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Age at menarche and secular trend in Maharashtrian (Indian) girls

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ABSTRACT Age at menarche of 366 Maharashtrian Brahmin, Maratha and Scheduled Caste girls was studied and two hypotheses relating menarcheal age to physical growth were compared. Results indicated that both measurements, the height (the indicator of skeletal maturity), and the weight (the indicator of fat accumulation), were positively correlated with age at menarche. The well known phenomena of children achieving greater size and maturing earlier as manifested by menarche in girls and the secular trend in the age at menarche are well demonstrated in the present study on the Maharashtrian girls of Pune city. The lowering of age at menarche at an average rate of about 6 months per decade in the last three decades in the present study, as compared to 3-4 months in some countries of Europe, North America, and several parts of the world, reflects upon the now improved socio-economic, nutritional and general health conditions in India as compared to these countries where similar standards were achieved much earlier.

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KEY WORDS

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The relationship of physical growth to menarcheal age in humans continue to intrigue the researchers. Two principal hypotheses have been postulated. The older one suggests a close correlation between rate of skeletal maturation and menarcheal age (Shuttleworth 1937, 1938; Simmons and Greulich 1943; Simmons 1944; Marshall 1974). Following this view bone age has been used clinically as the most appropriate general measure of developmental age in individuals which applies across human populations (Tanner and Whitehouse 1959; Eveleth and Tanner 1976). It has also been used as an accurate predictor of menarcheal age (Frisancho and Baker 1969; Marshall and Limongi 1976). The hypothesis postulates that the pre-menarcheal girl is growing towards an appropriate structural status to mitigate reproduction, and the age at which this status is attained is closely correlated with menarcheal age (Ellison 1982).

The second view was first put forward by Frisch and Revelle (1970), who suggested that age at menarche might be related to attainment of appropriate weight for reproduction rather than appropriate skeletal status. Associated with this view were the observations that obesity advanced menarche (Simmons and Greulich 1943) and under nourishment delayed menarche (Frisch 1972).

The present study attempts to find out the variation in age at menarche among the Brahmin (Ritually higher caste), Maratha (economically and politically higher caste) and Scheduled Caste (constitutional class of ex-touchables) girls

of Maharashtra state in India. The study further attempts to investigate whether the skeletal maturity as manifested by height, or body fat as represented by weight and body girths, are better indicators of the onset of menarche. Influence of diet, exercise, and socio-economic status of the family on the onset of menarche were also studied.

Materials and methods

366 Maharashtrian school girls in the age ranging from 9 years to 16 years formed part of the study. Data were collected between the months of June and December, 1991, from Pune city in Maharashtra. Standard anthropometric techniques, as described by Weiner and Lourie (1969), were followed for anthropometric measurements such as height, weight and some body girths. Based upon the age at onset of menarche the sample was classified to three age groups such as early, ideal and late matures. Information regarding their diet and level of physical exercise was also recorded.

Subjects were classified into three diet groups: the vegetarians, the non-vegetarians, and the egg eaters who were classified as eggeterians. Based on the level of physical exercise the subjects were divided into two categories such as those performing regular, and others, occasional exercise. Economic status was established on the basis of the profession of the parents as lower, middle and higher. Lower strata included daughters of loaders, housemaids and other manual labourers. Daughters of school teachers and clerks constituted the lower middle strata, while upper middle strata was represented by the daughters of white collar job holders such as doctors, engineers and managers etc.

Results and discussion

Of the 366 girls majority (68 p.c.) achieved menarche

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Table 1. Age at menarche in Maharashtrian girls irrespective of caste.

Age at menarche in years	Number of girls (n)	Percentage (%)
Early menarche 09+	2	00.54
10+	10	02.73
11+	54	14.75
Total:	66	18.02
Ideal age 12+	138	37.70
13+	112	30.60
Total:	250	63.30
Late menarche 14+	43	11.74
15+	7	1.91
Total:	50	13.65

between the age 12 years and 14 years, irrespective of caste. This was classified as the “ideal” age group for achieving menarche. Two girls experienced it as early as at ages nine and a half years. The early onset of menarche was recorded in 18% and late onset in 13.6 p.c. of the girls (Table 1).

Focus on caste-wise analysis of data showed that mean age at menarche for Brahmin and Maratha girls was more or less the same, *i.e.* 12 years and seven to eight months (Fig. 1), but in the Scheduled caste girls menarche was delayed by about seven to eight months. The differences were statistically highly significant (Table 2).

