Original Article

Iran J Pediatr
Jun 2010; Vol 20 (No 2), Pp:160-166

Assessment of Pubertal Development in Iranian Girls

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Received: *Sep 05, 2009*; Final Revision: *Feb 10, 2010*; Accepted: *Mar 11, 2010*

Abstract

Objective: We estimated pubertal development of 7,493 normal Iranian girls aged 6 to 20 years in a cross-sectional study.

Methods: Pubertal stages were assessed according to Tanner. The mean ages to achieve secondary sexual characteristics as well as the mean age at menarche were estimated. Weight and height were measured and body mass index (BMI) was calculated. Reference curves for different breast stages and menarche were constructed. The percentiles for attaining each stage were compared to data proposed by Tanner.

Findings: The mean age at breast bud stage (B2) was 10.10, pubic hair stage (P2) was 9.83, and menarche age was 12.55 years. The anthropometric variables were interpreted in different maturity stages. The mean age at attainment of puberty was compared with those of other populations.

Conclusion: Not only the onset of puberty in Iranian girls but also the duration of puberty is similar to data from most other countries. A lower age limit for the definition of precocious puberty than the traditional 8 years is documented for Iranian girls. However, it should be noted that considering the rate of evolution of pubertal findings is more important than the age of their appearance.

Iranian Journal of Pediatrics, Volume 20 (Number 2), June 2010, Pages:160-166

Key Words: Puberty; Adolescent Development; Sex Maturation; Iran

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Introduction

Development of secondary sexual characteristics and onset of menarche have significant consequences over physical and psychological health of adolescent girls. The process of pubertal development is traditionally subdivided into clinical stages, as proposed by Marshall and Tanner[1,2]. Studies from around the world have shown that the time of puberty can vary with ethnicity, environmental conditions, geographical location and nutrition[3-6]. Current data is in favor of continuation of a secular trend towards a lower age of pubertal development in girls especially in developed countries[3,4,5].

Assessment of the onset and progression of sexual maturation are important in pediatrics because this information has immediate clinical application in the interpretation of endocrine and growth status[7,8]. However, this assessment is only useful if updated and reliable reference data from the same population are available for comparison[5,6]. Thus the age limits used to define precocious puberty are necessarily subject to local assessment and regular revision.

There is limited data on pubertal development of Iranian girls[9]. This article describes the prevalence of secondary sexual characteristics in a random group of Iranian girls to evaluate the age at puberty onset, and compares our data with the percentile values published by Tanner[10]. Our data represents a standard for assessment of onset of pubertal changes in Iranian girls.

Subjects and Methods

Study subjects

Healthy Iranian girls from public schools were selected by clustered random sampling to participate in the study which was carried out during 2006. The study protocol was approved by the Ethics Committee of the Ministry of Health and the School Boards. A total number of 30 clusters including 7493 girls (aged 6.0–20 years) were selected from all provinces. Children with acute or chronic diseases and those who participated in heavy exercises were excluded. In all subjects, height, weight, and pubertal stages were measured by the same team of investigators.

Methods

Height was measured using a Harpenden stadiometer (Holtain Ltd, Crymych, UK) to the nearest mm. Body weight was measured to the nearest 100 g (SIMPLE, Japan). Body mass index (BMI) was calculated from the ratio weight/height square (kg/m^2). Pubertal stages were determined by visual inspection and palpation, using the criteria and definitions described by Marshall and Tanner[1]; ie breast stages 1–5 by both inspection and palpation; breast stage B2 corresponds to the breast bud stage with palpable glandular breast tissue and elevation of the papilla, stage B3 with further enlargement of the breast and areola with no separation of the contours, stage B4 where the areola and papilla form a secondary mound above the level of the breast, and stage B5 was assigned in case of the mature breast with projection of the papilla only.

The onset of puberty is measured as the age at breast development at Tanner stage 2 (B2).

Pubic hair stages (P1–P5) were also evaluated; stage P2 being assigned with the presence of long, slightly pigmented hair (straight or curled). Mean menarcheal age was documented as well using status quo and recall methods. The children were grouped by 1-year age intervals, which extended from the day of the child's birthday to the day before the next birthday.

Statistical analysis

We estimated the distribution of time of menarche, B2-B5 and P2-P5 by non-parametric analyses. For stages of breast development and menarche, the reference curves were estimated by a generalized additive logistic regression for each transition stage separately[11]. This model describes the probability of each stage as a smooth function of age, weight, or height. Student's t test was used to compare weight, height and BMI between pubertal and pre-pubertal subjects. Statistical analysis was done using SPSS 15 (SPSS, Chicago, Ill). All statistical references were made at α=0.05.

