



## Evaluation of nutritional status and body composition in pediatric patients with type 1 diabetes mellitus versus healthy controls

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### Abstract

**Background:** Nutritional management is one of the cornerstones of diabetes care and education. Energy intake and essential nutrients should aim to maintain ideal body weight, optimal growth and development and help to prevent acute and chronic complications. Understanding the body composition of diabetic children is vital for monitoring response to treatment and managing resulting weight changes.

**Aim:** To assess anthropometric measurements and body Composition in pediatric patients with type 1 Diabetes Mellitus versus healthy controls.

**Patients and methods:** This is a case- control study carried out from 1<sup>st</sup> of May 2024 to 31<sup>st</sup> of August 2024 in Pediatrics Endocrinology outpatient clinic of Central Child's Teaching Hospital in Baghdad. The study was carried on 50 diabetic patients and 50 healthy controls their age group ranges from (7-15 years) and who are assessed through distribution of detailed questionnaires, anthropometric measurements and body composition evaluation.

**Results:** There is significant difference in Z score means (Wt for age, Ht for age, and MUAC for age) between diabetic patients and healthy controls. (P value 0.024, 0.027 and 0.0001 respectively). The body composition parameters were found to be statistically non-significant.

**Conclusion:** Pediatric patients with type 1 DM demonstrated significantly lower anthropometric measurements compared to healthy controls. There was a slight reduction in the mean muscle mass percentage among diabetic patients.

**Keywords:** Type 1 diabetes mellitus, nutritional status, body composition

### Introduction

Type 1 diabetes mellitus (T1DM) is a very common chronic condition observed in childhood and adolescence that is related to autoimmune wrecking of pancreatic islets, resulting in partial or complete loss of ability to produce insulin, which can lead to severe complications if not adequately treated [1]. The components of T1DM treatment include insulin therapy, daily self-monitoring of blood glucose, age-adjusted diabetes nutritional education, and regular physical activity [2].

Nutritional management is one of the cornerstones of diabetes care and education. Energy intake and essential nutrients should aim to maintain ideal body weight, optimal growth and development and help to prevent acute and chronic complications. Regular monitoring of height, weight, and body mass index (BMI) is required to identify both excessive weight gain and failure to grow normally [3].

Body composition in children with T1DM varies significantly during the course of the disease and in most patients an excess accumulation of fat mass develops [4].

Bioelectrical impedance (BIA) is an advanced technique for quantitative studying the components of body composition. Recently it has extensively been used because it is fast, portable, inexpensive and noninvasive and it provides accurate data [5]. Body composition measurements can inform the clinical diagnosis of disease, improve prognosis, and facilitate the early assessment of adverse metabolic outcomes. Understanding the body composition of diabetic children is vital for monitoring response to treatment and managing resulting weight changes [6].

### Aim of the study

To assess anthropometric measurements and body Composition in pediatric patients with type 1 Diabetes Mellitus versus healthy controls.

### Patients and methods

This is a case - control study carried out from 1<sup>st</sup> of May 2024 to 31<sup>st</sup> of August 2024 in Pediatrics Endocrinology outpatient clinic of Central Child's Teaching Hospital in Baghdad. The study was carried on 50 diabetic patients and 50 healthy controls their age group ranges from (7-15 years) and who are assessed through distribution of detailed questionnaires. The participant was selected by communicating with their parents and caregivers.

### Selection (Inclusion) criteria:

- All diabetic children diagnosed by pediatric endocrinologist attending outpatient clinic during research period that their parents accept to participate in the study.
- Age (7-15) years
- Duration of disease more than 1 year.

### Exclusion criteria

- Children less than 7 years and more than 15 years.
- Children who have duration of disease less than 1 year.
- Patient's parents refuse to participate in the study.
- Children who are difficult to deal and to take measurement for them.

- Patients with type 2 diabetes and those with chronic conditions such as celiac disease, hypothyroidism or any other medical disease that affect growth.

The control group is children of similar age and gender who came to the paediatric outpatient clinics for routine evaluation and who had not been diagnosed with any metabolic disorder.

**Anthropometric measurements used in this study include:** weight, height, body mass index (BMI) and mid-upper arm circumference (MUAC). Measurements of weight were performed using a manual scale ensuring that the child stood with arms extended at their sides and was attired in light clothing. The weight was recorded in kilograms, with an allowable error of 0.1 kg. Height was assessed using a properly calibrated stadiometer which employs a fixed board to determine height in meters, to the nearest 0.5 cm. Participants were instructed to stand barefoot with heels together and the head aligned in a horizontal plane. BMI was calculated by dividing weight in kilograms by the square of height in meters. Mid-upper arm circumference was assessed utilizing a Gulick tape (Baseline 12-1201) ensuring an accuracy of 0.5 cm, in line with the standards set forth by the National Health and Nutrition Examination Survey [7].

