Pubertal Characteristics in Girls of Qazvin Province, Iran

Fatemeh Saffari*[1], MD; Maryam Rostamian[1], MD; Neda Esmailzadehha[1], MD; Keivan Shariatinejad[2], MSc, and Toktam Karimzadeh[1], MD

1. Department of Pediatrics, Qazvin University of medical sciences, Qazvin, Iran
2. Biostatistics, School of nursing and midwifery, Mashhad University of Medical Sciences, Mashhad, Iran

Abstract

Objective: Puberty is a critical time between childhood and adulthood. Many studies have reported that the mean age of breast development is decreasing. The aim of this study was to provide updated data on the pubertal development of girls and to evaluate precocious puberty in our population.

Methods: This cross sectional study was conducted in 6 to 16 year old school girls during 2009-2010 in Qazvin. 2240 healthy girls from all geographical regions with every socioeconomic status were selected by a stratified multistage cluster design to obtain representative sample of population. A questionnaire including demographic data, anthropometric measurements, secondary sexual characteristics, menarche status and its onset was filled out for every participant. Secondary sexual characteristics including breast development (B_{1-5}) and pubic hair (PH_{1-5}) were evaluated according to Marshal and Tanner recommendation.

Findings: The mean±SD of height, weight, and BMI of participants was 139.7±14.5, 36.1±12.9 and 17.9±3.7 respectively. The mean age (10th – 90th percentile) of B_2 and PH_2 were 9.71(7.67–11.4) and 9.82 years (7.84–11.42) respectively. Mean age of menstruation was 12.52 years. The mean BMI was significantly higher in pubertal females comparing to prepubertal girls (*P*<0.001). Average duration of puberty (the time from initiation of puberty to menarche) was 2.81 years.

Conclusion: The mean age of pubertal onset in girls living in Qazvin is 9.71 years. Menarche occurs at mean age of 12.52 and onset of puberty earlier than 6.24 years will be precocious. We found that girls in Qazvin had a slightly earlier age of initiation of puberty and of menarche in comparison with other studies in Iran.

Introduction

Puberty is a critical time between childhood and adulthood and is initiated centrally with reactivation of the gonadotropin releasing hormone (GnRH) pulse generator which in girls results in the stimulation of estradiol production. Puberty onset is determined by the appearance of breast buds in girls because breast tissue is the primary target for estradiol. Menarche usually occurs in middle or late puberty [1-3]. The criteria for sexual maturity stages in girls were first described by Marshall and Tanner in 1969 [4].

Normal onset of puberty varies in different populations and there are many conditions consisting of genetic and environmental factors, geographical location and nutrition that may affect this process [1,5,6].

* Corresponding Author;
 Address: Clinical Research center, Qazvin Children Hospital, Qazvin University of Medical Sciences, Qazvin, Iran
 E-mail: drfa_saffari@yahoo.com

Many studies have reported that the mean age of breast development is decreasing [5-9]. Obesity may also influence the timing of pubertal initiation and hormonal pattern [9].

Assessment of the onset of sexual development is necessary for accurate interpretation of the endocrine and growth status in adolescents. National data on these milestones can serve as a baseline for assessing secular trends in pubertal development; moreover these data helps the preparation of normative standards for puberty[10]. The aim of this study was to provide updated data on the pubertal development of girls and to evaluate precocious puberty in our population.

Subjects and Methods

This cross sectional study was conducted in 6 to 16 years old elementary and secondary school girls during 2009 to 2010 in Qazvin - a city located 150 km Southwest of Tehran with Mediterranean weather and spring rains.

This research was officially registered as project No. 701 at the College of Medicine, Qazvin University of Medical Sciences. The study protocol was approved by research deputy, ethics committee of Qazvin University of Medical Sciences and Qazvin office of education. Written informed consent was obtained from participants and their parents. If a girl had no tendency to participate in the study, was excluded. Also any chronic disorder or medication that might affect growth and puberty was subject to exclusion. Healthy status was defined on the basis of history, health records and physical examination.

Overall 2270 girls among a total of 12226 girls from public and private schools of all geographical regions with every socioeconomic status were selected by a stratified multistage cluster design to obtain representative samples of population. 12 of them had no tendency to participate; their characteristics were not significantly different from others and 18 girls were excluded because of underlain disease or medication.

A questionnaire including demographic data, anthropometric measurements, secondary sexual characteristics, menarche status and its onset was filled out for every participant.