Table 1: Comparison between percentile values proposed by Tanner and our data and delta values (Δ) for breast development at Tanner stage 2 (B2) and pubic hair development at Tanner stage 2 (P2) in girls

Girls	Percentile	B2 Age (yr)	Δ (yr)	P2 Age (yr)	Δ (yr)
Our data	3rd	6.2	2.9	7.4	0.8
Tanner		9.1		9.2	
Our data	10th	7.4	2.4	8.2	1.7
Tanner		9.8		9.9	
Our data	25th	8.6	1.8	9.2	1.5
Tanner		10.4		10.7	
Our data	50th	9.7	1.5	10.3	1.2
Tanner		11.2		11.5	
Our data	75th	10	1.9	11.4	0.9
Tanner		11.9		12.3	
Our data	90th	12.8	-0.2	12.4	0.6
Tanner		12.6		13.0	
Our data	97th	13.6	-0.4	13.2	0.6
Tanner		13.2		13.8	

Findings

Reference curves for pubertal stages and menarche: In Fig. 1 we present the reference curves for sexual development. Fig. 1A presents percentiles for breast stages and menarche in relation to age (months). The percentile3 values for stage B2 and menarche are 6.2 and 9.8 years respectively, and percentile 97 values are 13.6 and 14.4 years, respectively. Fig. 1B and 1C show percentiles for breast stages and menarche in relation to height and weight respectively. The P50 value for stage B2 related to height and weight are 135 centimeters and 29 kilograms, respectively. The comparison between percentile values proposed by Tanner and our data is shown in Table 1. Compared to Tanner's data in Iranian girls, the 50th percentile age of puberty onset (stage B2) and of P2 is decreased by about 1.5 yrs and 1.2 yrs respectively (Table 1).

The mean age (95% CI) at menarche as indicated was 12.55 (12.51 to 12.60) yr (Table 2). In pubertal females at the stage B2 and menarche, the mean BMI was significantly higher (P=0.001) than in pre-pubertal girls at the stage B1. The weight, height and BMI of pre-pubertal girls are compared to those of girls in stage B2 and higher in different age groups (Fig. 2).Characteristics of participants in each stage of breast development and at the onset of menarche are depicted in Table 3.

Table 2: Mean ages at reaching various pubertal stages in healthy Iranian girls. Results are presented as mean, the 95% confidence interval, and the lower and upper bounds (equal to ±2 SDs).

	Mean	95% CI	±2 SD
B2+	10.10	10.00-1021	6.96-13.23
B3+	11.62	11.51-11.74	8.08-15.16
B4+	13.55	13.44-13.66	9.51-17.58
B5+	14.92	14.84-14.99	11.28-18.55
Menarche	12.55	12.51-12.60	9.82-15.27
P2+	9.83	9.94-9.73	6.65-13.01
P3+	11.60	11.48-11.72	8.30-14.90
P4+	13.27	13.16-13..37	9.37-17.17
P5+	14.96	14.89-15.03	11.38-18.54

Discussion

We here present a nationwide study on pubertal development in 7,493 girls from Iran examined during 2006. This study provides references for pubertal stages in Iranian girls, which can be used for diagnosis of pubertal disorders in

