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ORIGINAL ARTICLE

The role of upper middle arm circumference in the detection of malnutrition in diabetic children

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ABSTRACT

Objective: Type 1 diabetes (T1D) is a chronic disease that requires continuous insulin therapy. The study aimed to screen the prevalence of malnutrition in children with T1D by measuring the mid-upper arm circumference (MUAC) and to compare the Z scores with the body mass index-standard deviation score (BMI-SDS) of Turkish children.

Material and Methods: In this cross-sectional study, patients who were followed up with the diagnosis of T1D in the Adana City Training and Research Hospital Pediatric Endocrinology Outpatient Clinic and admitted to the follow-up outpatient clinic between June and September 2022 were included in the study.

Results: Of the 94 patients included in the study, 52 (55.3%) were female and 42 (44.7%) were male. While 7 (7.4%) patients had a weight SDS for an age value below -2, seven (7.4%) patients had a height SDS for an age value below -2. According to BMI SDS values, 61 (64%) patients were found to have normal weight, 18 (19.1%) patients had mild malnutrition, and four (4.3%) patients had moderate malnutrition. According to the MUAC Z-score, 52 (55.3%) patients had normal weight, 30 (31.9%) had mild malnutrition, 5 (5.3%) had moderate malnutrition, and 1 (1.1%) had severe malnutrition. It was noteworthy that 18 (60%) of 30 patients with mild malnutrition, according to MUAC-SDS, were in the normal weight group according to BMI-SDS. It was found that there was a strong positive correlation between the BMI (kg/m^2) value of the patients and the arm circumference (cm) (r=0.867; p<0.001).

Conclusion: In conclusion, the prevalence of malnutrition in children with T1D was at very high rates, at 23.4% according to BMI-SDS values and 38.3% according to MUAC Z-score values. In addition, MUAC is an easy and effective method that can be applied in every case of malnutrition screening if standard percentiles of malnutrition are developed for Turkish children.

Keywords: Body mass index-standard deviation score, diabetes, malnutrition, mid-upper arm circumference.

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INTRODUCTION

Type 1 diabetes (T1D) is an autoimmune disease seen in early childhood, especially under the age of 5, whose frequency has been reported to increase in the last decade and progresses with acute and chronic complications. Although the main treatment is continuous subcutaneous insulin administration, regular and healthy nutrition, and exercise should always be part of the lives of these patients. Unfortunately, many families cannot realize the permanent changes that need to be made in their lifestyle, resulting in children not receiving adequate care. Although it has been clearly shown that T1D causes growth and developmental retardation in the years of crystallized insulin use, it is predicted that the negative effect of the disease on the growth and development of children will decrease with the introduction of analog insulins, pump treatments, and sensors.[1–4] Children with growth retardation usually have poor glycemic control and are diagnosed early and with long-term follow-up.[5,6]

In our study, it was aimed to scan the prevalence of malnutrition in children with T1D, which is considered a chronic disease, with the mid-upper arm circumference (MUAC) measurement and to compare the Z-score results used in evaluating this measurement with the body mass index-standard deviation score (BMI-SDS) of Turkish children.

MATERIAL AND METHODS

In this cross-sectional study, patients who were followed up with the diagnosis of T1D according to ISPAD criteria in the Adana City Training and Research Hospital Pediatric Endocrinology Outpatient Clinic[7] and admitted to the follow-up outpatient clinic between June and September 2022 were included in the study. Patients with additional chronic diseases that may cause malnutrition were excluded from the study. In addition, children with lipohypertrophy due to incorrect insulin administration to the arm region were excluded from the study. The researchers recorded the presence of malnutrition in the cases by measuring the MUAC. The weight measurements of the cases were taken with an electronic scale (accuracy 100 g), and their heights were measured with a Harpenden stadiometer. BMI and Z-score of weight and height data were calculated using the program https://www.ceddcozum.com.[8] Olcay Neyzi data from Turkish children was used in this program. MUAC was measured from the left arm, and if there was lipothyperthrophy, the case was excluded from the study. Since no percentile curves were published for Turkish children, MUAC Z-score were evaluated based on data from the Centers for Disease Control and Prevention and the national health and nutrition examination survey used for American children.[9] According to the BMI-SDS and MUAC Z-score results used, the patients were grouped as having mild (-1, – -1.99), moderate (-2, -2.99), and severe (-3 and below) malnutrition. Written informed consent was obtained from the children/parents, or legal guardians after the purpose and protocol of the study were explained. The study was conducted by considering ethical principles following the "Helsinki Declaration."

