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SHORT REPORT

Age of puberty in Iranian girls living in Tehran

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Abstract
The aim of this study was to determine the age of appearance of secondary sexual characteristics in Iranian girls living in Tehran. A cross-sectional study was conducted between 2003 and 2004 on 1420 6–17-year-old females in different parts of Tehran. Data were collected on the basis of a multistage probability sampling. Secondary sexual characteristics were evaluated by inspection and palpation, and were recorded according to Tanner staging. The subjects were asked about the occurrence of menarche and the age of its onset. Generalized additive logistic modelling was used for the analysis of data. The median age (percentile 10–percentile 90) of Tanner 2 of breast development (B2) and Tanner 2 of pubic hair growth (P2) among 1136 girls was 9.74 years (8.23–11.94) and 10.49 years (8.86–12.17), respectively. The ages of the 2.5 percentile for B2 and P2 were 7.42 and 7.03 years, respectively, so the onset of puberty at <7 years and 5 months is considered precocious in this population. The median age of menarche in 399 girls was 12.68 years (11.27–15.96).

Keywords: *Puberty, secondary sexual characteristics, menarche, thelarche, pubarche, genital development*

Introduction

The appearance of secondary sexual characteristics is a significant event, signalling the onset of physiological and psychological changes of profound importance to the individual, family and society. Religious and legal responsibilities depend on the age of puberty in many countries. Reports (Oostdijk et al. 1990; Kauli et al. 1997; Klein et al. 2001) about improvement of final height by treatment of precocious puberty with

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gonadotrophin-releasing hormone analogues, resulted in increasing requests for this treatment by families and physicians. Knowing the exact age of puberty is necessary to prevent over-treatment. Up-to-date, geographically relevant standards for the assessment of the onset of pubertal changes would help practitioners make clinical judgements on patients for whom growth and developmental problems are a concern. Studies from around the world have shown that the age of onset of pubertal changes can vary with ethnicity, environmental conditions, and geographical location (Eveleth et al. 1990). Because nationally representative pubertal data for Iranian girls are lacking, clinicians have relied largely on Marshall and Tanner's classic studies on variations of pubertal changes in girls (Marshall and Tanner 1969) despite previously described problems with the use of their methods (Tanner and Davies 1985; Burstein and Rosenfield 1986; Herman-Giddens and MacMillan 1991). To address these needs, we performed a study on schoolgirls in Tehran who were born between 1988 and 1997, to determine the age of different stages of puberty.

Subjects and methods

Study design

This cross-sectional study was conducted in primary and secondary schools of Tehran from October 2002 to April 2004. The study protocol was approved by the research deputy of the Iran University of Medical Sciences and Health Services and the Ethics Committee of the Ministry of Health and Medical Education. All participants gave informed consent.

Study design and samplings

This study used a stratified multistage probability sampling design. Sampling was done from north, south, east, west and the centre of Tehran, both from private and governmental schools to have cases from all socio-economic levels. Sample size in these areas was determined according to the number of students and the frequency of age groups studying in each area. In each stratum some schools were assumed as cluster and all of their students were conducted into the study. Among 1420 girls at the age of 6–17 years, inspection of secondary sexual characteristics was allowed in 1136 subjects. Menarche occurrence and date of its onset was requested from all of the girls. The subjects were enrolled into the study if they were healthy and did not have delayed puberty. Being healthy was defined as absence of any chronic disorder affecting growth and puberty, based on history, physical examination and children's health records. Delayed puberty was assumed as no secondary sexual characteristics until 16 years of age.

Procedures

Two teams performed data collection, each one included one physician and at least two medical students as interviewers. Demographic data were collected by filling out a questionnaire for each participant. Secondary sexual characteristics were evaluated according to Marshall and Tanner staging (Marshall and Tanner 1969). Physical examination was done by inspection and palpation. Participating physicians were trained for assessment of secondary sexual characteristics. The overall Kappa coefficient in

Table I. Age of study participants in different stages of puberty.

	Pubic hair			Breast		
Tanner stage	*n*	d.f.	Median (percentile 10–percentile 90)	*n*	d.f.	Median (percentile 10–percentile 90)
2	131	3	10.49 (8.86–12.17)	168	3	9.74 (8.23–11.94)
3	63	1	11.49 (10.03–12.94)	129	2	11.10 (9.31–12.63)
4	84	1	12.55 (10.75–14.34)	77	3	13.14 (10.56–14.87)
5	171	3	14.41 (13.16–15.83)	169	3	14.29 (12.78–17.05)
Total *n*	449			543		

Tanner stage as given in Marshall and Tanner (1969). d.f., degrees of freedom.

determining the different Tanner stages was above 80%. The interviewers were trained, skilled, and matched in filling out the questionnaires.

