Original Article

Nutritional Screening of Outpatient Type 2 Diabetes Mellitus Patients

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ABSTRACT

Objective: To examine the parameters affecting the existence and prevalence of malnutrition in type 2 diabetic patients at initial presentation

Design: Cross-sectional study

Setting: Department of Internal Medicine, Sakarya University Research and Education Hospital, Turkey

Subjects: Nutritional screening of 580 outpatients with the diagnosis of type 2 diabetes who presented to an outpatient clinic

Intervention: Medical treatment of diabetic patients

Main outcome measure: The parameters affecting the existence and prevalence of malnutrition in type 2 diabetic patients

Results: Mean ± standard deviation age of the patients was 54.6 ± 10.7 years. Of the 580 patients, 327 were women (56.4%). Malnutrition prevalence was 11.4% with Subjective Global Assessment and 9% with Mini Nutritional Assessment and Malnutrition Universal Screening Tool. Body mass index (BMI), albumin, fat%, mid-arm circumference and calf circumference were significantly lower and glycated hemoglobin (HbA1c) was significantly higher in patients with malnutrition, compared to patients without malnutrition. Malnutrition was significantly associated with weight loss, change in dietary intake and diminished physical activity (p = 0.005). Logistic regression model, including BMI ≤30.35 kg/m², HbA1c ≥8.69 mmol/mol, fat% ≤35.85% cut-off values, presence/absence of change in dietary intake and diminished physical activity as independent predictors of malnutrition revealed that patients with HbA1c ≥8.69 mmol/mol, fat% ≤35.85%, who had change in dietary intake or had diminished physical activity were 3.7, 2.9, 29.2 and 4.4 times more likely to have malnutrition.

Conclusion: Type 2 diabetic patients are often obese and thus higher cut-off for BMI and fat% may be necessary to detect malnutrition. Poor glucose control, decreased fat%, change in dietary intake and especially diminished physical activity are independent predictors of malnutrition in this population.

INTRODUCTION

Malnutrition comprises various clinical states resulting from low intake of macronutrients. It is associated with prolonged hospital stay, increase in frequency of readmissions, severity of infections, poor wound healing, disturbance in walking, falls and fractures. Malnutrition is more frequent in patients with chronic diseases[1].

Type 2 diabetes mellitus (DM) is a chronic metabolic disorder that is characterized by high blood glucose, insulin resistance and relative lack of insulin. Long term complications from high blood glucose include heart disease, stroke, and diabetic retinopathy that can result in blindness, kidney failure and poor blood flow in the limbs, which may lead to amputations[2]. Diabetes is associated with an increased risk of suffering malnutrition. Inflammation, oxidative stress and some genetic components can cause malnutrition in DM[3].

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Malnutrition Universal Screening Tool (MUST), Mini Nutritional Assessement (MNA), Nutrition Risk Screening-2002 (NRS-2002), and Subjective Global Assessment (SGA) are malnutrition scales that have been used in various patient populations. Also, anthropometric measurements and several laboratory parameters are used for malnutrition screening.[4,5]

There are few studies about malnutrition in DM. Diabetic complications, inability to adapt to the diabetic diet, diabetic gastropathy, loss of appetite, decrease of energy intake and problems associated with high blood glucose, nausea, and vomiting can cause malnutrition in diabetic patients.

In this study, we aimed to examine the parameters affecting the existence and prevalence of malnutrition in type 2 diabetic patients on initial presentation to an outpatient diabetes clinic.

SUBJECTS AND METHODS

A total of 580 outpatients with the diagnosis of type 2 DM who presented to the diabetes outpatient clinic at Sakarya University Hospital from 2012 to 2015 have been included in this study. We used American Diabetes Association Criteria 2012 to diagnose type 2 DM.

Patients who were pregnant or younger than 18 years, had a diagnosis of malignancy, type 1 diabetes mellitus, cerebrovascular diseases, thyroid dysfunction, cirrhosis, chronic renal failure (Cockcroft-Gault formula GFR < 60 ml/min) or in whom anthropometric measurements or nutrition tests could not be performed were excluded from the study.

Patients’ age, gender, diabetes duration, medications, additional diseases and history of smoking were recorded. Height, weight and anthropometric measurements (mid-arm circumference and calf circumference) of all patients were measured. Mid-arm circumference was defined as the circumference taken at the mid-point between the shoulder and elbow of the bare left arm using a tape measure. Calf circumference was measured from the largest part of right calf using a tape measure while the patient was sitting in the chair (leg from the knee bent at 90 °C). Basal metabolic rate (BMR), fat mass, fat free mass, total body water (TBW), body mass index (BMI) and fat% were measured by Tanita Composition Analyzer TBF-300. Demographic, anthropometric and laboratory data were compared between groups with and without malnutrition.

