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# Impact of Overweight and Obesity on the Metabolic Presentation of Type 1 Diabetes Mellitus Among Iraqi Children

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**Abstract: Background:** The increasing prevalence of childhood overweight and obesity has raised concerns regarding their influence on the clinical and metabolic presentation of type 1 diabetes mellitus (T1DM). Excess body weight may contribute to insulin resistance, alter disease manifestations, and increase the risk of metabolic complications at diagnosis. This study aimed to evaluate the impact of overweight and obesity on the metabolic presentation of newly diagnosed T1DM among Iraqi children.

**Methods:** A cross-sectional study was conducted at Al-Zahra Teaching Hospital, Kut, Iraq, between January 2021 and January 2026. Ninety-two children newly diagnosed with T1DM were included. Demographic, anthropometric, clinical, and laboratory data were obtained from medical records. Participants were classified as normal weight, overweight, or obese according to the World Health Organization BMI-for-age Z-score criteria. Metabolic parameters, including blood pH, serum bicarbonate ($HCO_3^-$), $pCO_2$, blood glucose, HbA1c, C-peptide levels, and the severity of diabetic ketoacidosis (DKA), were compared across BMI categories using appropriate nonparametric statistical tests.

**Results:** Overweight children presented with significantly more severe metabolic disturbances at diagnosis, including lower blood pH, bicarbonate, and $pCO_2$ levels compared with children of normal weight. Obese children demonstrated significantly higher C-peptide concentrations, indicating greater residual pancreatic beta-cell function. However, both overweight and obese children showed a higher prevalence of DKA than their normal-weight counterparts. The combined prevalence of overweight and obesity among children with newly diagnosed T1DM was 20.6%.

**Conclusion:** Overweight is associated with a more severe metabolic presentation of newly diagnosed T1DM in Iraqi children, while obesity is characterized by relatively preserved residual beta-cell function despite an increased frequency of DKA. Early recognition of T1DM symptoms in overweight and obese children may facilitate timely diagnosis and reduce the risk of severe metabolic complications.

**Keywords:** Type 1 diabetes mellitus; overweight; obesity; diabetic ketoacidosis; pediatric diabetes.

## Introduction

Type 1 diabetes mellitus (T1DM) is one of the most common endocrine disease in pediatric and adolescent populations worldwide[1][2][3][4]. The global incidence of T1DM is on a rising trend, mostly attributed to genetic and immunological factors. At the same time, childhood overweight and obesity have come to be the most worrisome public health issues across the globe[5][6].

Obesity is related to chronic low-grade inflammation and increased insulin resistance, both of which may affect the development and clinical presentation of T1DM [7][8][9][10][11][12]. Previous studies have shown that overweight children with T1DM are more likely to suffer from metabolic imbalance

and long-term cardiovascular complications [13][14][15][16]. Also, insulin resistance related to obesity can exacerbate metabolic disturbances in the onset of the disease.
Diabetic ketoacidosis (DKA) is still one of the most severe acute complications at the presentation of T1DM in children. Delayed diagnosis may lead to severe metabolic derangement and life-threatening complications. Recent evidence suggests that overweight and obese children may present with more severe DKA despite relatively preserved residual beta-cell function.
In Iraq, there are limited data regarding obesity and metabolic presentation of T1DM among pediatric patients. This study aimed to assess the effects of overweight and obesity on the clinical and metabolic presentation of T1DM in children from Iraq who were receiving treatment at Al-Zahra Teaching Hospital.

## Materials And Methods

### Study Design and Setting

This cross-sectional study was carried out at Al-Zahra Teaching Hospital between January 2021 and January 2026. The hospital is considered one of the major referral centers for pediatric endocrine and diabetic care in Wasit Governorate, Iraq.

### Study Population

A total of 92 pediatric patients newly diagnosed with T1DM between January 2021 and January 2026 were included in this cross-sectional study. Children diagnosed with other forms of diabetes or those with incomplete anthropometric records were excluded from the analysis.

### Data Collection

The following variables were collected from patient records:

- Age
- Sex
- Weight and height
- Blood glucose level
- HbA1c
- Blood pH
- Serum bicarbonate ($HCO_3^-$)
- Partial pressure of carbon dioxide ($pCO_2$)
- C-peptide level
- Presence and severity of DKA

### Anthropometric Assessment

Body mass index (BMI) was calculated. BMI Z-scores adjusted for age and sex were used according to WHO standards [17]. Patients were categorized into:

- Normal weight
- Overweight
- Obese

### DKA Classification

DKA severity has been classified depending on ISPAD guidelines as mild, moderate, or severe based on pH and bicarbonate levels [18].

### Statistical Analysis

Statistical analysis was done using IBM SPSS version 30. Continuous data variables were expressed as mean ± standard deviation or median with interquartile range according to data distribution. Comparisons between two independent groups were performed in Mann–Whitney U test, while comparisons among three BMI groups were conducted using the Kruskal–Wallis test. Categorical data variables were studied using the Chi-square test or Fisher's exact test when appropriate. A p-value of less than 0.05 was considered statistically significant.