Statistical methods

The main interest was the proportion of cases at a given age with secondary sexual characteristics and the median age of onset for each characteristic was determined. Data on menses were collected by the status quo method (Eveleth et al. 1990). Reference values were determined by the methodology of Mul et al. (2001). Developmental data were coded as stage transitions, i.e. as binary variables indicating whether or not a certain stage was reached. Reference curves expressing the transition probability as a function of age was estimated for each transition separately using the generalized additive model (GAM) (Hastie and Tibshirani 1990). The GAM used a logit link function and included age as a continuous explanatory variable. The amount of smoothness of the smoothing-spline was chosen from several models: degrees of freedom, d.f. = 1 (the logistic, most smooth model), d.f. = 2, d.f. = 3, and d.f. determined by cross-validation. The choice of the final model was guided by statistical tests of the deviance, by the visual appearance of the fitted curves (e.g. monotonically increasing), and by their fit to the age-conditional transition probabilities. If the difference between two models was not statistically significant, the simpler model was preferred. For each stage of pubertal events, median of age (percentile 10–percentile 90) has been reported.

Model fitting

The column labelled 'd.f.' lists the degrees of freedom selected for the final model (Table I). Cross-validation tended to produce curves with a shape that was too complex for these data. The best choices were either the logistic regression model (d.f. = 1) or the GAM model with d.f. = 3. For menarche, a model with d.f. = 2.5 was selected. All analyses were carried out with SPSS® version 11.0.5.

Results

Median age (percentile 10–percentile 90) of Tanner 2 of breast development (B2) was 9.74 (8.23–11.94), and median age of Tanner 2 of pubic hair growth (P2) was 10.49

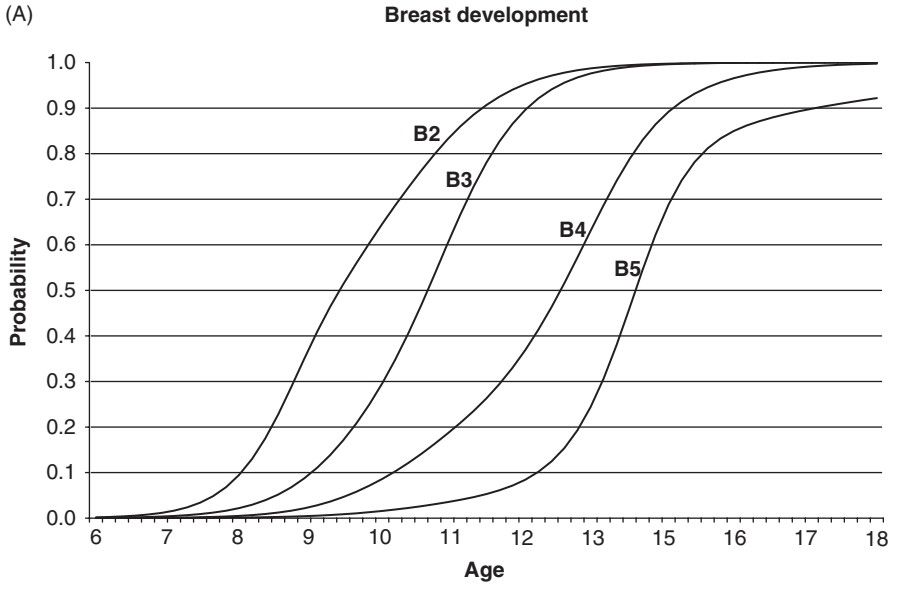

Figure 1. Probability of different stages of puberty in 6–18-year-old subjects. (A) Breast development, (B) pubic hair growth, (C) menarche. In all plots, the horizontal axis is age in years and the vertical axis is the probability of the event.

(8.86–12.17) years (Table I). There were 399 girls who had experienced menses. Median age of onset of menarche was 12.68 (11.27–15.96) years. The percentile 2.5 for B2 and P2 was 7.42 years and 7.02 years, respectively, and the percentile 97.5 for B2 and P2 was 13.11 years and 13.10 years, respectively. Figure 1 illustrates the age of development of pubertal stages.

Discussion

Girls begin puberty with breast buds and skeletal growth, followed by growth of pubic hair, axillary hair and menarche (Marti-Henneberg and Vizmanos 1997; Blondell et al. 1999). The mean age of B2 and P2 in white girls was reported to be 9.96 ± 1.82 and 10.51 ± 1.67 years, respectively, in the USA by Herman-Giddens et al. (1997). Although different research and analytical methods complicate the comparison of the results, ages of B2 and P2 in the present study were very similar to the US white girls.