SGA as well as MUST and MNA screening tests were performed for nutritional evaluation. MUST was used for patients below 65 years and MNA for those over 65 years, whereas SGA was performed for the whole group. After recording the parameters, patients were evaluated in three categories: (A) “nutritional status good/sufficient,” (B) “high risk of malnutrition” and (C) “severe malnutrition”. The last two categories were merged in all screening tests and patients were divided into two groups: normal nutritional status or malnutrition. After determination of malnutrition rates for each test, SGA was applied to all patients and was accepted as the gold standard for nutritional status.

In our study, change in dietary intake was defined as decreasing food intake during the last one month, whereas diminished physical activity was defined as working suboptimally and decreasing physical activity in the last one month.

Parameters that were used in SGA evaluation were assessed for their effect on nutritional status. Receiver operating characteristic (ROC) analysis was performed to determine cut-off values of the continuous parameters affecting nutritional status. Then, a logistic regression model was constructed using cut-off values and categorical variables to determine independent predictors of malnutrition.

Statistical Analysis

Data was analyzed using statistical software SPSS, version 15.0 [SPSS Inc, Chicago, IL] and MedCalc 16.4.3 [1993-2016 MedCalc Software bvba] trial version. Distribution characteristics of continuous data were determined using histogram examination and one-sample Kolmogorov-Smirnov test. Normally distributed data were presented as mean (standard deviation) and compared with 1-way analysis of variance. Non-normally distributed data were analyzed using Mann-Whitney U test. ROC analysis was used to determine cut-off values for significant continuous data. Categorical associations were evaluated using χ2 test and logistic regression analysis. Statistical significance was defined by p ≤0.05.

Ethical Statement

Ethical approval was obtained through the medical school ethic committee (Ethical recommendations of the Declaration of Helsinki and the Ethical Committee of Sakarya University, Faculty of Medicine). Informed consent were obtained from all patients.

RESULTS

We included 580 patients in this study. Mean (SD) age was 54.7 (10.4) years. There were 327 women (56.4%). Malnutrition prevalelce was the same (9%) with MNA and MUST. Malnutrition prevalence was 11.4% according to SGA. Other characteristics and demographic data are summarized in Table 1. BMI, albumin, fat%, mid-arm circumference and calf circumference were significantly lower, and glycated
hemoglobin (HbA1c) was significantly higher in patients with malnutrition, compared to patients without malnutrition (Table 1 and Fig 1).

Malnutrition was significantly associated with weight loss, change in dietary intake and diminished physical activity (Table 2) (Pearson $\chi^2 = 7.758, 222.2, 238.4, 190.5, 4.958$ and $p = 0.005, <0.001, <0.001$ and $=0.026$, respectively). It was not associated with gender, smoking, oral antidiabetic drugs/insulin or presence of additional disease (hypertension, coronary artery disease or others).

The effects of BMI, HbA1c and fat% on malnutrition were analyzed by ROC curve and areas under curve (AUCs) were found to be statistically significant (Figure 2 and Table 3). Sensitivity, specificity, positive predictive value, negative predictive value (NPV),

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### Table 1: Demographic, laboratory and anthropometric data in patients with and without malnutrition