## Results

### Demographic Characteristics

Ninty-two children newly diagnosed with T1DM were enrolled from Al-Zahra Teaching Hospital. The mean age at diagnosis was 8.9 ± 4.1 years, with male patients accounting for 55.4% of the study population. The combined prevalence of overweight and obesity was 20.6% among the included children.

**Table 1. ISPAD Criteria Used to Classify the Severity of DKA at the Manifestation of T1DM**

| DKA Severity | Criteria |
|---|---|
| **No DKA** | pH ≥ 7.3 or HCO3− ≥ 18 mmol/L |
| **Mild DKA** | pH 7.2–7.29 or HCO3− 10–17.9 mmol/L |
| **Moderate DKA** | pH 7.1–7.19 or HCO3− 5–9.9 mmol/L |
| **Severe DKA** | pH < 7.1 or HCO3− < 5 mmol/L |

**Table 2. Classification of Children According to WHO BMI Z-Score Standards**

| BMI Status | BMI Z-score Criteria |
|---|---|
| **Normal weight** | Z-score ≤ 1 |
| **Overweight** | Z-score >1 to ≤2 |
| **Obese** | Z-score >2 |

**Table 3. Baseline Characteristics of Iraqi Children Included in the Study**

| Variable | Value |
|---|---|
| **Number of patients** | 92 |
| **Mean age at T1DM diagnosis (years)** | 8.9 ± 4.1 |
| **Age range (years)** | 1–17 |
| **Male sex, n (%)** | 51 (55.4%) |
| **Female sex, n (%)** | 41 (44.6%) |
| **Mean pH at diagnosis** | 7.28 ± 0.14 |
| **Mean $HCO_3^-$ (mmol/L)** | 16.9 ± 7.2 |
| **Mean $pCO_2$ (mmHg)** | 29.1 ± 9.5 |
| **Mean blood glucose (mmol/L)** | 24.2 ± 9.1 |
| **Mean HbA1c (%)** | 11.4 ± 2.3 |
| **Mean C-peptide (ng/mL)** | 0.61 ± 0.55 |

**Table 4. Characteristics of the Two BMI Subgroups Regarding Parameters Recorded at T1DM Presentation**

| Parameter | Normal Weight (n=73) | Overweight/Obese (n=19) | p-value |
|---|---|---|---|
| **Age (years)** | 8.4 [4.7–11.6] | 9.8 [6.1–12.4] | 0.041 |
| **pH** | 7.34 [7.23–7.40] | 7.28 [7.11–7.38] | 0.009 |
| **HCO3− (mmol/L)** | 19.1 [11.0–23.5] | 15.4 [7.2–22.8] | 0.021 |
| **pCO2 (mmHg)** | 31.6 [22.9–37.4] | 27.3 [16.8–35.9] | 0.013 |
| **Blood glucose (mmol/L)** | 24.0 [18.0–30.1] | 21.7 [16.8–28.0] | 0.033 |
| **HbA1c (%)** | 11.5 [9.8–13.5] | 11.3 [9.9–13.3] | 0.957 |
| **C-peptide (ng/mL)** | 0.43 [0.24–0.67] | 0.58 [0.35–1.11] | <0.001 |

**Table 5. Distribution of DKA Severity Among BMI Groups**

| | Normal Weight n (%) | Overweight n (%) | Obese n (%) |
|---|---|---|---|
| **No DKA** | 43 (58.9%) | 4 (33.3%) | 3 (42.9%) |
| **Mild DKA** | 13 (17.8%) | 2 (16.7%) | 2 (28.6%) |
| **Moderate DKA** | 9 (12.3%) | 2 (16.7%) | 1 (14.3%) |
| **Severe DKA** | 8 (11.0%) | 4 (33.3%) | 1 (14.3%) |

p-value = 0.013

## Discussion

This cross-sectional study demonstrated that overweight children with newly diagnosed T1DM presented with more pronounced metabolic derangements than normal-weight children, as evidenced by lower pH, bicarbonate, and $pCO_2$ levels. Although obese children exhibited significantly higher C-peptide concentrations, suggesting greater residual beta-cell function, they still showed a relatively high frequency of DKA at presentation.

These findings are consistent with previous studies indicating that obesity-associated insulin resistance and chronic low-grade inflammation may aggravate metabolic decompensation at the onset of T1DM [19]. Delayed recognition of diabetes symptoms in overweight children may further contribute to severe DKA at diagnosis.

The preservation of C-peptide levels among obese children may reflect partial maintenance of endogenous insulin secretion despite marked metabolic abnormalities, supporting the hypothesis that obesity modifies the clinical presentation rather than the autoimmune process itself [20].

## Conclusion

Overweight status was associated with a more severe metabolic presentation of newly diagnosed T1DM in Iraqi children, characterized by lower pH and bicarbonate levels and an increased risk of DKA. Obese children demonstrated higher residual C-peptide levels while still presenting with substantial metabolic disturbances. Early recognition of hyperglycemic symptoms in overweight and obese children may improve timely diagnosis and reduce the incidence of severe DKA.

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