AJPMHS GLOBAL RESEARCH NETWORK

AMERICAN Journal of Pediatric Medicine and Health Sciences
Volume 4, Issue 6, 2026 ISSN (E): 2993-2149

Association of Obesity with Growth and Pubertal Development in Iraqi Children: A Cross-Sectional Study

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Abstract: Background: It has been said that overweight during childhood may disturb the normal pattern of somatic growth and sexual maturation. There is increasing evidence that adiposity influences both stature and the timing of pubertal onset, although the magnitude and direction of these effects may vary by sex. Such information among Iraqi children is lacking.
Objective: To investigate the relationship between obesity, linear growth, and pubertal development in Iraqi children and adolescents.
Methods: This was a hospital-based cross-sectional study conducted in the Pediatric Endocrinology Outpatient Clinic of Al-Zahra Teaching Hospital from January 2021 to December 2025. The study involved 250 participants between 3 and 18 years of age. Nutritional status was assessed based on body mass index percentiles adjusted for age and sex, and participants were classified as obese or non-obese. Height and weight were measured in standard units, and pubertal staging was done by Tanner criteria. Postmenarchal girls gave details of their menstrual history. The data were analyzed using IBM SPSS Statistics; $p<0.05$ was considered to be statistically significant. as $p < 0.05$.
Results: There were 250 children enrolled in this study. One hundred and thirty-six (54.4%) were males, and 114 (45.6%) were females. Only 26 (10.4%) children were found to be obese, whereas 224 (89.6%) children had normal or non-obese body mass index values. The children with obesity were taller on average and were at more advanced pubertal stages compared to their nonobese counterparts. For the girls, obesity was associated with earlier breast maturation and a lower age at menarche. For the boys, higher body mass index was associated with earlier genital development and larger testicular volume. There were positive correlations between body mass index and the indicators of pubertal progression.
Conclusion: Childhood obesity was associated with higher values of stature and pubertal maturation in this Iraqi sample. Such findings emphasize the requirement for early identification and effective management of overweight to attain healthy growth and developmental outcomes.

Keywords: Childhood obesity, Pubertal development, Linear growth, Body mass index, Tanner staging, Iraqi children.

Introduction

Childhood obesity is currently one of the most important public health dilemmas facing children and adolescents on a global scale [1][2][3][4][5]. Excess fat is known to have effects on linear growth and the timing of pubertal development in addition to its better-known metabolic and cardiovascular outcomes.

Several studies have shown that, in girls, there is a correlation between obesity and the early onset of puberty as well as a younger age at menarche; the relationship in boys is more variable but may also affect pubertal progression.

Leptin and other mediators from adipose tissue can, when energy reserves are sufficient, turn on

the hypothalamic-pituitary-gonadal axis.

In childhood, skeletal maturation is advanced in obese children, and there are changes in insulin and insulin-like growth factor-1 activity. Usually, they are taller than non-obese children. This increase in stature may be temporary, but it reflects important endocrine changes related to excess fat.

There is ample international evidence but data on the relationship of obesity with growth and pubertal development in Iraqi children are scanty. This study was, therefore, conducted on children and adolescents attending the Pediatric Endocrinology Outpatient Clinic of Al-Zahra Teaching Hospital to assess the relationship between obesity, linear growth, and pubertal development.

Methods

Study Design and Setting

This hospital-based cross-sectional study was conducted at the Pediatric Endocrinology Outpatient Clinic of Al-Zahra Teaching Hospital, Kut, Iraq, from January 2021 to December 2025.

Study Population

A total of 250 Iraqi children and adolescents aged 3–18 years were consecutively enrolled during the study period. The study population comprised 136 boys (54.4%) and 114 girls (45.6%). Participants were classified according to age- and sex-specific body mass index (BMI) percentiles into obese and non-obese groups based on internationally accepted criteria. Twenty-six participants (10.4%) were categorized as obese, while 224 (89.6%) were classified as non-obese.

Inclusion Criteria

- Iraqi children and adolescents aged 3–18 years.
- Availability of complete anthropometric and pubertal assessment data.
- Written informed consent obtained from parents or legal guardians.

Exclusion Criteria

Participants were excluded if they had chronic systemic diseases, congenital anomalies, known genetic syndromes, endocrine disorders other than obesity, or a history of prolonged use of medications that could affect growth or pubertal development.

Anthropometric Assessment

Body weight was measured to the nearest 0.1 kg with participants wearing light clothing and no shoes. Height was measured to the nearest 0.1 cm using a wall-mounted stadiometer. BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2). BMI percentiles were determined according to age- and sex-specific reference standards.

Pubertal Assessment

Pubertal development was assessed by Dr. Thulfagar Ibrahim Salih using Tanner staging criteria.

For girls:

- Breast development (B1–B5)
- Pubic hair development (PH1–PH5)
- Age at menarche, when applicable

For boys:

- Genital development (G1–G5)
- Pubic hair development (PH1–PH5)

- Testicular volume measured using a Prader orchidometer

Pubertal onset was defined as Tanner stage II or higher.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics. Continuous variables were expressed as mean ± standard deviation and categorical variables as frequencies and percentages. Independent-samples t-tests were used to compare continuous variables. For categorical variables, either the chi-square or Fisher's exact test was used. Pearson correlation analysis was carried out to assess the association of BMI with pubertal parameters. A p-value less than 0.05 was considered statistically significant (two-tailed).