In a bare feet standing position, height was measured using a metal stadiometer to the nearest 0.1 cm. Body weight was measured by using a portable Seca scale (Germany) with accuracy of 0.1 kg while subjects were lightly dressed. Body mass index (BMI) was calculated by dividing the weight in kilogram on the square of the height in meter. Students' age was measured by reduction of birth date from the date of data collection and was reported as years and months.

Examination by inspection and palpation was performed by trained general practitioner. Secondary sexual characteristics including breast development ($B_{1–5}$) and pubic hair ($PH_{1–5}$) were evaluated according to Marshal and Tanner recommendation[4].

Statistical analysis

Data was reported as mean±SD and 95% CI for variables. The status quo method was used to evaluate the onset of menarche, which is based on proportion of girls who had reached menarche at each age. Pubertal data were coded as stage transitions, indicating whether or not a certain stage had occurred. We estimated the probability of breast (B_{2-5}) and pubic hair (PH_{2-5}) stages and menarche by logistic regression. These probabilities were plotted against age, height, weight and BMI by Microsoft Office Excel 2007. These curves describe probability of girls in certain age, height, weight and BMI reaching a menarche or stages of breast. Categorical variables were analyzed by chi square test. *P*-values less than 0.05 were considered as statistically significant.

Findings

Total participation rate was 99.47%. The mean±SD of height, weight, and BMI of participants was 139.7±14.5, 36.1±12.9 and 17.9±3.7. In comparison with NCHS (National Center for Health Statistics) growth charts, the

Table 1: Case summaries of age, height, weight and BMI for each breast stage

Stage	n	Age (year) Mean (SD)	95% CI	Height (Cm) Mean (SD)	95% CI	Weight (Kg) Mean (SD)	95% CI	BMI(Kg/m^2) Mean (SD)	95% CI
B1	874	8.14 (1.38)	8.05-8.23	126.21 (8.30)	125.66-126.77	24.77 (5.01)	24.44-25.10	15.48 (1.94)	15.35-15.60
B2	260	9.71 (1.50)	9.53-9.90	137.05 (8.68)	135.99-138.11	33.75 (7.86)	32.79-34.71	17.96 (3.08)	17.58-18.33
B3	174	10.52 (1.51)	10.29-10.74	142.04 (8.69)	140.74-143.34	37.45 (7.54)	36.32-38.58	18.61 (3.43)	18.09-19.12
B4	411	11.76 (1.15)	11.65-11.87	149.57 (6.95)	148.90-150.24	43.23 (8.74)	42.38-44.08	19.33 (3.52)	18.99-19.67
B5	522	13.20 (1.03)	13.12-13.29	156.12 (5.95)	155.61-156.63	51.49 (9.22)	50.70-52.29	21.14 (3.49)	20.84-21.44

BMI: Body Mass Index; CI: Confidence Interval; SD: Standard Deviation; B: Breast Development

prevalence of underweight (BMI <5th percentile), normal weight (5th percentile <BMI<85th percentile), overweight (85th percentile <BMI<95th percentile) and obese (BMI >95th percentile) was 9.35%, 70.55%, 12.7% and 7.4% respectively.

The mean age (10th–90th percentile) of B$_2$ and PH$_2$ were 9.71 (7.67–11.4) and 9.82 (7.84 – 11.42) years respectively. Mean age of menstruation was 12.52 years. Relationships between breast and pubic hair stages with height, weight and BMI are shown in Table 1 and 2.

The P$_{50}$ value of height and weight for stage B$_2$ was 138 centimeters and 32 kilograms, respectively. The mean BMI was significantly higher in pubertal females - stage B$_2$ – compared to prepubertal girls - stage B$_1$- (*P*<0.001). The reference curves for sexual development are shown in Figs. 1-3. In comparison with percentile
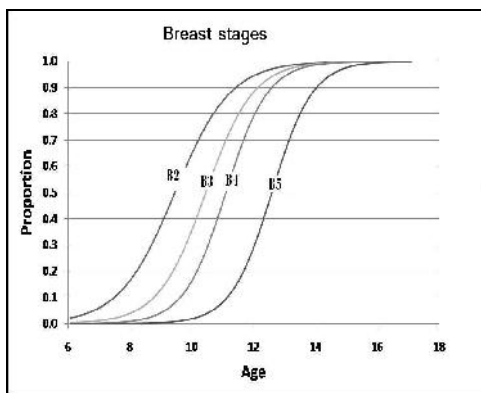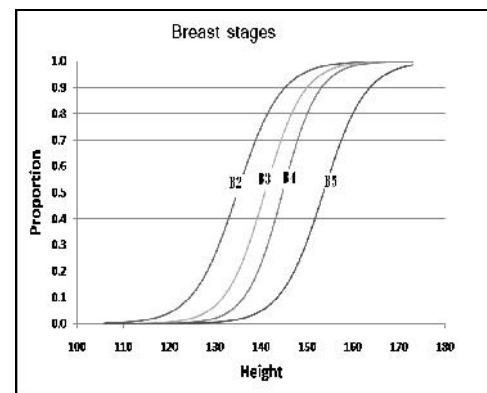