This study employed the bioelectrical impedance approach for analyzing body composition using InBody 270 device. The test was conducted in the morning at room temperature requiring the subject to stand on metal foot pads without footwear while holding a pair of electrodes attached to a handle, with their arms extended in front of their chest. It

gives accurate information about: basal metabolic rate (BMR), total body water, protein, minerals, body fat mass, skeletal muscle mass.

**Statistical analysis**

Data analysis was performed with the IBM SPSS-29 statistical software package (IBM Statistical Packages for Social Sciences, version 29, Chicago, IL, USA). Data were presented in simple measures of frequency, percentage, mean, standard deviation, and range (minimum-maximum values). The significance of difference of different means (quantitative data) were tested using Students-t-test for difference between two independent means. The significance of difference of different percentages (qualitative data) were tested using Pearson Chi-square test ( $\chi^2$ -test) with application of Yate's correction or Fisher Exact test whenever applicable. Statistical significance was considered whenever the P value was equal or less than 0.05. Pearson correlation was calculated for the correlation between two quantitative variables with its t-test for testing the significance of correlation [8, 9, 10, 11].

**Results**

This study was carried on 50 diabetic patients their Mean age and SD was 11.1±2.4 years and 50 healthy controls their Mean age and SD was 10.9±2.1 years. Females represent 52% and 50% of diabetic patients and healthy controls respectively. While males represent 48% and 50% respectively. Demographic characteristics were shown in table 1.

**Table 1:** Demographic characteristics of study participant

		Diabetics		Healthy controls		P value
		No.	%	No.	%	
Age (years)	7-10	20	40	22	44	0.774
	11-15	30	60	28	56	
	Mean±SD (Range)	11.1±2.4 (7 - 15)		10.9±2.1 (7 - 15)		0.619
Gender	Male	24	48.0	25	50.0	0.841
	Female	26	52.0	25	50.0	
*Significant difference between percentages using Pearson Chi-square test ( $\chi^2$ -test) at 0.05 level.						
#Significant difference between two independent means using Students-t-test at 0.05 level.						

The mean age at onset of DM and disease duration was 7.2±2.4 years and 3.8±2.3 years, respectively, with 76% of the patients having disease duration of less than 5 years. The HbA1c level was elevated, with a mean of 9.6±2.2 %, and

70% of patients had HbA1c levels of >8, and 30% had HbA1c levels of <=8. Disease characteristics were shown in table 2.

**Table 2:** Disease characteristics

		Diabetics	
		No.	%
Age at the onset of DM	<5years	5	10.0
	5--9	36	72.0
	=>10years	9	18.0
	Mean±SD (Range)	7.2±2.4 (2 - 12)	
Duration of DM since diagnosis	<5years	38	76.0
	5--9	10	20.0
	=>10years	2	4.0
	Mean±SD (Range)	3.8±2.3 (2 - 13)	
HbA1c (%)	Uncontrolled (>8.0)	35	70.0
	Controlled (<=8)	15	30.0
	Mean±SD (Range)	9.6±2.2 (6.0- 13.8)	

There is significant difference in Z score means (Wt for age, Ht for age, and MUAC for age) between diabetic patients and healthy controls. (P value 0.024, 0.027 and 0.0001

respectively). The body composition parameters were found to be statistically non-significant. As shown in table 3.

**Table 3:** Comparison between diabetics and healthy controls in regard to anthropometrics and body composition parameters.

	Diabetics	Healthy controls	P value
Weight (Kg)	37.4±11.9 (21.3-60.6)	39.6±9.9 (22.0-60.0)	0.305
Wt for age Zscore	-0.1±1.0 (-2.16 - 2.75)	0.3±0.9 (-1.31 - 2.16)	0.024#
Height (cm)	140.5±13.3 (110-166)	143.9±10.5 (124-167)	0.166
Ht for age Zscore	-0.6±1.3 (-4.43 - 3.15)	-0.1±0.9 (-1.53 - 2.24)	0.027#
BMI (Kg/m <sup>2</sup> )	18.4±3.2 (13.8-28.3)	18.9±3.0 (13.8-26.3)	0.430
BMI for age Zscore	0.3±1.0 (-2.04 - 2.76)	0.4±1.2 (-3.02 - 2.50)	0.398
MUAC (cm)	20.2±2.8 (15.0-26.0)	21.6±2.3 (17.0-26.0)	0.007#
MUAC for age Zscore	-1.3±0.9 (-2.87 - 0.25)	-0.7±0.7 (-2.45 - 0.50)	0.0001#
Fat mass	10.1±5.8 (2.0-25.0)	10.3±5.1 (4.2-22.3)	0.850
Fat mass%	25.5±8.0 (8.60 - 41.6)	25.1±8.1 (10.0 - 42.7)	0.786
Skeletal muscle mass	14.1±4.3 (6.9-24.6)	15.4±3.8 (9.7-24.2)	0.099
Skeletal muscle mass%	37.9±4.1 (30.9-45.9)	38.7±4.1 (30.07-49.7)	0.297
#Significant difference between two independent means using Students-t-test at 0.05 level.			