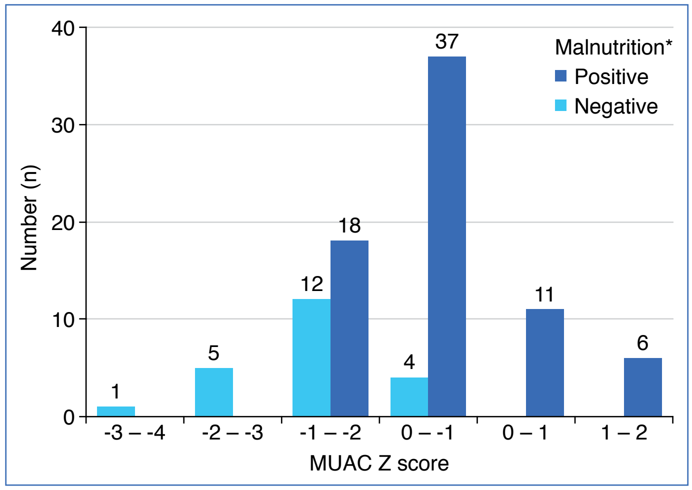

Figure 1: Classification of patients according to mid-upper arm circumference Z-score.

*: Malnutrition is classified according to body mass index standard deviation score.

Statistical Analysis

The Statistical Package for the Social Sciences 25.0 package program was used for statistical analysis of the data. Categorical measurements were summarized as numbers and percentages, and continuous measurements as mean and standard deviation (median and minimum¬–maximum where appropriate). Chi-square and Fisher's exact tests were used to compare categorical expressions. The Shapiro–Wilk test was used to determine whether the parameters in the study had a normal distribution. The Mann-Whitney U-test was used for the parameters that did not show a normal distribution. $p<0.05$ was accepted as the statistical significance level.

RESULTS

Of the 94 patients included in the study, 52 (55.3%) were female and 42 (44.7%) were male. Their mean age was 10.9±3.8 years, and the mean time elapsed since the diagnosis of diabetes was 3.35±2.2 years. Eight (8.5%) patients were under the age of 5, 24 (25.5%) were between 5 and 10 years of age, and 62 (66%) were between the ages of 10–18. The mean HbA1c values of the patients were 8.8±1.9%. While 7 (7.4%) patients had a weight SDS for an age value below -2, 7 (7.4%) patients had a height SDS for an age value below -2. According to BMI-SDS values, 61 (64%) patients were found to have normal weight, 18 (19.1%) patients had mild malnutrition, and 4 (4.3%) had moderate malnutrition. According to the MUAC Z-score, 52 (55.3%) patients had normal weight, 30 (31.9%) had mild malnutrition, 5 (5.3%) had moderate malnutrition, and 1 (1.1%) had severe malnutrition. The comparison of cases with and without any degree of malnutrition according to BMI-SDS values is given in Table 1.

It was noteworthy that 18 (60%) of 30 patients with mild malnutrition, according to MUAC-SDS, were in the normal weight group according to BMI-SDS (Fig. 1). When the numerical values of the measurements were compared, it was found that there was a strong positive correlation between BMI (kg/m^2) and arm circumference (cm) ($r=0.867$; $p<0.001$) (Fig. 2).

Table 1: Comparison of patients with and without malnutrition according to body mass index standard deviation score

	Malnutritio positive* n=22 (%)		Malnutrition negative* n=72 (%)		p
	%	n	%	n	
Gender					0.370
Girl	14	63.6	38	52.8	
Boy	8	36.4	34	47.2	
Height SDS					**0.028***
Below -2	4	18.2	3	4.2	
Above -2	18	81.8	69	95.8	
MUAC SDS					
-3 – -4	1	4.5	–	–	
-2 – -3	5	22.7	–	–	
-1 – -2	12	54.5	18	25	
0 – -1	4	18.2	37	51.4	
0–1	–	–	11	15.3	
1–2	–	–	6	8.3	
Age					0.213
Below 5 years	–	–	8	11.1	
5–10 years	5	22.7	19	26.4	
10–18 years	17	77.3	45	62.5	
Mean HbA1c	9.6±2.2		8.5±1.7		**0.036**
BMI	16.1±1.9		18.7±2.9		**<0.001**
BMI percentile	7.43±4.8		52.6±25.6		**<0.001**
Age	12.7±3.0		10.4±3.8		**0.022**
Diabetes diagnosis age	9.3±3.8		7.1±3.7		**0.020**

*: Body mass index-standard deviation score <-1. BMI: Body Mass Index; SDS: Standard deviation score; MUAC: Mid-upper arm circumference.

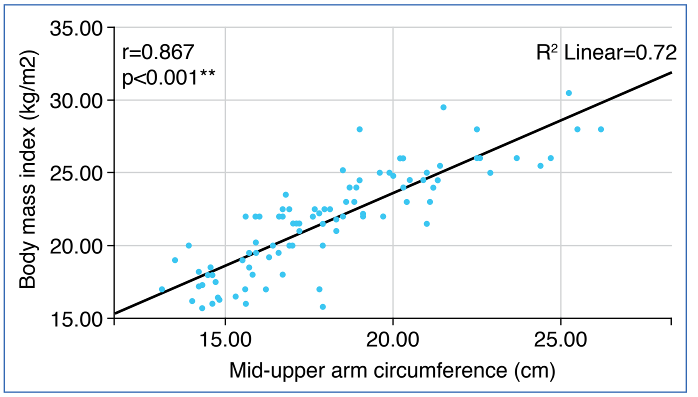

Figure 2: Relationship between body mass index (kg/m^2) and mid-upper arm circumference (cm).

