Age of puberty in a representative sample of Iranian girls

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Background: To obtain normal references for growth and pubertal development in a given population, assessment of pubertal stages is of great importance. This study aimed to determine the age of appearance of secondary sexual characteristics in a representative sample of Iranian girls.

Methods: This cross-sectional study was conducted during 2005-2006 in 3192 girl students, aged 6-17 years, in Isfahan, Iran. Participants were selected by multistage random cluster sampling from school students. Secondary sexual characteristics were evaluated by inspection and palpation, and were recorded according to Tanner staging. The self-reported date of menarche (if any) was recorded as well. Data were analyzed with Probit analysis based on the status quo method.

Results: The median ages (10th-90th percentile) of Tanner stage 2 breast development (B2) and Tanner stage 2 pubic hair growth (PH2) were 10.14 years (8.33-11.95 years) and 10.78 years (9.09-12.48 years), respectively. The ages of the 3rd percentile for B2 and PH2 were 7.48 and 8.29 years, respectively. The median age of menarche among the 3192 girls who had experienced menarche was 12.65 years (11.18-14.11 years).

Conclusions: The median age of puberty onset is 10.14 years, and the onset of puberty before 7.5 years is considered as precocious puberty in a representative sample of Iranian girls. The values obtained from the present study can provide baseline data for analysis of time trends, as well as for international comparisons.

Introduction

A peculiarity of sexual maturation is the physiological variation in age at onset of different stages of puberty despite nearly similar life conditions. This variability is considered to be in part because of genetic factors, ethnicity, and nutritional conditions. Hence, the age limits used to differentiate normal variation and sexual precocity are necessarily subjected to local assessment and regular revision. In many countries, religious and legal responsibility depends on the age of puberty, especially for girls, the onset of menstruation (menarche). In certain circumstances, the final height can be improved by treatment of precocious puberty especially central (true) type with gonadotropin releasing hormone (GnRH) analogues which delay epiphyseal fusion. Understanding of many factors like predicted adult height, bone age, birth weight, psychological status, and exact age of puberty is necessary for such treatment.[1,2] Diagnosing precocious or delayed pubertal development requires an accurate normal curve in each population. Correct staging of puberty is essential for differentiation of different pathologies, as various components of the endocrine system influence the breast and pubic development in girls. Therefore, up-to-date and reliable reference data from different populations are necessary to determine the pubertal stages of girls clinically.[3] Although the process of pubertal maturation consisting of a series of predictable events, several groups have categorized the sequence of changes in secondary sexual characteristics from different aspects. The most

frequently used staging system is that published by Marshall and Tanner.[4]

Precocious pubertal development is defined as more than 2.5 to 3 standard deviations (SD) earlier than the median or mean age in children entering puberty. Based on this definition, precocious puberty in girls has been defined as secondary sexual development (beginning of breast enlargement) before the age of 8 years.[5]

Iran is a vast country with a population of 70 000 000 in different ethnicities (Persian 51%, Azeri 24%, Gilaki and Mazandarani 8%, Kurd 7%, Arab 3%, Lur 2%, Baloch 2%, Turkmen 2%, and others 1%). In addition to ethnic differences, the climate and lifestyle factors have considerable variations in different parts of the country. Currently, three published data are available about the age of different stages of puberty especially for girls in Iran: one in southern part of the country,[6] the next from Tehran (metropolitan city),[7] followed by one in northern part of Iran.[8]

The majority of the population in the south of Iran is of Arab ethnicity, and in the north is of Gilaki and Mazandarani ethnic backgrounds, and those living in the metropolitan city of Tehran are of various ethnic backgrounds and have different lifestyles. The current data might not be representative of the general population of Iran, but it can represent the population mostly of Persians ethnicity. The aim of this study was to provide sexual maturation reference data for a representative sample of Persians girls living in Isfahan, the second largest city of Iran.

Methods

Study design and sampling

This cross-sectional study was conducted in Isfahan, which is located in the center of Iran at an altitude of 1560 meters above sea level, with a Mediterranean climate and a population of more than 2 millions.

The study was conducted from October 2005 to May 2006 in elementary, middle and high schools of the city. In order to avoid socioeconomic bias, participants were selected by stratified multistage random cluster sampling from public and private schools located in all five educational districts in different parts of the city (north, south, east, west and central) with different socioeconomic backgrounds. Primary units (clusters) were schools and secondary units were the students within the schools. The students were allocated code numbers and randomly selected using random number tables.

After necessary accommodation with authorities of the Provincial Education and Training Organization, the project team began the study in schools. Written informed consent was obtained from parents and school administrators, and oral assent from eligible students.

