RESEARCH ARTICLE

# Assessment of growth status in children and adolescents with type 1 diabetes mellitus in Baghdad: a case-control study

Farah Tareq Salih[1], Wasnaa Hadi Abdullah[2], Basma Adel Ibrahim[3], Najla Ibrahim Ayoub[4]

## Abstract

**Objective:** : To assess growth parameters in adolescents and children with type 1 diabetes mellitus, and the factors influencing their growth.

**Method:** The case-control study was conducted from February to December 2020 at the Endocrine Outpatient Clinic of the Central Child Teaching Hospital of Paediatrics, Baghdad, Iraq, and comprised patients aged 2-16 years who had type 1 diabetes for at least a year. The patients formed group A, while healthy controls matched for age and gender from different schools and kindergartens formed group B. Weight, height and body mass index of all the subjects in both groups were measured and worked out, and the values were compared. Data was analysed using SPSS 25.

**Results:** Of the 192 subjects, 96(50%) were in each of the 2 groups; 50(52.1%) girls and 46(47.9%) boys in group A, and 58(60.4%) girls and 38(39.6%) boys in group B. The overall mean age was 9.66±3.26 years. Group A children had significantly lower mean height, weight and body mass index Z scores compared to group B (p=0.001). The height Z score of group A children was significantly inversely associated with age, duration of disease, and glycated haemoglobin level (p=0.001), while the weight Z score was significantly inversely correlated with age and glycated haemoglobin (p=0.001). The body mass index Z score of group A was significantly inversely associated with age and glycated haemoglobin level (p<0.05).

**Conclusion:** Children with type 1 diabetes mellitus had significantly lower mean height, weight and body mass index Z scores compared to their counterparts in the control group. Pubertal age group, poor glycaemic control, longer disease duration, and using conventional insulin regimen were the factors affecting growth parameters.

**Key Words:** Diabetes, Glycated Hemoglobin, Glycemic, Ambulatory Care, Insulins

(JPMA 74: S48 (Supple-8); 2024) **DOI: https://doi.org/10.47391/JPMA-BAGH-16-12**

## Introduction

Type 1 diabetes mellitus (T1DM) is one of the most prevalent endocrine diseases in the paediatric age group [1]. There is a great deal of evidence indicating that patients with poor glycaemic control have a decline in their height velocity, while those with superior control keep their height in the normal velocity[2]. Insulin is a crucial organiser of the axis between growth hormone (GH) and insulin-like growth factors (IGFs), with appropriate IGF and IGF-binding protein concentrations in blood requiring proper insulin secretion[3]. Inflammatory indicators, such as C-reactive protein (CRP) and interleukin-6 (IL-6) are higher in TIDM patients, and these and other inflammatory cytokines might affect growth both directly on the growth plate and indirectly through IGF1 suppression[4].

Multiple daily insulin injection protocols and novel technologies, such as insulin pumps, have resulted in higher levels of insulin in the blood, causing increased GH and IGF concentrations in addition to height achievements independently of glycaemic control[5]. A severe form of growth failure in poorly controlled T1DM classically involves hepatomegaly, growth impairment and Cushingoid features[6].I It was first described in 1930 that poor glycaemic control typically involves a wide fluctuation between hyper- and hypo-glycaemia suggestive of a pattern of over- and under-inclination[6]. In Mauriac syndrome, growth failure is caused by decreased circulating IGF1 due to a lack of insulin's stimulatory impact and hyper-adrenocorticoids during episodes of ketosis and hypo-glycaemia may also contribute to stunting[6,7].

The current study was planned to assess growth parameters in adolescents and children with T1DM.

## Patients and Methods

The case-control study was conducted from February to December 2020 at the Endocrine Outpatient Clinic of the Central Child Teaching Hospital of Paediatrics (CCTH), Baghdad, Iraq, and comprised T1DM patients aged 2-16

[1]Department of Paediatrics, Central Child Teaching Hospital, Baghdad, Iraq.[2-4]Department of Paediatrics, Mustansiriyah University, Baghdad, Iraq.

**Correspondence:**Wasnaa Hadi Abdullah

**Email:** Wasnaa.hadi@uomustansiriyah.edu.iq

years who had been diagnosed for at least a year. T1DM patients suffering from other chronic illnesses or associated autoimmune diseases were excluded. The patients formed study group A, while group B comprised healthy controls matched for age and gender who were enrolled from different schools and kindergartens in Baghdad. The sample was raised using convenience sampling technique. Approval was obtained from the ethics review committee of the College of Medicine, Mustansiriyah University, Baghdad, and consent was taken from the parents of all the participants.