DISCUSSION

There is no standard approach to define malnutrition in the pediatric population older than 5 years. The Waterlow and Gomez classifications, which can be considered historical, are now much less used.[10,11] The most commonly used methods for this group of children are weight for age, height for age, and BMI. However, trained health personnel are needed to calculate and use all three methods successfully. While standard percentile curves for countries have been used to interpret these parameters for a long time, SDS values have been used in recent years because they are a better indicator of how much they deviate from normal children in the community.

In 2007, the World Health Organization also recommended using BMI for age to define malnutrition in schoolchildren and adolescents.[12] According to the BMI-SDS results used, the cases are evaluated as having mild (-1, -1.99), moderate (-2, -2.99), and severe (-3 and below) malnutrition. Although the recommended method is BMI measurement, it takes time to measure the weight and height of the cases, calculate the BMI, and evaluate the Z-scores, so it does not seem possible to apply it to every case in standard outpatient service conditions. In countries like Türkiye, where the number of cases per physician is high, MUAC, a faster and easier-to-measure method for malnutrition screening, has been used for years to screen for childhood malnutrition and determine compliance with nutrition programs. In 2007, the United Nations approved MUAC as an independent diagnostic criterion for malnutrition.[13] The American Society for Parenteral and Enteral Nutrition held a panel on childhood malnutrition. Recognizing that MUAC is a more sensitive prognostic indicator for mortality in malnourished pediatric cases than height–weight parameters, this panel suggested that MUAC measurements should be part of a full anthropometric assessment. Previous studies in this age group have reported a close relationship between MUAC and BMI, and MUAC is more consistent with fat mass than lean mass.[14]

It is estimated that there are approximately 20,000 children with T1D in Türkiye. These children comprise only a small fraction of the hundreds of thousands of children followed up with chronic illnesses. Hundreds of thousands of children in our country have chronic intestinal diseases, neurological disabilities, and chronic infections such as tuberculosis, which predispose them to malnutrition or are malnourished simply because they cannot reach food due to economic conditions and family overcrowding. Therefore, while planning our study, we wanted to draw attention to the importance of malnutrition screening in these children, which is followed in all pediatric outpatient clinics, and to emphasize the MUAC method, which can be applied in as fast as 30 s.

In evaluating our 7 cases with stunting (height <-2 SDS), an indicator of chronic malnutrition, it was remarkable that only 4 had BMI-SDS values in the mild malnutrition range and three were in the healthy group. In the MUAC measurements of the same cases, two children had mild malnutrition, one child had moderate malnutrition, one child had severe malnutrition (height SDS: -3.15, BMI-SDS: -1.33, MUAC Z-score: -3 – -4), and three children were evaluated as normal. In this case, it can be concluded that both methods are not sufficient to recognize chronic malnutrition. Therefore, we would like to emphasize the use of MUAC Z-score and BMI-SDS calculations for screening for malnutrition, additional measurement, and, if necessary, laboratory evaluation if chronic malnutrition is suspected in the case.

In the publications about MUAC in chronic diseases, Phong et al. [15] measured 49 patients' MUAC for screening malnutrition. MUAC Z scores identified 49% of their patients as malnourished; however, BMI Z scores identified 12% as malnourished.In addition, there was disagreement as to the degree of malnourished status. Our study found a strong correlation between the MUAC value (cm) and the BMI value (kg/m^2). However, in malnutrition classification, there were differences between the Z-score of the two data sets. It was remarkable that there were more cases of malnutrition according to MUAC Z-scores. In a study of 194 adolescents in an urban health center in Chetla, results showed 47.93% of the study population as per BMI and 60.30% as per MUAC were malnourished.[16] The main reason for discordance in our study may be the absence of standard percentile curves for Turkish children and the evaluation of data using Z-score for American children. It may explain the detection of 18 children in total with a normal weight according to the BMI-SDS assessment and mild malnutrition according to the MUAC Z-score.

In conclusion, the prevalence of malnutrition in children with T1D was at very high rates, at 23.4% according to BMI-SDS values and 38.3% according to MUAC Z-score values. With these values, we believe that MUAC is an easy and effective method that can be applied in every case of malnutrition screening if standard percentiles of malnutrition are developed for Turkish children.

Limitations

The study was planned for a small group of patients. The MUAC Z scores were not standardized, and the patients were not grouped by insulin type.

Statement

Ethics Committee Approval: The Adana City Training and Research Hospital Clinical Research Ethics Committee granted approval for this study (date: 22.09.2022, number: 2152).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – AA; Design – AA; Supervision – AA, DGT; Resource – AA, DGT; Materials – AA, DGT; Data Collection and/or Processing – AA, DGT; Analysis and/or Interpretation – AA; Literature Search – AA, DGT; Writing – AA; Critical Reviews – AA, DGT.

Conflict of Interest: The authors have no conflict of interest to declare.

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