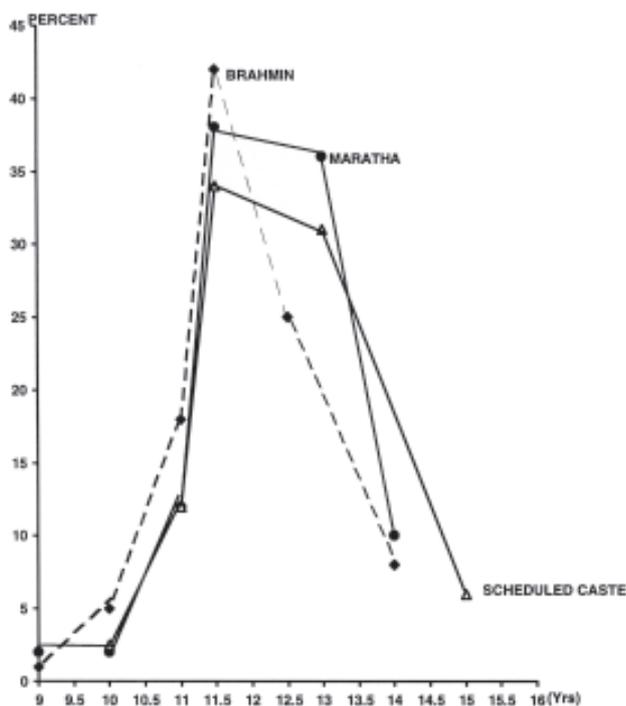


Figure 1. Age at menarche caste wise variation.

Table 2. Age at menarche in three caste groups.

Caste group	n	Menarche mean \pm SD
Brahmin	142	12.58 \pm 1.03
Maratha	107	12.60 \pm 0.86
Schedule caste	90	13.16 \pm 1.14
Others	27	13.08 \pm 0.97

$\chi^2 = 22.96$; d. f. 2.

Secular trend in age at menarche in Maharashtrian girls

A review of studies on mean menarcheal age of Maharashtra girls from 1960s onwards (Rakshit 1962; ICMR 1972; Kundalkar 1981) and the present study conducted a decade later, showed that there is a consistent lowering of age at menarche on an average, by about six months per decade (Fig. 2). When Rakshit (1962) studied Maharashtrian Brahmin women of Nagpur, he reported mean menarcheal age as 14 years and 4 months. Study undertaken by the Indian Council of Medical Research (ICMR 1972) reported the mean menarcheal age for Maharashtrian girls as 13 years and 9 months. Kundalkar (1981) reported it to be 13 years and 2 months, and the present study maintains the same trend showing a still lowering of age at menarche which now stands at 12 years and 6 months. From 1962 to 1991, in three decades, the age at menarche in Maharashtrian girls has lowered by about two years. In Hungary, too, the median menarcheal age as reported by national surveys of 1959-61 (Bottyán et al. 1963 /-Me = 13.28/; 1981-84 (Farkas 1986; Eiben 1988) has decreased at a rate of 2.6 months per decade by linear regression (Bodzsár 1998).

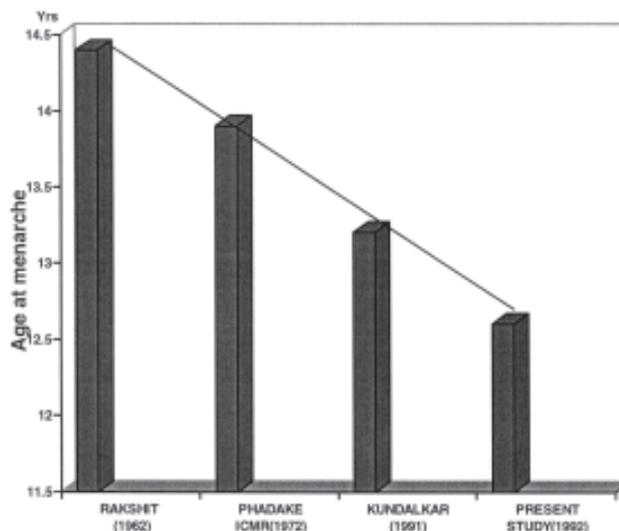


Figure 2. Secular trend for age at menarche as seen in Maharashtrian girls in last four decades.

Table 3. Economic status and menarche.

