Original Article

Puberty and Growth Parameters of Iraqi Type 1 Diabetic Adolescents

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Abstract

Background: Diabetes and other chronic diseases can affect linear growth and pubertal development. Poor glucose control, long duration, and younger age at onset negatively affect growth and pubertal development. **Objectives:** This study was designed to describe height, body mass index, and sexual maturation of Iraqi type 1 diabetic adolescents, and their relation to the age at diagnosis, duration of disease, and insulin dose. **Materials and Methods:** Seventy type 1 diabetic patients were involved in this cross-sectional study. Their ages ranged between 10 and 18 years with diabetes for more than 2 years. Height, weight, body mass index, and pubertal stage were assessed. Then they were correlated with insulin dose, age at diagnosis, and duration of diabetes. **Results:** There was no significant difference between male and female mean height *Z* score, whereas the mean body mass index *Z* score was significantly higher for females than for males. Most of the patients had normal height and body mass index, and only 14.3% and 4.3% were short and underweight, respectively, and there was a significant inverse correlation between duration of diabetes and height SD. Twenty-seven females had menarche. Its age ranged from 10 to 16 years, with a mean of 13.5 ± 1.44 years. Three males and three females (8.6%) had delayed puberty, and no patient had precocious, with a significant positive correlation between pubertal development and height SD. **Conclusion:** Although there is an improvement in growth parameters for Iraqi diabetic children, they are still abnormal, especially with long diabetes duration.

Keywords: Adolescents, growth parameter, puberty, type 1 diabetes

Introduction

Diabetes and other chronic diseases can disturb physiology, thus affecting linear growth and pubertal development.[1,2] Growth retardation in type 1 diabetes (T1D) represents a combination of pathophysiologic processes as calorie wasting from hyperglycemia or malabsorption secondary to celiac disease, chronic acidosis, increased glucocorticoid production, hypothyroidism, and delayed puberty. Added to that, hypoinsulinemia will affect insulin-like growth factor 1 level and action as insulin suppresses insulin-like growth factor-binding protein-1 and regulates the expression of growth hormone receptor (GHR).[3] Calorie wasting and subsequent malnutrition can cause hypogonodotropic hypogonadism and delayed puberty.[4]

Although successful treatment of T1D, particularly during puberty, is associated with normal growth and sexual maturation,[2] poorly controlled diabetes mellitus with or without the full Mauriac syndrome will lead to growth failure and maturational delay.[4,5] There is evidence to suggest that poor glucose control, long duration, and younger age at onset negatively affect growth and pubertal development.[6] This study was designed to describe height, body mass index (BMI), and sexual maturation of Iraqi type 1 diabetic adolescents and their relation to the age at diagnosis, duration of disease, and insulin dose.

Materials and Methods

Seventy diabetic patients were included in this cross-section retrospective study, who visited the National

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Diabetes Center in Baghdad during the period from February to September 2016.

Inclusion criteria were age 10–18 years with T1D for more than 2 years. Any patient with chronic disease that may affect the growth and puberty, such as hypothyroidism, celiac disease, asthma, congenital heart disease, etc., was excluded from the study. Also patients who finished puberty before the development of diabetes were excluded.

The following information was obtained from patients' medical records according to their last medical visit: gender, age at onset of diabetes, duration of disease, insulin dose/day, insulin regimen used, height and weight which had been measured with a calibrated stadiometer sensitive to 0.1 cm and electronic scales sensitive to 0.1 kg, respectively, pubertal stage that had been assessed according to the Tanner stage by pediatric endocrinologist, and HbA1c.

Depending on these information, BMI was calculated by dividing weight in kilogram by square height in meter. Then height and BMI percentile and *Z*-score were calculated by an anthropometric calculator depending on CDC charts as there are no special Iraqi charts, and they were considered abnormal if value is more than −2 or 2 SD from the mean. Also the Tanner stage for each patient was plotted on a special chart,[7] and it was considered delayed if it was below 3rd centile and advanced if it was more than 97th centile.

This study was approved by the Scientific Council of Pediatrics/Iraqi Commission of Medical Specialization. Statistical analysis was performed using SPSS version 23 software. Pearson's correlation coefficient was used to assess the relation between the study variables. A *P*-value of ≤ 0.05 was considered significant.

Results

Seventy patients were included in this study: 28 (40%) males and 42 (60%) females. Their ages ranged from 10 to 18 years. The mean age at diagnosis of diabetes was 8 ± 2.9 years (1–14 years), mean duration of the disease was 5.24 ± 2.8 years (2–12 years), and the mean insulin dose/kg/day was 1 ± 0.37 (0.4–3 U). Sixty-six patients (94.3%) were on conventional insulin regimen, 4 (5.7%) on basal bolus regimen, and none on insulin pump. The mean for weight SD was – 0.17 ± 1.23.

There was no significant difference between male and female mean height *Z*-score, whereas the mean BMI *Z*-score was significantly higher for females than for males [Table 1]. Most of the patients had normal height and body mass index, and only 14.3% and 4.3% were short and underweight, respectively [Table 2], and there was significant inverse correlation between duration of diabetes and height SD as shown in Table 3. Twenty-seven females had menarche. Its age ranged from 10 to 16 years, with a mean of 13.5 ± 1.44 years. Three males and three females (8.6%) had delayed puberty, and no patient had precocious one as illustrated in Table 4, with a significant positive correlation between pubertal development and height SD [Table 5].