Fig. 1A: Breast stages in relation to age (years)

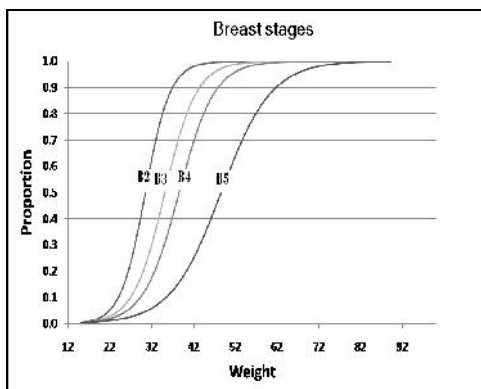

Fig. 1B: Breast stages in relation to height (centimeters)
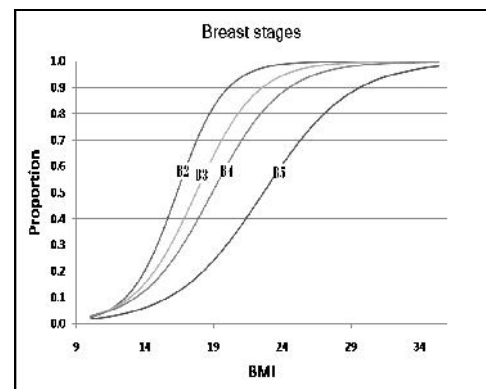

Fig. 1C: Breast stages in relation to weight (kg)

Fig. 1D: Breast stages in relation to BMI (kg/m^2)

Table 2: Case summaries of age, height, weight and BMI for each pubic hair stages

Stage	n	Age (year)		Height (cm)		Weight (kg)		BMI (kg/m^2)	
		Mean(SD)	95% CI	Mean(SD)	95% CI	Mean (SD)	95% CI	Mean(SD)	95% CI
PH$_1$	887	8.14(1.39)	8.05-8.23	126.14(8.26)	125.59-126.68	24.75(4.99)	24.42-25.07	15.48(1.94)	15.35-15.61
PH$_2$	260	9.82(1.44)	9.65-10.00	137.59(7.92)	136.63-138.55	34.19(7.55)	33.28-35.11	18.07(3.01)	17.71-18.44
PH$_3$	183	10.61(1.44)	10.41-10.82	142.5(8.02)	141.34-143.66	37.58(7.17)	36.54-38.62	18.55(3.43)	18.05-19.04
PH$_4$	384	11.81(1.17)	11.69-11.93	149.43(6.55)	148.77-150.08	43.63(8.73)	42.76-44.5	19.56 (3.5)	19.21-19.91
PH$_5$	528	13.17(1.07)	13.08-13.26	156.57(5.63)	156.09-157.05	51.44(9.22)	50.66-52.23	21.01(3.58)	20.71-21.32

BMI: Body Mass Index; CI: Confidence Interval; SD: Standard Deviation; PH: Pubic Hair

value proposed by Tanner, the 50th age percentile of puberty onset (stage B$_2$) is decreased by 1.44 years in our subjects. The 2.5th percentile for B$_2$ and PH$_2$ was 6.24 and 6.68.

Estimation of length of time between breast and pubic hair stages is shown in Table 3. Average duration of puberty (the time from initiation of puberty to menarche) in present study was 2.81 years.

Discussion

The study of pubertal onset is an important area of interest in medical research as complex physiological and psychological changes in this stage occur. Evaluation of pubertal development is essential for obtaining normal references for puberty in a population[11]. The timing of pubertal onset is variable. This variability is related to factors that result in entering puberty either very early or late. The secular trends in age at menarche are related to social class, economic status, urban versus rural location, education and number of family members[12]. The onset of puberty occurs across a wide range of ages in healthy adolescents. Several pathologic conditions affect the timing of puberty directly or indirectly. However; most variations in pubertal timing is not attributed to any clinical disorder[13].