A thorough history was taken from the parents regarding the date of birth, age of diagnosis, duration of the disease, type of insulin and regimen used, dose of insulin, any other chronic illnesses, and family history of short stature.

Each subject underwent a clinical evaluation which included a general examination, growth measurements involving weight, height, and body mass index (BMI). The height, weight and BMI values were plotted on the Centres for Disease Control and Prevention (CDC) growth charts[8] for boys and girls to obtain a percentile ranking, and Z-score was calculated using an anthropometric electronic calculator depending on CDC charts[9]. Both parents' heights were recorded and mid-parental height was determined using the formula[10]: (father's height -13) + mother's height /2 (for girls), and father's height + (mother's height +13) /2 (for boys).

Glycaemic control was assessed using enzymatic glycated haemoglobin (HbA1c) assay (Siemens Atellica CH Analyser system, United States), and the mean of all readings available for the preceding 12 months was calculated. All diabetic patients were sent for screening of coeliac disease using anti-tissue transglutaminase (tTG) antibodies or intestinal biopsy as well as thyroid function test through thyroid stimulating hormone (TSH) and free thyroxin (T4).

Data was analysed using SPSS 25. Independent t-test, two-tailed analysis of variance (ANOVA), and Pearson's correlation test (r) were used, as appropriate. $P<0.05$ was considered significant.

## Results

Of the 203 subjects assessed, 11(5.4%) had to be excluded, and, as such, the final sample stood at 192(94.6%). Of them, 96(50%) subjects were in each of the 2 groups; 50(52.1%) girls and 46(47.9%) boys in group A, and 58(60.4%) girls and 38(39.6%) boys in group B. The overall mean age was 9.66±3.26 years. In both groups, majority of children were aged 7-11 years; 44(45.8%) in group A and 64(66.7%) in group B. There were no significant intergroup differences in terms of age (p=0.098) and gender (p=0.244).

In group A, 65(67.7%) patients were diagnosed at age 5-10 years, 74(77.1%) had TIDM for <5 years, 79(82.3%) were on a conventional insulin regimen, and 49(51%) had poor glycaemic control, with HbA1c >9%.

Group A children had significantly lower mean height, weight and BMI Z-scores compared to group B (p=0.001).

**Table-1:** Distribution of the case group by mean height Z (HtZ) score and clinical characteristics

| Clinical Characteristics | HtZ Mean ± Std. Dev | P-Value |
|---|---|---|
| **Age (Years)** | | |
| 2 - 6 | - 0.57 ± 1.05 | 0.001 |
| 7 - 11 | - 0.17 ± 0.93 | |
| 12 - 16 | - 1.42 ± 1.48 | |
| Gender | | |
| Boy | - 0.90 ± 1.57 | 0.235 |
| Girl | - 0.58 ± 1.05 | |
| **Duration of T1DM (Years)** | | |
| < 5 | - 0.46 ± 1.06 | 0.005 |
| ≥ 5 | - 1.65 ± 1.71 | |
| **Insulin Regimen** | | |
| Basal Bolus Regimen | - 0.007 ± 0.77 | 0.012 |
| Conventional Regimen | - 0.89 ± 1.37 | |
| **Glycaemic control** | | |
| Good | - 0.25 ± 0.85 | 0.001 |
| Fair | - 0.07 ± 1.08 | |
| Poor | - 1.32 ± 1.33 | |

T1DM: Type 1 diabetes mellitus.

**Table-2:** Distribution of the case group by mean weight Z (WtZ) score and clinical characteristics.

| Clinical Characteristics | WtZ Mean ± Std. Dev | P-Value |
|---|---|---|
| **Age (Years)** | | |
| 2 – 6 | 0.08 ± 0.88 | 0.001 |
| 7 – 11 | - 0.33 ± 1.30 | |
| 12 - 16 | - 1.33 ± 1.51 | |
| **Gender** | | |
| Boy | - 1.14 ± 1.52 | 0.003 |
| Girl | - 0.26 ± 1.23 | |
| **Duration of T1DM (Years)** | | |
| < 5 | - 0.52 ± 1.34 | 0.039 |
| ≥ 5 | - 1.24 ± 1.65 | |
| **Insulin Regimen** | | |
| Basal Bolus Regimen | - 0.36 ± 0.81 | 0.310 |
| Conventional Regimen | - 0.75 ± 1.54 | |
| **Glycaemic control** | | |
| Good | 0.21 ± 0.98 | 0.001 |
| Fair | - 0.12 ± 0.97 | |
| Poor | - 1.31 ± 1.55 | |

T1DM: Type 1 diabetes mellitus.