Age of menarche was reported to be 13.47 years by Marshall and Tanner (1969). There is a secular trend towards earlier puberty that has been clearly shown in different populations (Liu et al. 2000; Karlberg 2002). In the research performed by Marshall and Tanner, the study girls came primarily from lower socio-economic sector (residents of children's home), so they may have received sub-optimal care before entering the home. Girls from south of Iran were reported to start menarche with a mean ($\pm$SD) of 12.91 ($\pm$1.23) years of age (Ayatollahi et al. 2002), similar to our results. The study subjects of Herman-Giddens et al. (1997) were girls referred to paediatric clinics and the method of evaluating of breast development was inspection of photographs of children; the evaluation of breast budding

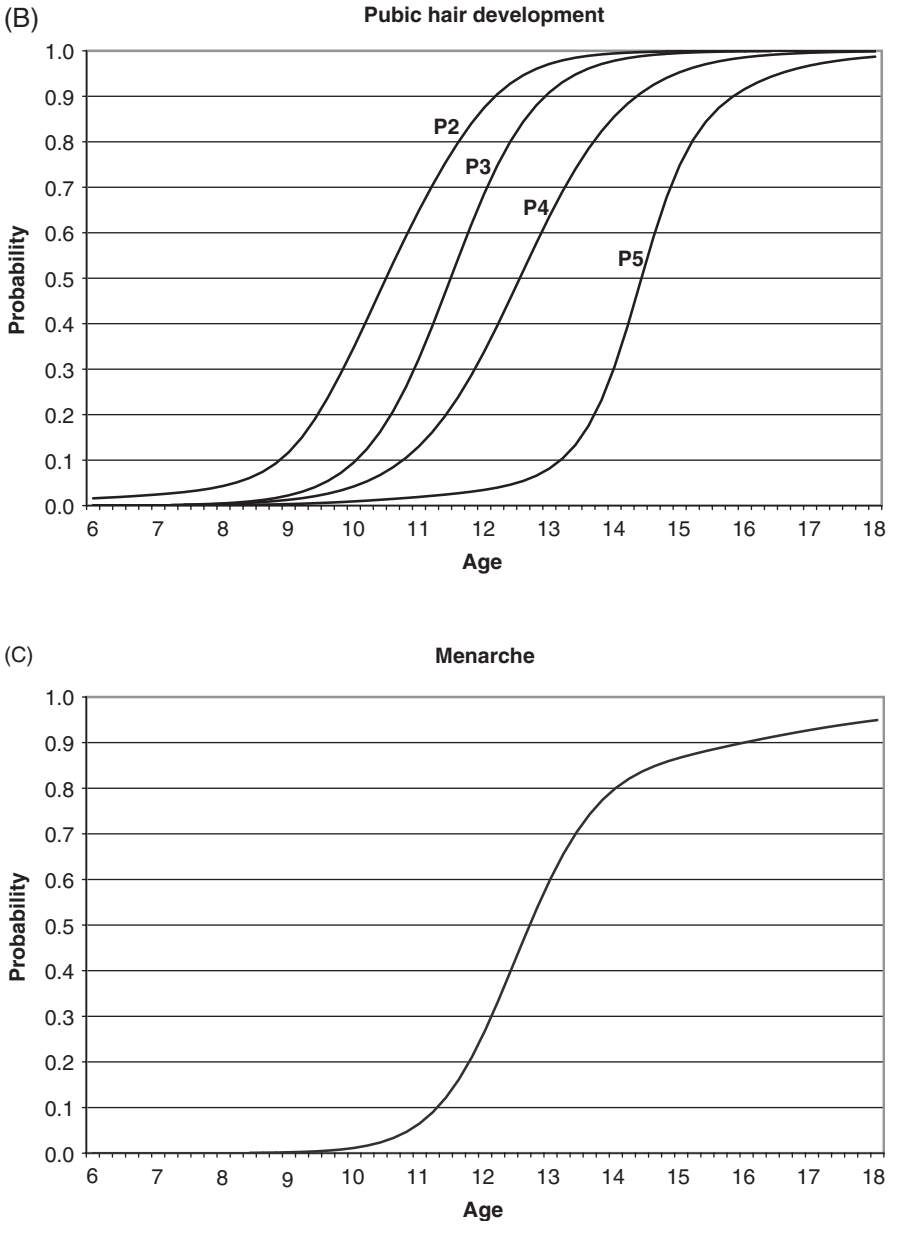

Figure 1. Continued.

with this method can be overestimated in obese and underestimated in slim girls, while our method of evaluation was palpation and the samples were from healthy school children. The multistage probability proportional sampling minimizes the effect of sampling biases. According to the definition of precocious puberty that is <2 SD of the mean age of puberty or the age of puberty in less than 2.5% of population, the onset of puberty below 7.42 years (7 years and 5 months) should be considered precocious in Iranian girls who are living in Tehran.

Conclusions

The median age of pubertal onset in Iranian girls who are living in Tehran is 9.74 years. Menarche occurs at the median age of 12.68 years. The onset of puberty less than 7 years and 5 months is considered precocious in the study area.

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