

## Association of Age at Menarche with BMI: A Population Based Comparative Study on Bengali Women

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### Abstract

The age at Menarche is showing a steady decline around world. Increased adiposity in adolescence worldwide may have some influence on timing of puberty. A population based cross-sectional study has been designed in rural and urban Bengali women aged 10–60yrs to explore the relationship between adolescent obesity and mean age at menarche. Patterns of BMI, body weight, height, waist circumference, hip circumference and waist-hip ratio were analyzed in early, average and late maturing girls along with their prevailing socioeconomic conditions. The result shows that adolescent girls with higher BMI and abdominal fat are experiencing early age at menarche. Negative association between mean age at menarche and average per capita income has been demonstrated simultaneously. Studies with adult woman have shown that prevalence of obesity is highest in those women who had experienced an early menarche in their adolescence.

**Keywords:** Menarche; BMI; Adolescence; Obesity.

### Introduction

Puberty in female is a phase of continuous growth and development in which reproductive and endocrine functions mature from a quiescent stage so that the individual becomes capable of sexual reproduction. Puberty is typically associated with some major physiological changes like onset of breast development (thalarche), appearance of pubic hair (puberche) and onset of menstrual bleeding (menarche). Menarche is often considered to be a landmark event in women's reproductive life. The mean age at menarche varies greatly between populations across world. Age at menarche as early as eight years to as late as nineteen years has been reported in various population based studies [1, 2]. In India, the mean age at menarche in Solan Rajput and Punjabi urban girls was reported to be 13.0 [3] and 12.06 yrs [4] respectively. A recent study with Bengali girls has put the value at 12.1 yrs in urban area [5]. A steady decline in the age at menarche has been reported in a number of studies throughout the world [6], a phenomenon termed as 'secular trend', first coined by J.M Tanner. Similar secular shift in

median age at menarche was reported from Patiala, India [7].

Mean age at menarche is believed to be influenced by a host of environmental and genetic factors. Body size and composition in adolescence have been associated with timing of menarche. A study with rural Punjabi girls showed that girls with low ponderal index had earlier menarche than those with high ponderal index. Post menarcheal girls were taller, heavier and broader than pre-menarcheal girls of same age group [8]. Dietz et al reported an inverse relationship between age at menarche and body weight [9]. Another study reported that women with late sexual maturation eventually grew taller in adulthood [10]. A hypothesis of critical body weight and mean age at menarche was proposed by Frisch et al [11] which says that mean body weight of 48 kg at menarche does not change as the menarcheal age increases. A study on Hispanic, Black and White adolescent girls in US has reported that overweight prevalence rate was highest among early maturing girls across all race/ethnic groups [12].

It seems that, there exists a relationship between body growth in adolescence and timing of sexual

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maturation. Increased adiposity in adolescent girls might bear some relationship with gradual decline age at menarche. The present study has been designed specifically to assess the impact of growing adiposity on age at menarche in adolescent Bengali girls. Simultaneously, analysis was undertaken to explore whether or not an early sexual maturation in young female leads to development of obesity in adulthood.

## Materials and Methods

### Study design and Sampling

A community based cross-sectional comparative study was undertaken among rural and urban Bengali women aged 10–60 years in West Bengal. For rural sample, we selected five sub-centre villages in one of the Blocks in West Midnapore District by multistage sampling. For urban sample, we randomly selected one municipal area out of 128 municipalities in West Bengal. A total of 130 subjects were considered for the current study, 80 from rural and 50 from urban areas.

### Tool and techniques

A pre-designed, pre-tested and semi-structured schedule was prepared in local language for the collection of information on basic background characteristics, age at menarche and socio-economic status of the participants. Anthropometric rod, weighing machine and steel tape were used as tools during the field study. Anthropometric measurements taken were stature, body weight, waist circumference and hip circumference. Derived indices like body-mass index [weight (kg)/height (m)<sup>2</sup>] and waist-hip ratio [waist circumference (cm)/ hip circumference(cm)] were calculated from measured anthropometric parameters. Socio-economic status of the respondents were measured and expressed according to Prasad's Socio Economic Classification scale [13]. The information was collected by ensuring

one to one interaction with every respondent and informed consents were taken from all of them.

### Ethical issues

The entire study protocol and schedule was duly approved by Institutional Ethical Committee, Medical College, Kolkata.

### Data entry and analysis

Responses from all participants were compiled in Microsoft Excel worksheet and analyzed accordingly.