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Normal n = 514</th>
<th>Malnutrition n = 66</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean ± SD)</td>
<td>54.7 ± 10.4</td>
<td>54.1 ± 12.5</td>
<td>0.678</td>
</tr>
<tr>
<td>Gender (W/M)</td>
<td>297/217</td>
<td>30/36</td>
<td>0.57</td>
</tr>
<tr>
<td>Smoking (n(%))</td>
<td>65 (13)</td>
<td>8 (12)</td>
<td>0.904</td>
</tr>
<tr>
<td>Drug usage (OAD/Insulin)</td>
<td>344/170</td>
<td>48/18</td>
<td>0.343</td>
</tr>
<tr>
<td>Additional disease (n(%))</td>
<td></td>
<td></td>
<td>0.962</td>
</tr>
<tr>
<td>- Hypertension</td>
<td>192 (37)</td>
<td>24 (36)</td>
<td></td>
</tr>
<tr>
<td>- Coronary disease</td>
<td>36 (7)</td>
<td>6 (9)</td>
<td></td>
</tr>
<tr>
<td>- Other</td>
<td>5 (1)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>DM duration (month, median)*</td>
<td>48 (119)</td>
<td>36 (119)</td>
<td>0.204</td>
</tr>
<tr>
<td>BMI (kg/m², median)*</td>
<td>34.2 (7.98)</td>
<td>28 (7.6)</td>
<td>0.002</td>
</tr>
<tr>
<td>Fat free mass (kg, median)*</td>
<td>52.3 (14.5)</td>
<td>51.7 (14)</td>
<td>0.689</td>
</tr>
<tr>
<td>Basal metabolic rate (kcal, median)*</td>
<td>1587 ± 253</td>
<td>1499 (336.5)</td>
<td>0.351</td>
</tr>
<tr>
<td>Fat mass (kg, median)*</td>
<td>29.3 ± 17</td>
<td>25.6 (16.6)</td>
<td>0.016</td>
</tr>
<tr>
<td>TBW (kg, median)*</td>
<td>38.4 (11.4)</td>
<td>36 (9.2)</td>
<td>0.743</td>
</tr>
<tr>
<td>Fat mass (%)</td>
<td>29.2 (17.1)</td>
<td>25.4 (16.4)</td>
<td>0.005</td>
</tr>
<tr>
<td>Mid-arm circ (cm, median)*</td>
<td>33 (6)</td>
<td>30 (5)</td>
<td>0.018</td>
</tr>
<tr>
<td>Calf circ (cm, median)*</td>
<td>39 (6)</td>
<td>36 (5.5)</td>
<td>0.09</td>
</tr>
<tr>
<td>LDL (mg/dL median(SD))</td>
<td>132 (41.7)</td>
<td>126.7 (28.6)</td>
<td>0.365</td>
</tr>
<tr>
<td>FBS (mg/dL median)*</td>
<td>173 (106.5)</td>
<td>174 (154)</td>
<td>0.101</td>
</tr>
<tr>
<td>HbA1c (% median)*</td>
<td>8.1 (3.1)</td>
<td>9 (4.4)</td>
<td>0.01</td>
</tr>
<tr>
<td>Albumin (g/dL, median)*</td>
<td>4.4 (0.5)</td>
<td>4.3 (1.7)</td>
<td>0.031</td>
</tr>
<tr>
<td>Creatinine (mg/dL, median)*</td>
<td>0.8 (0.2)</td>
<td>0.9 (0.3)</td>
<td>0.126</td>
</tr>
</tbody>
</table>

*: interquartile range

OAD: oral antidiabetic drugs; DM: diabetes mellitus; BMI: body mass index, LDL: low density lipoprotein; FBS: fasting blood glucose; HbA1c: glycated hemoglobin; TBW: total body water

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![Fig 1](image1.png)  
**Fig 1:** Mean logarithms of BMI, HbA1c, fat%, mid-arm circumference and calf circumference in the groups with(1) and without(0) malnutrition. CC=circumference

![Fig 2](image2.png)  
**Fig 2:** ROC curve of BMI, HbA1c and fat% where state variable is the malnutrition
<8.69 mmol/mol, fat% >35.85%, without change in dietary intake or with normal physical activity (Table 5). Assumptions of logistic regression were met and Nagelkerke R² was 54.1%.

**DISCUSSION**
Performing nutritional evaluation has an important impact on patients' outcome and healthcare costs. In a study on diabetic patients over the age of 65, malnutrition risk was reported to be higher in patients with DM compared to non-diabetic patients. We analyzed the nutritional status in a large sample of type 2 diabetic patients on their initial presentation and obtained a snapshot of the nutritional status of this specific population.

Malnutrition is well known to be common among patients with chronic diseases. The prevalence of malnutrition was 44% in pre-dialysis patients with end stage renal failure, and 16% and 25 – 40% in patients with chronic heart failure and advanced chronic obstructive pulmonary disease, respectively. In a Spanish study including 1090 elderly hospitalized diabetic patients, malnutrition was detected in 39.1% of patients. Nutritional risk on admission to various clinics was found to be 15% in a large multi-center study conducted in our country, but the prevalence of malnutrition in diabetic patients was not determined. Malnutrition prevalence was reported to be 76% among 2329 elderly hospital inpatients. However, in this study, the malnutrition prevalence was statistically similar in patients with and without diabetes. On the other hand, presence of diabetic complications on admission was associated with a higher probability of being malnourished in a Spanish multicentre study. Prevalence of malnutrition was 11.4% in our study. Younger age and outpatient-based characteristics might explain detection of lower prevalence of malnutrition in our study.