**Table-3:** Distribution of the case group by mean body mass index Z (BMIZ) score and clinical characteristics.

| Clinical Characteristics | BMIZ Mean ± Std. Dev | P-Value |
|---|---|---|
| **Age (Years)** | | |
| 2 - 6 | 0.12 ± 1.43 | 0.222 |
| 7 - 11 | - 0.42 ± 1.51 | |
| 12 - 16 | - 0.68 ± 1.38 | |
| **Gender** | | |
| Boy | - 1.01 ± 1.24 | 0.001 |
| Girl | - 0.06 ± 1.46 | |
| **Duration of T1DM (Years)** | | |
| < 5 | - 0.49 ± 1.55 | 0.625 |
| ≥ 5 | - 0.32 ± 1.07 | |
| **Insulin Regimen** | | |
| Basal Bolus Regimen | - 0.62 ± 1.07 | 0.604 |
| Conventional Regimen | - 0.41 ± 1.53 | |
| **Glycaemic control** | | |
| Good | 0.44 ± 1.04 | 0.004 |
| Fair | - 0.16 ± 1.25 | |
| Poor | - 0.89 ± 1.54 | |

T1DM: Type 1 diabetes mellitus.

The height Z (HtZ) score of group A children was significantly inversely associated with age, duration of disease and HbA1c level (p=0.001) (Table 1).

The weight Z (WtZ) score in group A children was significantly inversely correlated with age and HbA1c level (p=0.001) (Table 2).

The BMI Z (BMIZ) score in group A children was significantly inversely associated with age and HbA1c level (p<0.05) Table 3).

## Discussion

Most patients in the current were diagnosed at age <10 years, especially at age 5-10 years, with a mean of 7 years, which was similar to the mean age 7.3 years[11] and 7 years [12] reported earlier. There is a global trend towards younger age at T1DM onset, with an increment of incidence about 12.6% in children aged 0-9 years[13].

Compared to the control group, the patients were significantly shorter and lighter with lower height, weight and BMI Z-scores (p=0.001). The finding was parallel to the results of Khadilkar et al.[14]

In the current study, the height of patients who were still on conventional twice-daily insulin regimen was significantly lower than those receiving basal insulin, indicating that an appropriate basal insulin dosage can play a vital role in augmenting growth. This has been earlier reported by Bizzarri et al. who suggested that modern advancements in insulin therapy have allowed children with T1DM to achieve a normal ultimate height[15].

In the current study, the type of insulin did not seem to affect patients' weight or BMI, though some studies stated that patients on basal insulin tend to be overweight[16,17]. The difference could be attributed to the fact that the current study had only a few patients on basal-bolus regimen (17%).

The duration of the disease was found in the current study to inversely affect growth in patients with disease duration >5 years who had lower HtZ and WtZ values, as earlier observed by Bonfig et al[3] and Elamin et al[18].

Patients with poor glycaemic control were affected in all three parameters of growth in the current study, which was earlier reported by Elamin et al.[18], while Donaghue et al. reported only height which was adversely affected by increased HbA1c levels[19].

Patient's height and weight in the fair and good control groups in the current study did not seem to be affected, making it possible for patients with fair control to achieve relative normal growth and final adult height. This was earlier observed by Assar et al.[9] but Aljuhani et al. in Saudi Arabia [20] found that patients in the fair control group were the most affected in terms of height.

**Limitation:** The current study has limitations as the sample size was not calculated which could have influenced the power of the study, while convenience sampling technique was used.

## Conclusion

T1DM children had significantly lower mean height, weight and BMI Z-scores compared to healthy children. Pubertal age group, poor glycaemic control, longer disease duration, and using a conventional regimen of insulin were the factors affecting growth parameters the most.

**Disclaimer:** None.

**Conflict of Interest:** None.

**Source of Funding:** None.

## References

1. Weber DR. Diabetes Mellitus. In: Kleigman RM, Geme JW St, eds. Nelson Textbook of Pediatrics, 21st ed. Amsterdam, Netherlands: Elsevier; 2020; pp 3019–42.
2. Giannini C, Mohn A, Chiarelli F. Growth abnormalities in children with type 1 diabetes, juvenile chronic arthritis, and asthma. Int J Endocrinol 2014;2014:265954. doi: 10.1155/2014/265954
3. Bonfig W, Kapellen T, Dost A, Fritsch M, Rohrer T, Wolf J, et al. Growth in children and adolescents with type 1 diabetes. J Pediatr 2012;160:900-3.e. doi: 10.1016/j.jpeds.2011.12.007
4. Mitchell DM. Growth in patients with type 1 diabetes. Curr Opin Endocrinol Diabetes Obes 2017;24:67-72. doi: 10.1097/MED.0000000000000310