## Results

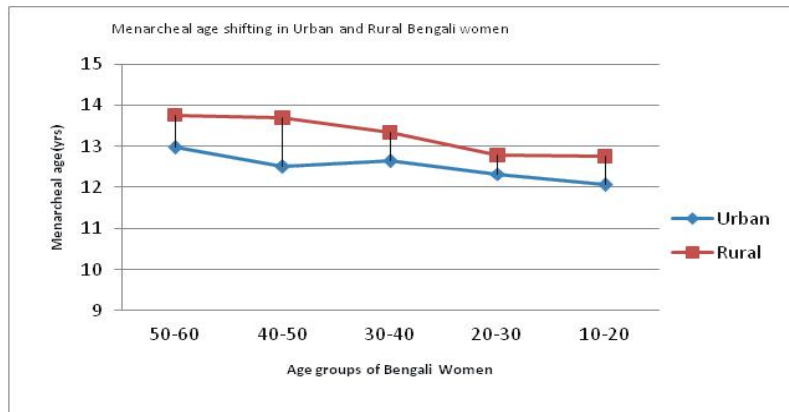
A total of 130 women aged 10–60 years participated in our community based study. 80 of them are from rural areas and rest 50 is from urban area. 31.1 % of the rural respondents belong to lower socio economic status (class V of Prasad's scale), whereas 37.5 % of the urban respondents belong to higher socio economic status (class I of Prasad's Scale). Table-1 represents the mean age at menarche along different age groups in both urban and rural respondents. It shows that the mean age at menarche in adolescent urban girls (12.06) is lower than that of rural adolescents (12.76). A general trend in the shifting of mean age at menarche was also observed in the current sample.

In Table-2, Mean values of body weight, height and BMI were compared among early maturing (menarche is less than equal to 11.9 yrs), average (menarche between 12.0–13.1 yrs) and late maturing (menarche is greater than equal to 13.2 yrs) adolescent girls. BMI showed a progressive rise in its mean value from late to early maturing girls. Mean body weight was highest among early maturers in both rural and urban sample. Table-3 compared mean values of waist and hip circumference in different adolescent groups. It clearly shows that mean waist and hip circumference values were highest among

**Table 1:** Mean age at menarche among Urban and Rural respondents (n=130)

Age groups	Mean age at menarche (yrs)	
	Urban women (n=50)	Rural women (n=80)
(10–20)	12.06	12.76
(21–30)	12.33	12.79
(31–40)	12.64	13.34
(41–50)	12.50	13.70
(51–60)	12.97	13.76

**Fig. 1:** Menarcheal age shifting in Urban and Rural Bengali women

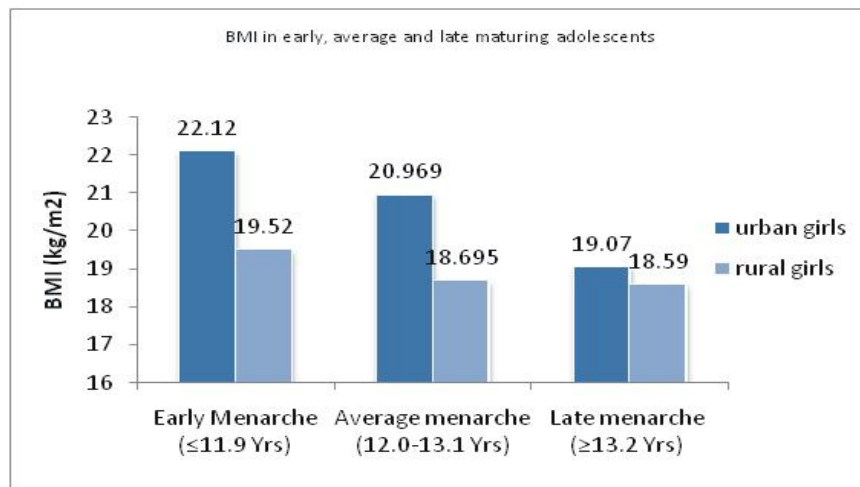


those girls who experienced an early menarche. When waist-hip ratios were compared (Table-4), it was found that menarcheal age was lowest in overweight girls having higher waist-hip ratio. Table-

5 represents relationship of mean age at menarche with socio-economic status of respondents. It is clear that girls coming from higher socio-economic class in both rural and urban areas exhibited early