Socio-economic status of parents	n	Mean \pm S.D.
Lower hamals, housemaids and manual labours	65	13.16 \pm 1.05 (13 years and 2 months)
Middle lower school teachers, clerks etc.	196	12.50 \pm 1.03 (12 years and 6 months)
Middle upper engineers, doctors, managers etc.	105	12.16 \pm 1.02 (12 years and 2 months)
Higher directors, industrialists, executives etc.	9	12.16 \pm 0.95 (12 years and 2 months)
Total:	366	12.16 \pm 1.05

Age of menarche and socio-economic status

It was observed that, in general, daughters of hamals (loaders), housemaids, day laborers experienced menarche later than the girls of the middle and higher economic groups, as represented by daughters of clerks school teachers and senior executives, doctors, engineers, etc. The difference was about 12 months (Table 3). Thus, the trend of lowering of age at menarche was well marked as we moved from lower and middle, to higher economic group. It was further seen that a maximum number of girls (57.4 p.c.) experiencing an earlier onset of menarche (between 9-13 years) belonged to middle and higher socio-economic stratum. Only 5.5 p.c. of girls from lower economic strata achieved menarche early. The differences were statistically significant.

The relationship between age at menarche and socio-economic status investigated in India (ICMR 1972; Bai and Vijayalakshmi 1973) revealed that the mean menarcheal age steadily increased with the decrease in per capita income. In later study the socio-economic differences were, however, non-significant. It is now generally accepted that protein-rich diet induces an earlier onset of menarche (Valsik et al. 1973). However, in another study (Padmavati et al. 1984) on Andhra state girls showed attainment of menarche significantly later by non-vegetarian girls as compared to vegetarians. Apparently, nutrition cannot be the only influential factor. Shastree et al. (1974) recorded two traditional non-vegetarian groups showing lowest and highest menarcheal ages. A plausible

Table 4. Vegetarianism and menarche.

Group	n	Menarcheal age (mean)
Vegetarian	73	13.58 \pm 0.96
Vegetarian + Egg	98	13.08 \pm 1.25
Non-vegetarian	105	12.33 \pm 1.09

explanation could be the ethnic differences, among other factors. The use of different criteria by different authors for a socio-economic class makes any attempt difficult (variations in currency exchange rates, when the rupee is devaluing very fast, inflation, etc.), so it is high time that we categorized people on the basis of their profession rather than their income, especially to establish the lower socio-economic status. All hamals, laborers, housemaids, etc., can easily be put under the lower economic group and so on. Defining social status on the basis of parental occupation has been used quite often recently (Eiben 1972; Miller et al. 1972; Prebeg et al. 1979; Farkas 1980; Danker-Hopfe 1986).

Parent's occupation and mean menarcheal age of the daughters is strongly associated in the present study too.

Vegetarianism and menarche

Nutrition has always been considered a major influential factor in pubertal growth period. Several studies (Malina 1979) have been attempted to trace the relationship of diet and onset of the menarche. First evidence in this line was given by Kralj-Cercek (1956) who noted that in poorly nourished Slovenian populations the menarcheal age was related to the amount of protein, and particularly the meat, consumed. Shastree et al. (1974) conducted a study on Maharashtrian girls and found that non-vegetarian girls would menstruate about 6 months earlier than a vegetarian.

As stressed earlier by Kralj-Cercek (1956) and Shastree et al. (1974), the present study also showed a positive correlation of age at menarche and non-vegetarian diet (Table 4). In the present study too a steady increase in the number of girls in the early, ideal and late age groups was noticed as the food habits changed from vegetarian to eggatarian and maximum number of girls experiencing early menarche were reported in the non-vegetarian group. The differences were statistically highly significant (Table 5).

Table 5. Vegetarianism and menarche in three age groups.

Age group	n	Vegetarian n %		Eggetarian n %		Non-vegetarian n %	
Early menarche (9-11 years)	66	17	25.75	19	28.78	30	45.45
Ideal menarche (12-13 years)	250	43	17.20	68	27.20	139	55.60
Late menarche (14-15 years)	50	13	26.00	11	22.00	26	52.00
Total:	366	73	19.94	98	26.70	195	53.27

$\chi^2= 7.592$; d. f. 2

Table 6. Physical activity and menarche.

Age group	Total	Regular exercise (n, %)		Occasional exercise (n, %)	
Early menarche (9-11 years)	63	22	33.84	43	66.15
Ideal menarche (12-13 years)	251	93	37.05	158	62.94
Late menarche (14-15 years)	50	11	22.00	39	78.00
Total:	366	126	34.42	240	65.57

Physical exercise and menarche

It is felt by some researchers that not only the intake but expenditure of calories is also important. Girls who have to do more physical work, or have a long, tiresome way to school have a greater expenditure of calorie which may delay the onset of puberty (Valsik et al. 1973). Indian schools normally have some or the other kind of exercise a few times a week which forms a part of the child’s physical training. In the present study too the girls coming from nearby areas walked or cycled down to their schools. Besides, there were some students who were more fond of participating in certain outdoor games such as volleyball, badminton, swimming (a few), etc. More girls (66.15 p.c.) experiencing an earlier onset of menarche were the ones who were occasional exercisers. In the ideal age (between 12-13 years) the girls experiencing menarche (63 p.c.) did not do any regular exercise. The girls achieving menarche late (78 p.c.) were also occasional exercisers (Table 6). The differences between the exercising group and the non-exercising group were statistically non-significant. Delay in secretion of specific hormones responsible for sexual maturity was given as the probable reason by Satwanti et al. (1982) in the sports women achieving late menarche.