Results and Discussion

Results

The study included 250 children and adolescents from Iraq, aged 3 to 18 years (mean age 10.8 ± 3.9 years). There were 136 boys (54.4%) and 114 girls (45.6%) in the sample. Twenty-six participants were noted to be obese (10.4%) and 224 were classified as non-obese (89.6%).

Obese children had significantly higher body weight, BMI, and BMI percentile compared with nonobese children ($p < 0.001$). They were also significantly taller, with higher mean height-for-age values ($p = 0.008$).

Obesity was significantly associated with earlier breast development and younger age at menarche in the girls. The mean age at menarche was significantly lower in the obese girls compared to non-obese girls (11.6 ± 0.8 vs. 12.5 ± 0.9 years, $p = 0.01$). For boys, participants with obesity showed earlier genital maturation and greater mean testicular volume compared to non-obese boys ($p = 0.03$).

BMI was significantly positively correlated with height-for-age, Tanner stage, and testicular volume. In girls, higher BMI was inversely associated with age at menarche — signaling earlier menstrual onset as adiposity increases.

Table 1. Demographic Characteristics of the Study Population

Variable	Total (n = 250)
Age (years), mean ± SD	10.8 ± 3.9
Boys, n (%)	136 (54.4%)
Girls, n (%)	114 (45.6%)
Obese participants, n (%)	26 (10.4%)
Non-obese participants, n (%)	224 (89.6%)

Table 2. Comparison Between Obese and Non-Obese Participants

Variable	Obese (n = 26)	Non-Obese (n = 224)	p-value
Height (cm), mean ± SD	145.8 ± 18.4	138.2 ± 20.1	0.008
Weight (kg), mean ± SD	59.6 ± 14.2	38.9 ± 16.8	<0.001
BMI (kg/m²), mean ± SD	29.1 ± 3.8	18.4 ± 3.1	<0.001
BMI percentile, mean ± SD	97.8 ± 1.2	56.3 ± 24.8	

Table 3. Pubertal Characteristics

Variable	Obese	Non-Obese	p-value
Girls' age at menarche (years)	11.6 ± 0.8	12.5 ± 0.9	0.010
Tanner stage ≥ II (girls), n (%)	7/8 (87.5%)	54/106 (50.9%)	0.040
Tanner stage ≥ II (boys), n (%)	14/18 (77.8%)	68/118 (57.6%)	0.030
Testicular volume (mL), mean ± SD	8.9 ± 3.4	6.7 ± 2.8	

Discussion

This cross-sectional study assessed the link between obesity, linear growth, and pubertal development in children and adolescents from Iraq who were receiving care at the Pediatric Endocrinology Outpatient Clinic of Al-Zahra Teaching Hospital. It was found that increased body weight was related to increased stature and earlier pubertal maturation. This effect was more evident in girls than in boys.

In this study, the obese participants were significantly taller than their non-obese peers, despite having similar chronological ages. This finding agrees with other studies, which have reported that children with obesity generally have accelerated growth during childhood [6][7][8][9][10][11]. Increased insulin secretion, enhanced insulin-like growth factor-1 activity, and earlier advancement of skeletal maturation may contribute to this temporary increase in stature. Although obese children tend to be taller during childhood, their relative height advantage may diminish over time as a result of earlier epiphyseal fusion.

Obesity was also significantly associated with early pubertal development. Breast maturation and age at menarche were found to be earlier in girls with obesity as compared to non-obese girls. This finding is consistent with many other epidemiological studies which have indicated that adiposity is among the most robust determinants for early pubertal onset in females [12][13][14][15].

Boys who were obese had earlier genital development and larger testicular volume. Although the relationship between obesity and the timing of puberty in males remains less consistent across studies, the present findings suggest that increased body mass index may modestly accelerate puberty [16][17][18]. Differences in study populations, definitions of obesity, and hormonal profiles may explain the variability reported in previous investigations.

Body mass index had a positive correlation with height-for-age, Tanner stage, and testicular volume. In girls, higher body mass index was associated with a younger age at menarche. These data provide evidence for the concept that excess fat has an impact on both somatic growth and reproductive maturation through related metabolic and hormonal mechanisms, including hyperinsulinemia, high leptin levels, and increased peripheral aromatization of sex steroids [19][20][21].

The association between obesity and the advance of puberty was more significant in girls than in boys, which suggested that the regulatory mechanisms of puberty in females might be more sensitive to the endocrine signals that come from fat. These results are fairly consistent with those of other studies from around the globe [13,14,18] and represent sex-specific patterns.

Limitations

Several limitations need to be recognized. First, the cross-sectional design precludes making causal inferences. Second, the study was carried out at a single tertiary center, which may limit the generalizability of its findings. Finally, subgroup analyses were less statistically precise because the number of obese participants was small. Routine hormonal assays and radiographic evaluations of bone age were not conducted.

Conclusions

Childhood obesity was significantly correlated with tall stature and advanced pubertal development in children and adolescents of the Iraqi city (Kut). More specifically, this association was found to be stronger in girls, who exhibited early breast maturation and a younger age at menarche. Results draw attention to the significance of early detection and proper management of childhood obesity to mitigate its impact on normal growth and reproductive maturation. Larger prospective multicenter studies are recommended to further clarify the long-term consequences of obesity on pubertal timing in Iraq.

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