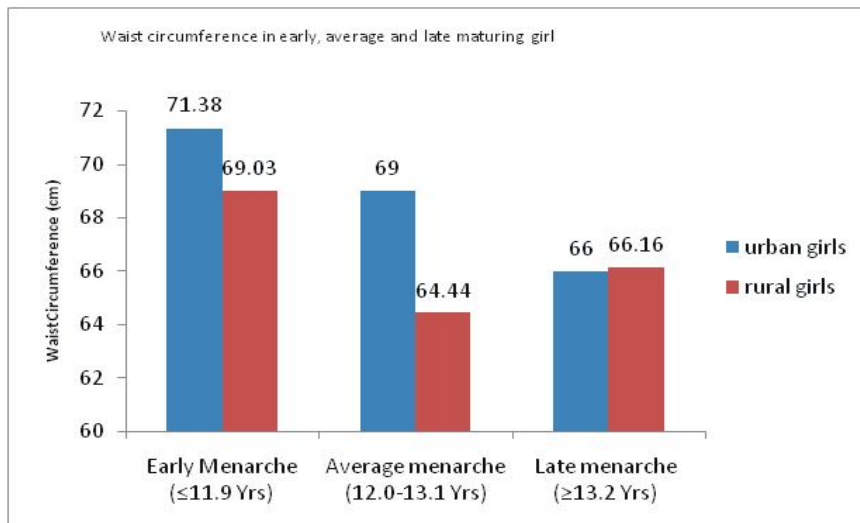
**Table 2:** Mean age at menarche and anthropometric variables in early, average and late maturing adolescents

	Mean age at menarche(yrs)		Mean body height (cm)		Mean Body weight (kg)		Mean BMI (kg/m <sup>2</sup> )	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Early Menarche ( $\leq 11.9$ yrs)	11.01	11.13	152.5	152.26	51.61	45.45	22.12	19.52
Average menarche (12.0-13.1 yrs)	12.4	12.65	154.95	151.11	50.75	42.69	20.969	18.695
Late menarche ( $\geq 13.2$ yrs)	13.78	14.07	157.02	149.31	47.2	41.56	19.07	18.59



**Table 3:** Waist and hip circumference in early, average late maturing girls

	Mean age at menarche(yrs)		Mean waist circumference (cm)		Mean hip circumference (kg)	
	Urban	Rural	Urban	Rural	Urban	Rural
Early Menarche ( $\leq 11.9$ yrs)	11.01	11.13	71.38	69.03	90.38	85.73
Average menarche (12.0-13.1 yrs)	12.4	12.65	69	64.44	90	82.25
Late menarche ( $\geq 13.2$ yrs)	13.78	14.07	66	66.16	89.2	80.66

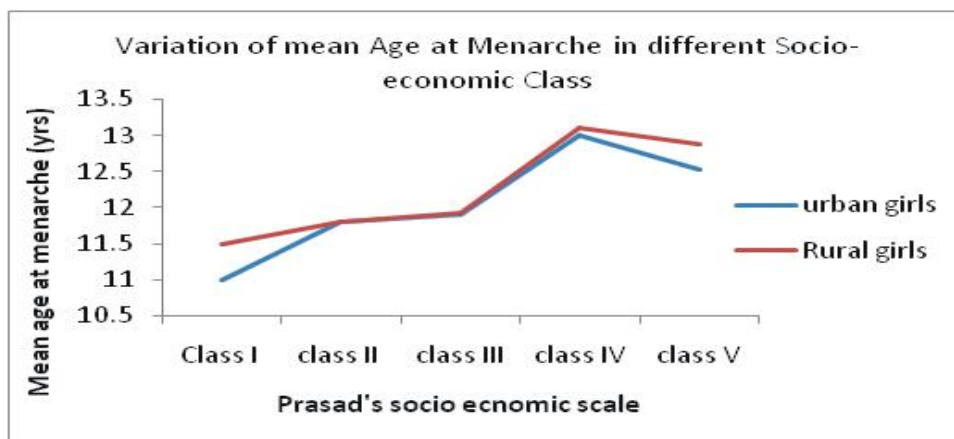


**Table 4:** Waist- hip ratio and mean age at menarche in different BMI-based categories of obesity

	Mean age at menarche (yrs)		Mean waist-hip ratio		Mean BMI (kg/m <sup>2</sup> )	
	Urban	Rural	Urban	Rural	Urban	Rural
Overweight (BMI 24.9-29.9)	10.92	12.25	0.85	0.84	27.041	26.12
Normal (BMI 18.5-24.9)	12.28	12.77	0.77	0.83	21.322	20.55
Underweight (BMI less than 18.)	12.56	12.87	0.73	0.77	16.72	16.82