In our study, no correlation was found between HbA1c and both anthropometric measurements and body composition parameters (r < 0.5). As shown in Table 4.

**Table 4:** Correlation between HbA1c and both anthropometric and body composition parameters in all patients with T1DM.

Parameters	HbA1c	
	r	P
Weight (Kg)	0.336*	0.017
Height (cm)	0.296*	0.037
BMI (Kg/m <sup>2</sup> )	0.286*	0.044
MUAC (cm)	0.436**	0.002
Fat mass	0.363**	0.010
Fat mass%	0.340*	0.016
Skeletal muscle mass	0.257	0.072
Skeletal muscle mass%	-0.262	0.066
*Correlation is significant at the 0.05 level. **Correlation is significant at the 0.01 level.		

**Discussion**

Type 1 diabetes mellitus (T1DM) is a very common chronic condition observed in childhood and adolescence. Nutritional management is one of the cornerstones of diabetes care and education. [3].

Our study included 50 diabetic patients and 50 healthy controls, most of the participant in the 2 groups were in the adolescent age group, 60% and 56% respectively.

In regard to diabetic patients the mean age at onset of DM and disease duration was 7.2±2.4 years and 3.8±2.3 years, respectively, with 76% of the patients having disease duration of less than 5 years. This is consistent with Hussein *et al* [12].

Most of our patients had poor glycemic control as 70% had HbA1c more than 8, with a mean of 9.6±2.2 %. This is comparable to the study of Hussein *et al* [12]. But Eke *et al* found higher results [4]. The ISPAD consensus guidelines recommend that Individuals with T1DM undergo testing for glycosylated hemoglobin at least once a year, aiming for a treatment target of HbA1c levels below 7.5% [13].

We found that anthropometric measurements including: weight for age z-score, height for age z-score and MUAC z-score were significantly lower in diabetic patients than in healthy controls. This similar to Hussein *et al* [12], Dohan *et al* [14] and Eke *et al* [4]. But this is inconsistent with Grabia *et al* who found that physical development was similar in both

groups [15]. There is a divergence in the literature regarding anthropometric parameters in children diagnosed with diabetes. Although it is widely recognized that these children exhibit impairments in their anthropometric measurements some studies link these impairments to metabolic control, while others contend that variations in growth parameters cannot be solely explained by metabolic factors. This discrepancy points to the potential involvement of additional mechanisms contributing to growth failure in children with diabetes mellitus, highlighting the need for further research to better understand the factors affecting growth in this population [14].

Concerning the parameters of body composition, the results showed that the mean body fat percentage was nearly identical for diabetic patients and healthy controls.

However, diabetic patients exhibited a slightly lower mean skeletal muscle mass percentage, but this difference was not statistically significant. Eke *et al* found the majority of participants with T1DM showed lower skeletal muscle percentage relative to the control group. However, it is noteworthy that younger diabetic patients demonstrated a higher mean body fat percentage than their age and sex-matched counterparts [4]. For diabetic patients who are historically regarded as lean, shifts in body composition is an undesirable result of diabetes management. This is especially true for the rise in central abdominal adiposity, which correlates with dyslipidaemia and insulin resistance [16, 17, 18].

Concerning the association between HbA1c and the various anthropometric measurements as well as body composition parameters, we unfortunately found no correlation. This is consistent with Galli-Tsinopoulou *et al*, who found no correlation between HbA1c and anthropometric variables [19]. While Hassan *et al*. identified a significant negative correlation among all diabetic patients, as well as in female subjects, between HbA1c levels and various anthropometric measurements and body composition parameters, with the exception of lean percentage which was positively correlated. The same correlation found in males with the exception of fat percentage and lean percentage, for which no significant correlations were found [20]. This may be due to discrepancies in sample size the overall characteristics of the population.

## Conclusion

This study underscores the significance of evaluating nutritional status in pediatric patients with type 1 DM. We found that those patients demonstrated significantly lower anthropometric measurements compared to healthy controls. There was a slight reduction in the mean muscle mass percentage among diabetic patients, but this difference was not statistically significant. It is advisable for all pediatric patients with diabetes to have regular appointments at specialized dietary clinics and undergo assessments by specialists to prevent negative nutritional consequences and attain optimal nutritional health.

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