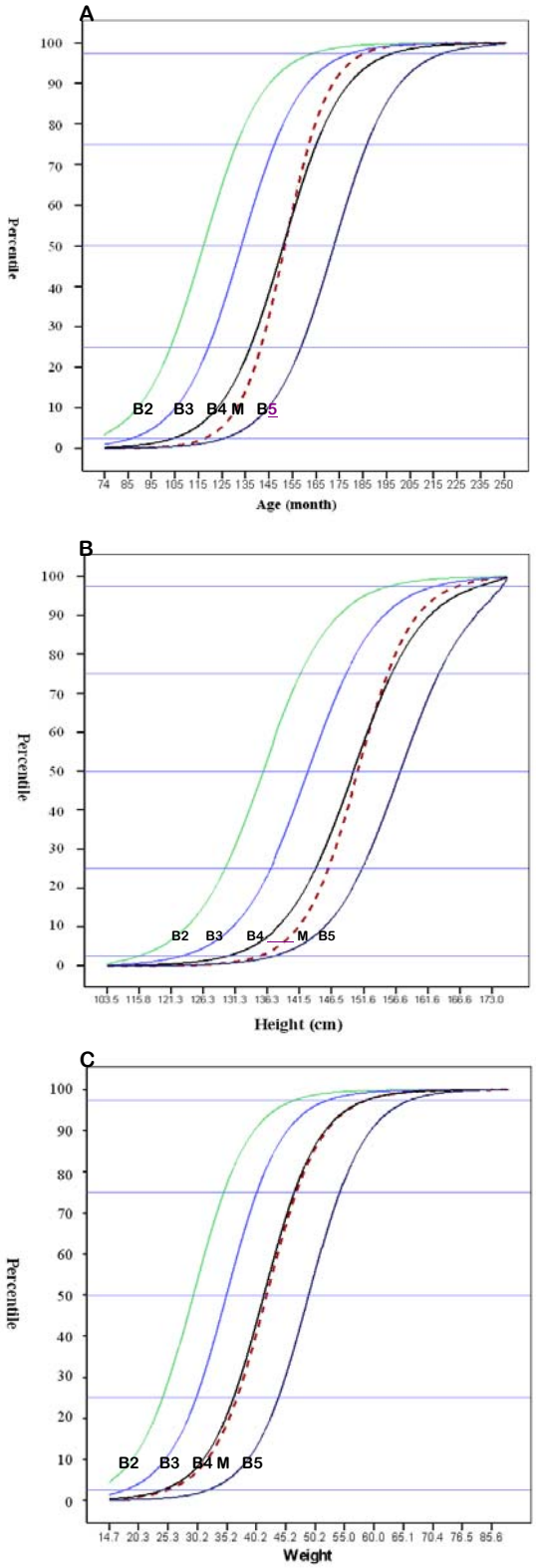

Fig. 1: Reference curves for secondary sexual characteristics and menarche in Iran. **A**, Breast stages and menarche in relation to age (months); **B**, Breast stages and menarche in relation to height (centimeters); **C**, Breast stages and menarche in relation to weight (kilograms)

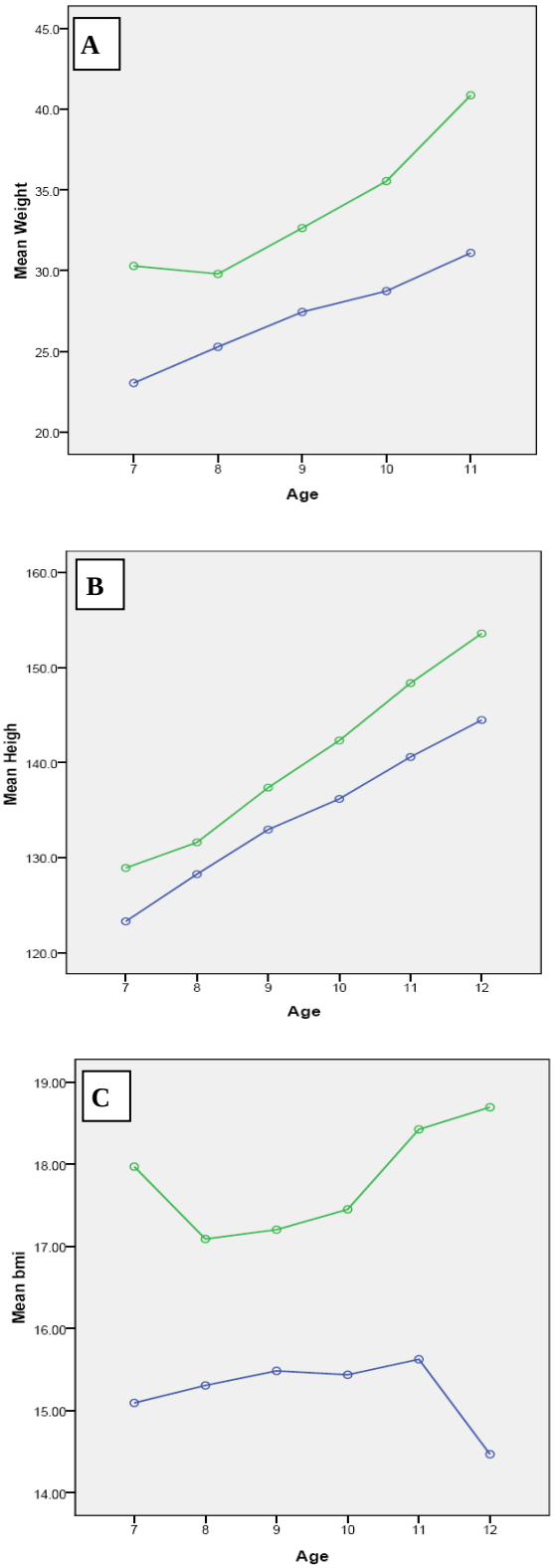

Fig. 2: Depiction of means of weight (A), height (B), and BMI (C), of pre-pubertal girls (blue lines) as well as girls who have entered the puberty (green lines) in relation to age.