**Table 5:** Mean age at menarche in different socio-economic class.

Socio -Economic class (Prasad's classification)	Average Per Capita Income(Rs.)		Mean age at menarche (yrs)		Mean BMI (kg/m <sup>2</sup> )	
	Urban	Rural	Urban	Rural	Urban	Rural
Class I	11,819	11,666.6	10.985	11.5	25.9	21.44
class II	3,000	3,000	11.8	11.8	18.61	20.58
class III	2000	1885.4	11.9	11.925	15.89	21.82
class IV	937.5	997.5	13	13.11	19.98	18.31
Class V	678.5	578.5	12.52	12.87	16.64	19.02



menarche than those coming from lower socioeconomic classes.

Table-6 represents the relationship between early menarche and adulthood obesity. Current study with

adult women shows that mean BMI, body weight, waist circumference and hip circumference are highest in those adult women who experienced an early menarche in their adolescence. The percentage of

**Table 6:** Anthropometric variables in adult women according to different classes of menarcheal age-range in puberty

	Mean adult body weight (kg)		Mean adult BMI (kg/m <sup>2</sup> )		Mean adult waist circumference (cm)		Mean adult hip circumference (cm)	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Adults who experienced an Early Menarche (≤11.9 Yrs)	77.05	48.65	31.523	21.106	94.11	72.91	109.88	88.15
Adults who experienced Average menarche (12.0-13.1 Yrs)	63.58	44.77	26.63	19.77	84.05	69	97.36	84.95
Adults who experienced a Late menarche (≥13.2 Yrs)	63.2	43.67	25.9	19.4	82.27	67.95	93.9	83.32

prevalence of obesity was also highest (44.4%) among those adults who had an early sexual maturation.

### Discussion

The onset of menstrual bleeding or menarche is recognized to be a landmark event in a female's reproductive life. Menarche in adolescent female is influenced greatly by body dimension and obesity alongside other factors. The current study with rural and urban Bengali girls shows strong relationship between mean age at menarche and body mass index. The higher is the body mass index in adolescence, the higher is the possibility of having an early menarche. BMI, although an acceptable marker of total body fat, hardly indicates the topography of fat distribution. Waist circumference, on the contrary is a recognized anthropometric marker of central adiposity. Therefore, from our study, we may conclude that adolescent girls who are fatter with higher abdominal obesity experience early sexual maturation. This observation goes well with the study by Johnston et al [14] who reported that girls with earlier menarche were heavier than girls who reached menarche late when adjustments for height was done. A Danish study shows that individuals who were underweight were more likely to experience a delay in menarche [15]. A clear relationship between age at menarche, BMI and socioeconomic status has emerged from this present study. Girls coming from higher socioeconomic strata are experiencing menarche earlier than those coming from poor families. This finding is very similar to a study by Michelson et al [16] who reported that Negroid population had a later onset of puberty than the Whites possibly because of a lower standard of living among the Negros. He also concluded that puberty comes earlier in economically privileged section than those who are underprivileged regardless of racial and climatic variation.

The negative association of menarcheal age with that of BMI and obesity can be explained from the concept that weight gain act as a key signal for secretion of **leptin**, a hormone secreted from adipose tissue. Leptin acts on hypothalamus to increase the secretion of Gonadal releasing hormone (GnRH) which in turn may cause activation of pituitary-ovarian axis to initiate puberty [17]. It can readily explain the delay in onset of first menstrual bleeding in thinner girls with lower BMI. The observed relationship between age at menarche and socioeconomic status of the respondents in the current study can be analyzed from angle of nutrition. With higher socioeconomic condition comes better nutrition. This along with low level of physical activity in adolescence may cause development of obesity and early onset of puberty.

From our present study, it can be stated that early menarche predisposes a woman towards obesity in adulthood. Women who experienced an early menarche in their adolescence have developed higher body weight, BMI, chest and hip circumference in adulthood. The observation goes well with other studies in which early maturation has been associated with increased fatness especially truncal obesity in adult women [18, 19]. Mean age at menarche can therefore be recognized as one of the predictors of adiposity in adulthood.

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