The subjects were enrolled in the study if they were healthy; i.e., they had no chronic disorders, confirmed by physical examination and report of school health providers. Those who had any signs, symptoms or history of chronic diseases, for instance, deformities, asthma, epilepsy, pulmonary diseases and anemia were excluded from the study and referred to the Outpatient Department of the University Hospital. This study was approved by the Ethics Committee of the Endocrine and Metabolism Research Center, Isfahan University of Medical Sciences.

Procedures

The project team consisted of a pediatric endocrinologist and an assistant of pediatrics. Both of them were female. They examined all participants for secondary sexual characteristics such as breast development and pubic hair according to the methods of Marshall and Tanner.[4] Breast stages (B1-B5) in girls were determined by palpation: breast stage 2 (B2) corresponded to the breast bud stage with palpable glandular breast tissue and elevation of papilla; breast stage 3 (B3) showed further enlargement of the breast and areola, with no separation of the contours; breast stage 4 (B4) showed the areola and papilla from a secondary mound above the level of the breast; and breast stage 5 (B5) was assigned in case of the mature breast with projection of the papilla only. Pubic hair stages (PH1-PH5) were evaluated by inspection: pubic hair stage 2 (PH2) was assigned with the presence of long, slightly pigmented hair (straight or curled). The self-reported date of menarche (if any) was recorded.

Statistical analysis

Median age at the onset of menarche was estimated by the status quo method, which is based on the proportion of girls at each age who had reached a certain event, i.e., menarche. Then a probit analysis with age as the dependent variable was used to determine the age at menarche by estimating the age at which 10%, 50% and 90% of the girls attained menarche. Age grouping was based on 6-month intervals, and the midpoint of each 6-month interval was taken as the representative age for that group; for example, 12.5 to 12.99 years, had a midpoint of 12.75 years. Models were fit using SPSS for Windows software (version 14; SPSS, Chicago, IL). The same analysis was conducted for other Tanner pubertal stages. The probability of different stages of puberty plotted against age in Microsoft Office Excel 2003 software.

Results

Overall 3290 students were invited to participate in the study, and the parents of 3228 of them signed the
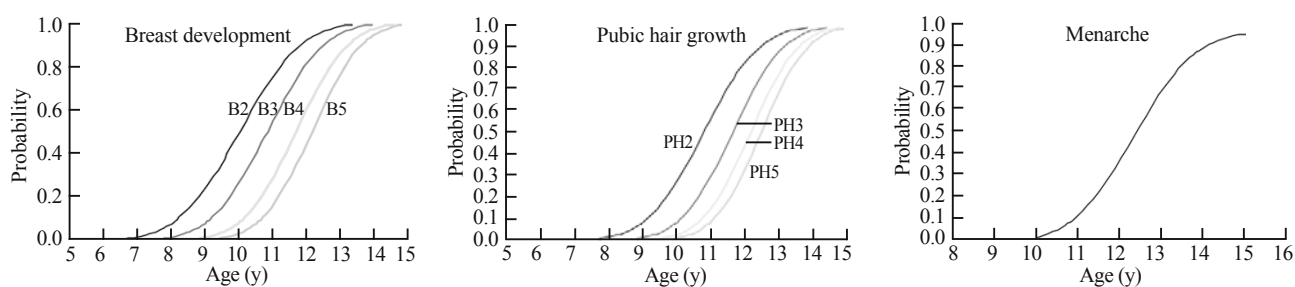
Fig. Probability of different stages of puberty in girls aged 6-17 years.

Table. Age of participants according to the puberty stage

Tanner stage	Pubic hair (*n*=1929)		Breast (*n*=2098)	
	n	Median (10th-90th percentile)	*n*	Median (10th-90th percentile)
2	232	10.78 (9.09-12.48)	208	10.14 (8.33-11.95)
3	156	11.64 (10.09-13.20)	232	10.94 (9.28-12.61)
4	97	12.18 (10.73-13.64)	135	11.78 (10.23-13.33)
5	1444	12.50 (11.08-13.92)	1523	12.24 (10.76-13.72)

consent form. Thirty-six students were excluded from the study because of chronic diseases (14 students), disagreement of examination for pubertal stages (12), and missing data (10). Hence, 3192 healthy girls aged 6-17 years were investigated for the age of puberty. The median age (10th-90th percentile) of B2 was 10.14 years (8.33-11.95 years), and the median age of PH2 was 10.78 years (9.09-12.48 years) (Table). Overall 1398 (43.8%) girls experienced menses with a median age of 12.65 years (11.18-14.11 years) at its onset.

The 3rd percentile for B2 and PH2 was 7.48 and 8.29 years, respectively, and the 97th percentile for B2 and PH2 was 12.79 and 13.28 years, respectively. The age at development of different pubertal stages is shown in Fig.