MUST, MNA, NRS-2002 and SGA are malnutrition scales that have been used in daily clinical practice and studies. In a study of 134 participants, there was fair agreement between the SGA and MNA,

### Table 2: Items of SGA in patients with and without malnutrition

<table>
<thead>
<tr>
<th>Items of SGA</th>
<th>Normal n(%) n = 514</th>
<th>Malnutrition n(%) n = 66</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight loss</td>
<td>26 (5)</td>
<td>43 (65)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Change in dietary intake</td>
<td>23 (5)</td>
<td>44 (67)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diminished physical activity</td>
<td>29 (6)</td>
<td>43 (65)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

SGA: Subjective Global Assessment

### Table 3: Area under curve for BMI, HbA1c and fat % where the state variable is malnutrition.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Area Standard Error</th>
<th>p-value 95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI ≤ 30.35</td>
<td>0.618 0.039</td>
<td>0.002 0.54 to 0.69</td>
</tr>
<tr>
<td>HbA1c ≥ 8.69</td>
<td>0.602 0.042</td>
<td>0.01 0.52 to 0.68</td>
</tr>
<tr>
<td>Fat% ≤ 35.85</td>
<td>0.606 0.038</td>
<td>0.05 0.53 to 0.60</td>
</tr>
</tbody>
</table>

BMI: body mass index; HbA1c: glycated hemoglobin

**positivie** likelihood ration, negative likelihood ratio values and the disease prevalence for these parameters are shown in Table 4. A logistic regression model was developed using BMI ≤30.35 kg/m², HbA1c ≥8.69 mmol/mol, fat% ≤35.85% cut-off values as well as presence or absence of change in dietary intake and diminished physical activity as independent predictors for malnutrition. It revealed that patients with HbA1c ≥8.69 mmol/mol, fat% ≤35.85%, who had change in dietary intake or had diminished physical activity were 3.7, 2.9, 29.2 and 4.4 times as likely to have malnutrition compared to patients with HbA1c ≥8.69 mmol/mol, fat% >35.85%, without change in dietary intake or with normal physical activity (Table 5). Assumptions of logistic regression were met and Nagelkerke R² was 54.1%.

### Table 4: Sensitivity, specificity, PPV, NPV, LR+ and LR - values for BMI ≤ 30.35, HbA1c ≥ 8.69, fat % ≤ 35.85 in assessment of malnutrition

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>LR+</th>
<th>LR-</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI ≤ 30.35</td>
<td>0.62</td>
<td>0.60</td>
<td>16.9 92.5 1.57 0.63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HbA1c ≥ 8.69</td>
<td>0.60</td>
<td>0.56</td>
<td>14.3 92 1.37 0.71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat% ≤ 35.85</td>
<td>0.55</td>
<td>0.60</td>
<td>15.4 91 1.38 0.75</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

BMI: body mass index; HbA1c: glycated hemoglobin; Malnutrition prevalence: 11.4%; PPV: positive predictive value; NPV: negative productive value; LR+: positive likelihood ratio; LR-: negative likelihood ratio

**DISCUSSION**
Performing nutritional evaluation has an important impact on patients' outcome and healthcare costs. In a study on diabetic patients over the age of 65, malnutrition risk was reported to be higher in patients with DM compared to non-diabetic patients. We analyzed the nutritional status in a large sample of type 2 diabetic patients on their initial presentation and obtained a snapshot of the nutritional status of this specific population.

Malnutrition is well known to be common among patients with chronic diseases. The prevalence of malnutrition was 44% in pre-dialysis patients with end stage renal failure, and 16% and 25 – 40% in patients with chronic heart failure and advanced chronic obstructive pulmonary disease, respectively. In a Spanish study including 1090 elderly hospitalized diabetic patients, malnutrition was detected in 39.1% of patients. Nutritional risk on admission to various clinics was found to be 15% in a large multi-center study conducted in our country, but the prevalence of malnutrition in diabetic patients was not determined. Malnutrition prevalence was reported to be 76% among 2329 elderly hospital inpatients. However, in this study, the malnutrition prevalence was statistically similar in patients with and without diabetes. On the other hand, presence of diabetic complications on admission was associated with a higher probability of being malnourished in a Spanish multicentre study. Prevalence of malnutrition was 11.4% in our study. Younger age and outpatient-based characteristics might explain detection of lower prevalence of malnutrition in our study.