Table 3: Characteristics of studied girls in each stage of breast development and at the onset of menarche (The mean values are showed)

Stage of puberty	No	Height (cm)	Weight (kg)	BMI (kg/m²)
B1	2126	128.44	25.32	15.24
B2	804	140.39	33.06	16.64
B3	930	149.28	39.57	17.68
B4	1253	156.81	47.44	19.26
B5	1101	159.19	54.94	21.67

Iranian girls. Our cross sectional study found that girls are beginning pubertal development at younger ages than suggested in Tanner's reference percentiles used in clinical practice.

We found that, on average, Iranian girls begin puberty about 10.10 years which is 0.7 yr earlier than Tanner's British population[10]. Our data are comparable with studies from recent studies of other countries[1;3;5;6;12-15] (Table 4).

Much earlier sexual maturation in American girls was evident from two recent epidemiological studies (PROS and NHANES III)[12,16]. In the PROS study from 1991 to 1992, breast development (occurrence of stage B2) was 8.87 years in African-American girls and 9.96 years in white girls[12]. In the NHANES III study from 1988 to 1994, age at B2 was 9.48 years in African–American girls and 10.38 years in white girls[16,17]. Importantly, we found a lower limit (equal to lower 3rd percentile) for age at attaining B2 of 6.2 years (Fig. 1).

Thus, based on our present data, the age at which a girl should be examined for precocious puberty in Iran should be changed to this age limit. Recent guidelines for definition of precocious puberty in white American girls propose an age limit of 7 years for evaluation of early maturation[18].

In the present study we found a mean age at B2 of 10.10 years in Iranian girls that are higher compared with the American studies. Our previous study conducted in Tehran, revealed a similar mean age at B2 of 10.15 years[9].

Our findings are in accordance with other studies from Europe and Africa. Age at B2 was estimated to be 10.7 years in the Netherlands in 1997[6], 10.8 years in Denmark in 1993[5], 10.3 years in central Italy in 2004[19], and 10.7 years in Egypt in 2004[20]. The small differences could be attributed to the genetic background as well as the environmental factors specific to each population. We estimated a mean menarcheal age of 12.55 years for Iranian girls. However, in the previous study conducted in 2005 an age of 14.54 years was discovered for girls living in Tehran[9]. This marked difference is caused by invalid method of data gathering regarding age of menarche in the 2005 study. The problem resolved in the present study using both status quo and recall methods for documenting the age of menarche.

In the two American studies (PROS and NHANES III) age at menarche was 12.06 and 12.16 years, respectively, in African–American girls, and 12.55 and 12.88 years, respectively, in white girls[12,16]. The menarche age has also been changed to a lower age during the previous decades[21,22]. The duration of puberty in girls (B2 to M) in Iran (2.4 years) was similar to results from United States (2.3 years), Denmark (2.5 years), Venezuela (2.2 years) and Egypt

Table 4: Mean ages at onset of breast development (B2) and menarche in different populations around the world

Country	Years data collected	Age at B2	Age at menarche
England	1969	11.2	13.5
USA	1992-1993	10W, 8.9 B	12.9W, 12.2B
USA	1988-1994	10.4W, 9.5B	12.6W, 12.1B
Denmark	1991-1993	10.8	13.4
Egypt	1997-2001	10.7	12.4
Venezuela	2000	10.4	12.6
Current study	2006	10.1	12.55

W, whites; B, blacks

(1.73 years) for example. Some data have indicated that the earlier girls begin the onset of secondary sexual characteristics, the longer the time period until menarche is reached[23,24]. An important pubertal issuen is the relationship between obesity and sexual maturation. It is proposed that fat mass is a facilitator for the timing of puberty in girls[25]. Leptin levels rise in girls at the time of puberty[26]. It is suggested that overweight girls with higher leptin levels are more likely to enter puberty at an earlier age[21]. Our results as several other studies demonstrated an association between BMI and early pubertal timing[27-29] (Fig. 2).

Moreover, girls with a larger body composition (larger weight and higher height) enter the puberty at a lower age (Fig. 2). Our results show that a weight of about 30 kilograms is critical for onset of puberty (Fig. 1C, 2B).

Conclusion

In conclusion, we found that Iranian girls' age at B2 was 10.10 years. Mean menarcheal age was 12.55 years. Not only the onset of puberty in Iranian girls but also the duration of puberty is similar to data from most other countries. A lower age limit for the definition of precocious puberty than the traditional 8 years is documented for Iranian girls. However, it should be noted that considering the rate of evolution of pubertal findings is more important than the age of their appearance.

Acknowledgment

This study was supported by a grant to Ali Rabbani from Ministry of Health and Medical Education, Tehran, IR Iran.

Conflict of Interest: None

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