We present data on height, weight, BMI and pubertal development in 2240 girls from Qazvin province, Iran (2009–2010). The summary of some other studies is shown in Table 4.

The mean age of B$_2$, PH$_2$ and menarche in the US white girls reported by Herman-Giddens et al was 9.96±1.82, 10.51±10.67 and 12.88±1.20, which happened later in comparison with our study[8]. A study on Turkish girls reported that the mean age of puberty onset, pubic hair and menarche were 10.1±1, 11±1 and 12.2±0.9 years[20]. These results showed that age of B$_2$ and PH$_2$ onset in Turkish girls is higher than in current study; while menarche onset is lower. The onset of puberty in Copenhagen in 2006 was 9.86 which is close to our study but estimated age at menarche was 13.13 years[7] which occurs later than that of Qazvin girls. This difference could be because of racial, nutritional and environmental varieties. The mean age of menarche in UK and Denmark studies were 12.9 and 13.13 years, respectively [4,7]. It can be concluded that our subjects

Table 3: Length of time between breast and pubic hair stages

Breast stages	n	Time Mean (Year)	Pubic hair stages	n	Time Mean (Year)
B1 to B2	874	1.53	PH1 to PH2	886	1.64
B2 to B3	260	0.80	PH2 to PH3	260	0.79
B3 to B4	174	1.24	PH3 to PH4	183	1.20
B4 to B5	411	1.45	PH4 to PH5	384	1.36

B: Breast Development; PH: Pubic Hair

Table 4: Results summary of some studies

| Place	no	Mean or Median Age (year)			Source
		B₂	P₂	Menarche	
England	192	11.15	11.69	13.47	Marshall-Tanner,1960 [4]
Iran (All provinces)	7493	10.10	9.83	12.55	Rabbani et al, 2006 [14]
Iran (Tehran)	1420	9.74	10.49	12.68	Razzaghi et al, 2003-4 [15]
Iran (Isfahan)	3.92	10.14	10.78	12.65	Kashani et al, 2005-6 [16]
Britain	3938	10.2	11	12.9	Chrstensen et al, 1999-2005 [17]
Bangkok	300	9.4	11.1	11.2	Mahachoklertwattana, 1997-1999[18]
Copenhagen	995	9.86	11.09	13.13	Juul et al, 2006 – 2008 [7]
Turkey	10.20	10.1	11	12.2	Bundak et al, 2002 [19]
Denizli, Turkey	15.62	9.13	-	12.41	Semiz et al, 2005 [20]
USA Afr-Amer	1623	9.5	9.5	12.2	Wu et al 2002 [21]
White	1168	10.3	10.6	12.6	
Egypt		10.71	10.40	12.44	Hosney et al, 2000 [22]
China	20654	9.20	11.16	12.27	Ma et al, 2003-4 [10]
Spain	266	10.72	-	12.42	Marco et al, 2000 [23]

B: Breast Development; PH: Pubic Hair

experience earlier menarcheal age than European girls. We find also earlier entry into B₂ and PH₂ stages than in British study[17].

The result of a study in Tehran reported by Razzaghy et al[15] was close to our study in B₂ onset but mean age of pubarche and menarche was higher. In comparison with Rabbani et al study[14] including all provinces of Iran the mean age of B₂ onset was later than that of Qazvin study while the PH₂ onset and menarche were similar. Compared with Isfahan study[16] B₂ and PH₂ onset is earlier than present study whereas the mean age at menarche is in concordance with it. The mean age of menarche in this study was 12.52 years.

