51	31.62±56.11	***0.402***

DM: Diabetes mellitus, BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, FPG: Fasting plasma glucose, HDL: High-density lipoprotein LDL: Low-density lipoprotein, AST: Aspartate aminotransferase ALT: Alanine aminotransferase

results of the male patients was 11.8±2 and female patients was 12.2±2. There was no statistically significant difference between male and female patients regarding their MNA screening scores.

In logistic regression analysis, duration of diabetes [(between 15-20 years OR: 5.535 (95% CI:1.15-26.61), >20 years OR: 7.147 (95% CI:1.59-31.96)] and BMI [<25 kg/m^2 OR: 4.565 (95% CI:1.47-14.13)] were the independent risk factors correlated with malnutrition.

Discussion

In this study, one in every four patients hospitalized due to poor glycemic control had malnutrition or malnutrition risk. More than half of the patients with malnutrition risk had a BMI >25 kg/m^2 and higher. These results are noteworthy given the fact that malnutrition is often associated with low BMI and patients with diabetes have high BMI.

Considering the age of the cohort several factors including physiological changes occurring with aging, autonomic neuropathy and multi-drug use may have predisposed to malnutrition (9, 10). In a multicenter observational study investigating the incidence of malnutrition (with NRS-2002) in hospitalized patients (mean age: 63); incidence of malnutrition was found as 23.7% and 30.1% of these patients were diabetics (11). In another study investigating the incidence of malnutrition (with MNA) of hospitalized elderly (mean age: 78) diabetics and the effect of malnutrition on the prognosis; prevalence of patients with malnutrition risk was found as 39.1% and percentage of patients with malnutrition was 21.2% It was also reported as the result of multivariate analysis that female gender, age and existence of diabetic complications were the factors correlated with malnutrition (12). In our study, according to MNA test one in four and according to NRS-2002 about one in five hospitalized diabetic patients were found to have malnutrition or risk for malnutrition supporting the hypothesis that the risk for malnutrition might be high in diabetics. However, lower incidence in our study compared to the previous studies might be caused by the relatively lower mean age of our patients.

Although there was a correlation between diabetes duration and malnutrition, patients with malnutrition had diabetes diagnosis for less than five years. However most of the patients with malnutrition risk had higher diabetes duration. In patients with long diabetes duration, insulinopenia develops due to decrease in beta cell reserve and decrease in the fat free body mass because of decrease in intra- and extracellular fluid (13, 14). Given that the mean duration of diabetes was long and glycemic control was poor in our patients, we believe that these factors may have played a role in high rate of malnutrition in our cohort.

Multi-drug use has been reported to be correlated with malnutrition in diabetic patients. In a prospective study by Vischeret al. with 146 patients with diabetes (mean age: 82.5, mean BMI: 29.6 kg/m^2); 51.4% of the patients were observed to use oral hypoglycemic agents, 30.8% insulin and 9.6% insulin+oral hypoglycemic agents; MNA score was found to be low even in obese patients and it was emphasized that unnecessary drug use should be avoided in elderly diabetic patients (10). Given that in our study 41.3% of the patients were using oral antidiabetics, 76.9% insulin and 19.2% oral antidiabetics + insulin; multidrug use may have had a partial role in malnutrition rate of our study.

Comorbidities may also have effects on malnutrition in diabetic patients. In a prospective, randomize controlled, double-blind study; 60 patients aged 60 years and over who have Wagner grade 1-2 diabetic foot ulcer for more than four weeks were included and 2/3 of the patients were observed to have malnutrition (15). On the other hand, incidence of protein malnutrition was reported to be higher in the diabetics who have hemodialysis compared to the non-diabetics (16). In our study; high incidence of comorbidities such as hypertension, hyperlipidemia, coronary artery disease, chronic kidney disease and heart failure may have contributed to the high incidence of malnutrition. Exclusion criteria of our study including severe heart, kidney and liver disorders, patients requiring intensive care and unconscious patients might have enabled healthier interpretation of the data.

In our study malnutrition and malnutrition risk were observed in overweight and obese patients suggesting nutritional imbalance and micronutrient deficiency can be seen in obese persons. In a study by

Horvath et al. morbid obese patients had significant micronutrient deficiency and women were more inclined to have nutritional deficiencies (17).This observation underlines the importance of food quality. Overeating foods which are rich in energy but poor in nutrients may cause both obesity and malnutrition.

There are several limitations of the study. Although our sample size was sufficient enough to detect malnutrition, it was relatively small for subgroup analyses. We were unable to provide data on possible associations. Also, due to scarceness of relevant data we were unable to compare our study results with other reports.

In conclusion; incidence of malnutrition and risk for malnutrition may be high even in overweight and obese patients with type 2 diabetes. Assessment of the nutritional status regardless of body mass index and determination of the nutritional characteristics especially in patients with poor glycemic control should not be overlooked.

Compliance with Ethical Standards

Setting: Research was conducted at Istanbul Medeniyet University Goztepe Training and Research Hospital

Ethics Approval: Ethics Committee of Istanbul Medeniyet University approved the protocol (Date: 09.09.2014, No: 2014/0139).

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