MUST, MNA, NRS-2002 and SGA are malnutrition scales that have been used in daily clinical practice and studies. In a study of 134 participants, there was fair agreement between the SGA and MNA,
with MNA identifying more “at-risk” patients and the SGA better identifying existing malnutrition\(^\text{[15]}\). In another study, the sensitivity and specificity of MUST were 61% and 76%, respectively, when SGA was used as the gold standard\(^\text{[16]}\). We found lower prevalence of malnutrition with MNA and MUST compared to SGA.

In our study, we also assessed the differences between the items of SGA on their effects on malnutrition. Weight loss, change in dietary intake and diminished physical activity were the parameters in SGA\(^\text{[4]}\). We found that malnutrition was significantly associated with weight loss, change in dietary intake and diminished physical activity; and our logistic regression model revealed that change in dietary intake and diminished physical activity increased malnutrition risk by 29.2 and 4.4 times, respectively.

It appears prudent to adopt a higher normal reference value for BMI in diabetic patients than what is currently used for the general population. A BMI between 24 and 29 kg/m\(^2\) has been suggested as an ideal cut off value to be used in elderly patients admitted to hospital in order to avoid underestimating malnutrition; however, adjustments have not been made for the presence of diabetes\(^\text{[17]}\). We found that BMI ≤30.35 kg/m\(^2\) was the cut-off for malnutrition, and this figure agreed with a Spanish study on malnutrition in elderly diabetic patients where 15.5% of the malnourished subjects and 31.9% of those at risk had a BMI ≥30 kg/m\(^2\)\(^\text{[4]}\). Lower fat%, mid-arm circumference and calf circumference are related with malnutrition\(^\text{[14]}\). In agreement, we found that BMI, fat%, mid-arm circumference and calf circumference were significantly lower in patients with malnutrition. An increased number of subjects in our study sample had a BMI within the overweight or obese ranges, as would be expected in a type 2 diabetic population. We developed a logistic regression model using BMI ≤30.35 kg/m\(^2\) as an independent predictor for malnutrition, and found that malnutrition increased 1.7 times in diabetic patients who had a BMI ≤30.35 kg/m\(^2\). Ideal fat% is 23.6 according to Jackson & Pollock in our patient groups\(^\text{[18,19]}\). We found a cut-off value as fat ≤35.85% in diabetic patients for malnutrition screening. Malnutrition increased 2.9 times in diabetic patients who had a fat% ≤35.85%.

There is no study about relation between malnutrition and HbA1c level in diabetic patients. We found that malnutrition increased 3.7 times in diabetic patients who had a HbA1c ≥8.69 mmol/mol. It needs to be clarified whether uncontrolled DM causes malnutrition or vice versa.

Albumin is one of the most frequently used parameters in the evaluation of nutritional status. There is a close association between serum albumin levels and malnutrition\(^\text{[5]}\). In agreement, albumin was significantly lower in patients with malnutrition in our study.

Association of malnutrition with gender is controversial\(^\text{[11,13]}\). Malnutrition was not associated with gender, smoking and oral antidiabetic drugs/insulin in our study, and this finding agreed with a study from Belgium\(^\text{[13]}\), although it did not agree with another one\(^\text{[11]}\).

Association between disease duration and malnutrition varies according to the studied group of patients in the literature. In one study, malnutrition prevalence was higher in patients having diabetes for more than 10 years compared to those having diabetes for less than 10 years, and this condition has been associated with complications of diabetes\(^\text{[11]}\). An increased prevalence of malnutrition has been described in patients with nephropathy and diabetic foot ulcers\(^\text{[20,21]}\). In our study, there was no association between diabetes duration and malnutrition. This may have been due to the shorter duration of diabetes in our patient.

We found in this study that a higher cut-off for BMI and fat% may be necessary to rule out malnutrition in type 2 diabetic patients. A HbA1c < 8.69 mmol/mol had a NPV of 92% for malnutrition. We also found that change in dietary intake and especially diminished physical activity were independent predictors of malnutrition in this population, with an odds ratio of 29.2 and 4.4 respectively.

CONCLUSION

Type 2 diabetic patients are often obese and thus, a higher cut-off for BMI and fat% may be necessary to detect malnutrition. Poor glucose control, decreased fat%, change in dietary intake and especially diminished physical activity are independent predictors of malnutrition in this population.

ACKNOWLEDGMENT

Ali Tamer monitored the patients, participated in study design, statistics and coordination and helped to interpret the data and to draft the manuscript. Mustafa Volkan Demir participated in data analysis and interpretation and wrote the manuscript. Hakan Cinemre, Tezcan Kaya and Ahmet Nalbant participated in the study design and statistics, oriented the data collection and revised the manuscript critically. All authors read and approved the final manuscript.

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REFERENCES