As findings of other studies in Iran show, the age of menarche onset does not widely differ around Iran[14-16,24,25]. Puberty onset in our study was 1.44 years earlier than that of Tanner study. Recent studies have shown that the mean age of puberty onset has decreased in most populations[9]. It may be due to better socioeconomic status resulting in overnutrition and obesity or endocrine disruptors in the environment[26]. We found similar to most studies[27] a significantly higher BMI in pubertal compared to prepubertal girls. Childhood obesity has become a major health concern in recent years, especially with regard to metabolic abnormalities[28,29]. There is coincidence between decreased pubertal onset with increase in obesity prevalence which leads to speculation that increasing adiposity and earlier pubertal development in girls are related. This hypothesis is still controversial. Early breast development may be the reflection of increased peripheral
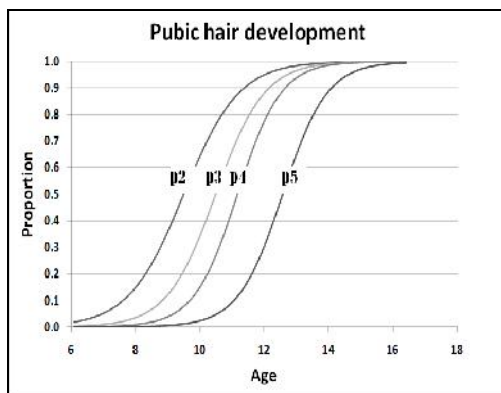
Fig. 2: Pubic hair stages in relation to age (years)
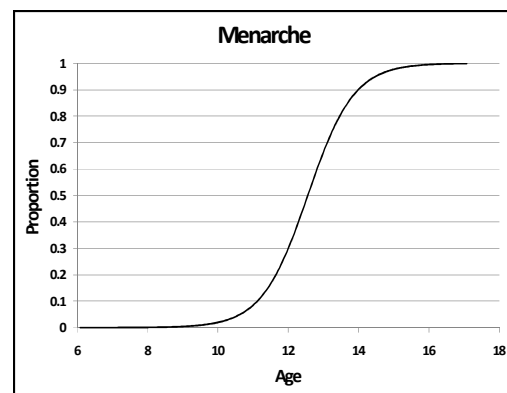
Fig. 3: Menarche status in relation to age (years)

aromatization of androgens in adipose tissue[30-32]. Children who develop puberty earlier are more likely to be overweight. Methodological difficulties in assessing puberty like visual inspection versus palpation and the difficulty in examining early breast buds in obese girls are important matters of discussion. On the other hand, the relation between higher adiposity and pubertal development could be consequence of accelerated neuroendocrine system maturation[31].

In our subjects the 2.5th percentile for B_2 was 6.24 and pubertal onset in less than 6.24-year olds is considered precocious. This is considerably lower than the result of Razzaghi et al study in Tehran[15]. Precocious puberty definition is based on statistical considerations. Usually a deviance of 2 standard deviation below the mean in the population or the age of puberty in less than 2.5% is considered as precocious[33]. Earlier puberty has been shown to be associated with psychosocial problems, risk taking behavior and increased risk of breast cancer that is a motivation for studying differences in pubertal development. Early age at puberty has been linked to insulin resistance and obesity as well[34]. Short stature is an important presentation in children with earlier onset of puberty and more shortened prepubertal periods. Epiphyseal fusion is an estrogen dependent process, therefore early production of sex steroids can cause rapid maturation of skeleton that results in compromised adult height[13].

The age of menarche has been decreased during recent decades[22]. In this study average duration of breast and pubic hair developement appears to progress more quickly between stage 2 and 3 (0.8 years) than other stages. The duration of puberty in Razzaghi et al (2.9 years) and Mahachoklertwattana et al (2.8 years) studies is near to our study but in Rabbani et al and some other studies was lower[7,22-23]. On the other hand, the pubertal duration in northern Europe countries is higher[5]. Martí-Henneberg et al indicated that healthy girls who have earlier pubertal onset are slower in their pubertal development[35].

Present study was performed regional, cross-sectional and only in girls which can be seen as limitations of the study. However, several strong points characterize the study including population based nature and large sample size that increase the precision of findings. Although these results cannot be extended to all regions of Iran, they prepare basic data which is limited, since little work has been done in this area. As former study of all provinces in Iran has been studied in a lower proportion of population, the current survey and similar studies with large samples would be helpful in estimation of national data on puberty. Finally, it is clear that cohort surveys are needed to confirm these results.

Conclusion

In conclusion the mean age of pubertal onset in girls living in Qazvin is 9.71 years. Menarche occurs at mean age of 12.52 and onset of puberty earlier than 6.24 years will be precocious. An advance in the timing of onset of puberty could be result of urbanization, socio-economic condition improvement together with improved health services and changes in lifestyle and nutrition. We found that girls in Qazvin had a slightly earlier age of initiation of puberty and of menarche in comparison with other studies in Iran. A longitudinal study of a similar population is needed to confirm the results.

Acknowledgment

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