Discussion

This study shows that most of the Iraqi diabetic patients are on conventional insulin regimen (2–3 doses per day). This result differs from the German study by Rohrer *et al.*,[8] which shows that the median number of injection is equal to 4 per day. This difference may be related to the high cost and unavailability of long- and rapid-acting insulin in Iraqi hospitals.

In comparison to 2001 (the period of economic blockage),[9] the height and weight SD means for Iraqi diabetic children were improved. They were −1.75±1.3 and −0.75±1.2 for height [Table 1] and −1.24±1.25 and −0.17±1.23 for weight in 2001 and 2016, respectively, which may be attributed to the improvement in the economic state and to the better availability of medications at 2016 in comparison to 2001. In spite of this, growth parameters of

Table 1: Mean ± SD of height, height *Z*-score, BMI, and BMI *Z*-score according to gender

Variable mean ± SD	Total	Male	Female	*P*-value
Height (cm)	150.5± 10.6	151 ±10.4	149±10.8	0.42
Height *Z*-score	−0.75 ± 1.2	−0.63±1.2	−0.82±1.3	0.53
BMI (kg/m^2)	20.36 ± 3.66	18.6±2.7	21.5±3.7	<0.001
BMI *Z*-score	0.234 ± 1.006	−1.89±1.0	0.517±0.9	0.003

Table 2: Distribution of height and BMI *Z*-score according to the gender

Z-score	Males	Females	Total	%
Height >−2 SD	5	5	10	14.3
Height −2 - +2 SD	23	36	59	84.3
Height >+2 SD	0	1	1	1.4
BMI >−2 SD	1	2	3	4.3
BMI −2 - +2 SD	27	39	66	94.3
BMI >+2 SD	0	1	1	1.4

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Table 3: Relation of height SD, BMI SD, and SMR percentile with duration of diabetes, insulin dose, and age at onset of diabetes

Variable 1	Variable 2	Pearson's correlation (*r*)	*P*-value
Height SD			
	Duration	−0.372	0.002
	Insulin dose	0.112	0.356
	Age at onset	0.140	0.248
BMI SD			
	Duration	−0.006	0.962
	Insulin dose	0.067	0.581
	Age at onset	0.003	0.980
SMR %			
	Duration	−0.216	0.073
	Insulin dose	0.057	0.637
	Age at onset	−0.185	0.125

Table 4: Distribution of patients according to puberty

Puberty	Male		Female		Total	
	No.	%	No.	%	No.	%
Normal puberty	25	89.3	39	92.3	64	91.4
Precocious puberty	0	0	0	0	0	0
Delayed puberty	3	10.7	3	7.7	6	8.6
Total	28	100	42	100	70	100

Table 5: Relation of SMR percentile with height and BMI SD

Variable 1	Variable 1	Pearson's correlation (*r*)	*P*-value
SMR %	Height SD	0.433	0
	BMI SD	0.109	0.368

Iraqi diabetic children at 2020 are still significantly lower than their peers.[10] In a study conducted in Basrah at 2020, 24.59% and 19.68% of diabetic children are short and underweight, respectively,[10] whereas in our study 14.3% were short and 4.3% were underweight [Table 2]. This difference may be caused by different used cut limit for short stature and underweight (the Basrah study used 5th centile, whereas we use –2 SD which is about 2.3 centile).

The mean for height SD (−0.75±1.2) was lower than that found by Walter *et al.*[11] in Germany and Austria (0.22 ± 1), calculated using contemporary national reference data. This difference may be related to the use of different growth charts which reflected the actual height of German and Austrian population, but did not for Iraqi one as there is no Iraqi national growth chart. There was a significant inverse correlation between height SD and duration of diabetes [Table 3], which was documented in other studies.[6,12]

The mean BMI in this study sample was 20.3 [Table 1]. This result is comparable to the study done by García-García *et al.*[13] and less than the result found by Maria Svensson *et al.*[14] This study also showed that the mean BMI and BMI SD were significantly higher in females [Table 1], whereas they were higher for males (although not significant) in studies of Rohrer *et al.*[8] and Khadilkar *et al.*[15] This difference may be related to the different used growth charts or different eating habits.

Pubertal onset is delayed in children with T1D, and this delay increases with higher glycohemoglobin, lower BMI SDS,[8] and duration of diabetes.[16] What we found in this study was that 8.6% of diabetic patients showed delayed puberty [Table 4], with a significant positive correlation between SMR% and height SD [Table 5], but not BMI SD or disease duration [Tables 3 and 5]. Attia *et al.*[12] in their cross-sectional study involved 20 diabetic males (age 14–18 years) and found that 25% of male patients had delayed puberty, whereas it was 10.7% in ours [Table 4]. This difference may be explained by different sample sizes and age criteria.

Mean age of menarche was 13.5 years, which means that there is about 0.75 year delay from the mean age of menarche in normal population (12.75 years).[17] This result is comparable to the study of Rohrer *et al.* (13 years),[8] more than what found by Danielson *et al.* (12.8),[18]

García-García *et al.* (12.6),[13] and Pereira *et al.* (12.3)[19] and less than what found by Elamin *et al.* (15.1 years).[20]

There were three limitations in this study: they are small sample size, the absence of regular HbA1c assessment for most of patients which prevents taking it as an indicator for diabetes control, and being almost all patients on conventional insulin regimen, so type of insulin regimen was not taken as study variable.

Conclusion

Although there is an improvement in growth parameters for Iraqi diabetic children, they are still abnormal, especially with long diabetes duration.

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Conflicts of interest

There are no conflicts of interest.

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