5. Donaldson MDC, Gregory JW, Van-Vliet G, Wolfsdorf JI, Deladoëy J. Diabetes Mellitus. In: Practical Endocrinology and Diabetes in Children, 4th ed. Hoboken, NJ: Wiley-Blackwell, 2019; pp 19-74.
6. Kim MS, Quintos JB. Mauriac syndrome: growth failure and type 1 diabetes mellitus. Pediatr Endocrinol Rev 2008;5(Suppl 4):s989-93.
7. Granados A, Gebremariam A, Lee JM. Relationship Between Timing of Peak Height Velocity and Pubertal Staging in Boys and Girls. J Clin Res Pediatr Endocrinol 2015;7:235-7. doi: 10.4274/jcrpe.2007
8. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, Flegal KM, Guo SS, Wei R, et al. CDC growth charts: United States. Adv Data 2000;2000:1-27.
9. Chou JH, Roumiantsev S, Singh R. PediTools Electronic Growth Chart Calculators: Applications in Clinical Care, Research, and Quality Improvement. J Med Internet Res 2020;22:e16204. doi: 10.2196/16204
10. Bamba V, Kelly A. Assessment of Growth. In: Kleigman RM, Geme JW St, eds. Nelson Textbook of Pediatrics, 21st ed. Amsterdam, Netherlands: Elsevier; 2020; pp 151–7.
11. Assar S, Riahi K, Bashirnezhad S, Yazdanpanah L, Latifi SM. The Relationship between Metabolic Control and Growth in Children with Type I Diabetes Mellitus in Southwest of Iran. Scientifica (Cairo) 2015;2015:917542. doi: 10.1155/2015/917542
12. Ardicli D, Kandemir N, Alikasifoglu A, Ozon A, Gonc N. Clinical characteristics of type 1 diabetes over a 40 year period in Turkey: secular trend towards earlier age of onset. J Pediatr Endocrinol Metab 2014;27:635-41. doi: 10.1515/jpem-2013-0320
13. Chiang JL, Maahs DM, Garvey KC, Hood KK, Laffel LM, Weinzimer SA, et al. Type 1 Diabetes in Children and Adolescents: A Position Statement by the American Diabetes Association. Diabetes Care 2018;41:2026-44. doi: 10.2337/dci18-0023
14. Khadilkar VV, Parthasarathy LS, Mallade BB, Khadilkar AV, Chiplonkar SA, Borade AB. Growth status of children and adolescents with type 1 diabetes mellitus. Indian J Endocrinol Metab 2013;17:1057-60. doi: 10.4103/2230-8210.122623
15. Bizzarri C, Timpanaro TA, Matteoli MC, Patera IP, Cappa M, Cianfarani S. Growth Trajectory in Children with Type 1 Diabetes Mellitus: The Impact of Insulin Treatment and Metabolic Control. Horm Res Paediatr 2018;89:172-7. doi: 10.1159/000486698
16. Birkebaek NH, Kahlert J, Bjarnason R, Drivvoll AK, Johansen A, Konradsdottir E, et al. Body mass index standard deviation score and obesity in children with type 1 diabetes in the Nordic countries. HbA1c and other predictors of increasing BMISDS. Pediatr Diabetes 2018;19:1198-205. doi: 10.1111/pedi.12693.
17. Boucher-Berry C, Parton EA, Alemzadeh R. Excess weight gain during insulin pump therapy is associated with higher basal insulin doses. J Diabetes Metab Disord 2016;15:47. doi: 10.1186/s40200-016-0271-5
18. Elamin A, Hussein O, Tuvemo T. Growth, puberty, and final height in children with Type 1 diabetes. J Diabetes Complications 2006;20:252-6. doi: 10.1016/j.jdiacomp.2005.07.001
19. Donaghue KC, Kordonouri O, Chan A, Silink M. Secular trends in growth in diabetes: are we winning? Arch Dis Child 2003;88:151-4. doi: 10.1136/adc.88.2.151
20. Aljuhani FM, Al-Agha AE, Almunami BA, Meftah EA, Sultan RA, Sultan RA, et al. Growth status of children and adolescents with type 1 diabetes mellitus in Jeddah, Saudi Arabia: a cross-sectional study. Curr Pediatr Res 2018;22:249-54.