Discussion

Assessment of pubertal stages is necessary to obtain normal references for pubertal development in a given population. The mean age of B2 and PH2 can be used for many clinical purposes such as determining exact age of precocious and delayed puberty. A positive secular decrease in the age of puberty onset is reported.[3]

In our study, the median ages for onset of B2, PH2, and menarche were 10.14, 10.78, and 12.65 years, respectively. These results are similar to those in the USA reported from the Pediatric Research in Office Settings (PROS) Network by Herman-Giddens in 1997, in which the mean ages (±SD) of B2, PH2 and menarche in white girls were 9.96±1.82, 10.51±1.67, and 12.88 ±1.20 years, respectively.[9] A study on Egyptian girls from North of Africa reported that the mean ages of B2, PH2, and menarche were 10.71±1.6, 10.46±1.36,

and 12.44 years, respectively.[10] We found lower age for B2 but very similar ages for PH2 and menarche. Huen et al[11] in 1997 reported that the mean ages of B2, PH2 and menarche in Chinese girls living in Hong Kong were 9.78, 11.64, and 12.38 years, respectively. Compared with their results, we found higher age for B2, PH2 and menarche. Our findings in the ages of B2 and PH2 were consistent with those of the study in Lithuania (Eastern Europe) that reported the onset of B2 and PH2 was at 10.2 (10.1-10.3) and 11 (10.8-11.3) years, respectively.[12] The mean age for onset of B2 was 10.88 years in Denmark,[13] 10.5 years in the Netherlands,[3] 10.8 years in Germany,[14] and 11.1 years in the UK.[4] The mean age of PH2 was 10.8 years in the Netherlands,[3] 11.29 in Denmark,[13] and 11.7 years in the UK.[4] In general, we reported lower ages for B2 and PH2 than the Western Europe. The mean ages of menarche in Denmark,[13] the Netherlands,[2] and UK[15] were 13.42, 13.15 and 12.9 years, respectively, which indicate that Iranian girls experience menarche at an earlier ages than Western European girls. However, these European studies are too old to make an accurate comparisons. The mean age of menarche in our study is similar to that reported from the Northern part of Spain (12.68 years).[16]

In a recent study in Iranian girls living in Tehran, the median ages (10th-90th percentile) for B2 and PH2 were 9.74 (8.23-11.94) and 10.49 years (8.86-12.17), respectively.[6] We found higher ages for B2 and PH2 in girls mostly of Persian ethnicity in comparison to studies conducted in other parts of Iran, which included minority ethnicities in addition to Persians. The mean age at onset of menarche in Iranian girls living in the south Iran where has populations of Arab and Mazandaran ethnicities including Gilaki and Mazandarani ethnicities and the median age at menarche in girls living in Tehran where has different ethnicities such as Persian, Azeri, Gilaki and Mazandarani, Kurd, Arab and others are reported 12.91±1.23 years,[6] 12.68 (11.27-15.96)[7] and 12.5 years (12.4-12.5).[8] The girls in our study were mostly Persian, their ages at menarche were similar to those of girls of other ethnicities from other parts of Iran.

Precocious and delayed puberty should be defined by occurrence of secondary sexual characteristics in the

population, but there is no consensus on whether -2SDS or -2.5SDS should be used as a cut-off. We used the 3rd percentile which is close to the usual cut-off measure of -2SD. In our study, the 3rd percentile for B2 is close to that reported by Razzaghi-Azar et al in Tehran,[7] and the age of precocious puberty is also very close to theirs, but it is lower than 8 years as the internationally used age limit for precocious puberty.[1,2] However, the Lawson Wilkins Pediatric Endocrine Society recently issued new recommendations for the age at which puberty should be considered precocious, lowering the prevailing standards from 8 years to 7 years for white girls and to 6 years for black girls.[17] These differences in age of puberty are due to differences in ethnicity, genetics, nutrition, climate and socioeconomic status in different countries. In addition, as the age of puberty might have changed over time, the differences in the years of various studies can be another reason for the differences between studies.

Limitations of this study included cross-sectional nature and the interpretation of reference curves for consecutive pubertal stages. In addition, we could not provide information about the tempo at which a child has passed through the consecutive stages of puberty. Such information can be obtained from future longitudinal studies. In contrast, the main strength of this study is its population-based design and the large sample size. The detailed physical examination conducted by an expert team increases the validity of the findings in this study.

In conclusion, the median age of pubertal onset in girls living in Isfahan is 10.14 years. It is very close to the usual age of 10 years, which is internationally used as the age of puberty. Menarche occurs at the median age of 12.65 years in Isfahan. The onset of puberty less than 7.5 years is considered precocious in the study area. The values obtained from the present study can provide baseline data for analysis of time trends as well as for international comparisons.

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