Body measurements and menarche

The girls who achieved menarche earlier (between 9-11 years) showed the maximum mean body weight (46 kg)

among the three age groups, being 5 kg more than the mean weight of the girls in ideal age group. The late menarche group of girls showed the least mean body weight (37 kg) which was about 4.5 kg less than that of the ideal group (Table 7).

A similar trend was observed for maximum mean body height (154.84 cm) which was shown by the girls who attained early menarche (between 9-11 years). Minimum height was observed for the girls in the late menarche age group while a uniform trend was maintained from 12, 13 and 14 years when the mean height remained constant (Table 7).

All the four body girths viz. chest girth, hip girth, mid arm girth, and calf girth showed a positive correlation with age at menarche. The girls experiencing an early menarche (9-11 years) showed the maximum values for all these girths as compared to the other groups, the ideal and the late maturers. Except for shoulder breadth the differences between the early and late menarcheal group were statistically significant (Table 7).

The reverse was true for the late maturers experiencing menarche as late as 14 to 15 years or more (Table 7). It was in conformity with the earlier such studies (Sharma 1970; Bali and Randhwa 1978).

Considerable literature exists on the relationship at adolescence between body and sexual maturation. Tanner (1962) related body size with puberty. A similar attempt made by Simmons and Greulich (1943) which showed that the earlier the menarche, the greater was the peak velocity of the height spurt. It seems, therefore, that in early matures the whole process goes more quickly and more intensely, so that a greater total result is achieved despite the smaller amount of time taken (Tanner 1962).

Richy (1937) in his longitudinal study on the girls at adolescence plotted distance curves for height and weight from age 6 to 16 years. He found the early menarche girls were greater in height and weight at ages 6 to 8 years. He concluded that even before the influence of adolescence spurt can make itself felt, they are large girls before puberty, both as regards height and weight is concerned. Bardhan (1962)

Table 7. Body measurements and age at menarche.

Measurement	Age at menarche in years			't' value between early and late menarche group
	9-11 years n = 66 (Early menarche)	12-13 years n = 250 (Ideal menarche)	14-15 years n = 50 (Late menarche)	
Body height (cm)	154.84±1.14	151.81±0.58	147.89±2.49	2.534 S*
Body weight (kg)	46.03±1.35	41.68±0.64	37.05±1.14	5.082 S*
Chest circumf. (cm)	76.35±1.20	72.85±0.27	71.41±0.66	3.607 S*
Mid-arm circumf. (cm)	21.98±0.63	20.76±0.22	19.57±0.28	3.495 S*
Hip circumf. (cm)	85.12±1.61	80.76±0.63	77.90±1.00	3.767 S*
Calf circumf. (cm)	29.64±0.69	28.64±0.21	26.89±0.70	2.797 S*
Biacromial diameter (cm)	34.88±0.74	34.47±0.21	33.04±0.70	0.024 NS**

*S denotes significant; ** N. S. denotes non-significant values

found a gradual increase in height with the chronological age. This increase was observed for weight, too. Sharma (1970), while commenting upon growth in Maharashtra children, pointed out that pubescent girls between 11 and 14 years were 3-6 centimeters taller, and 4-6 kg heavier than non-pubescent girls. The same trend was observed in the present study, too. In India, socio-economic and nutritional differences are well marked in the populations and consequently, so is the age at menarche. Since human growth and body size responds with considerable sensitivity to environmental quality, the positive secular trend in populations of developing world has largely been attributed to improved nutritional and health conditions (Ulijaszek 1998). In most European countries the socio-economic differences in certain growth phenomenon, including menarcheal age, have decreased considerably in the recent past. This is probably because in these countries some nutritional and environmental factors required for an optimum physical development are already available (Susanne 1980). It was suggested by Padmavati et al. (1984) to study, if such trends are appearing in India, at least in some populations or geographical regions. In the present study conducted in the Maharashtra state in western India this trend has been well demonstrated.

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