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Original Research Article

Age at menarche in urban school-going girls: association between socio-economic status, BMI and physical activity

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ABSTRACT

Background: Menarche, one of the most reliable markers of pubertal maturity, is a result of a complex interplay between genetic and environmental factors. Since accelerated pubertal development is an important determinant of prognostic disease risk, especially in developing countries, attention must be focused on this important public health aspect.
Methods: Total 200 school-going girls aged between 10-15 years studying in municipal, public-funded and private schools in Mumbai were included in the study based on the inclusion criteria of having attained menarche only in the last three months. Sociodemographic and anthropometric details were collected using a structured schedule and physical activity data was collected using the physical activity questionnaire for older children and adolescents.
Results: Socioeconomic status and family size were found to significantly influence the age of onset of menarche ($p<0.001$). Anthropometric indices of height, weight and BMI were found to have significant negative correlations indicating that taller, heavier girls reached menarche earlier than their shorter and lighter peers ($p<0.000$). Level of physical activity was also found to be an important contributing factor to age at menarche such that a higher level of physical activity was observed in girls with higher mean menarcheal age ($p<0.000$).
Conclusions: Age at menarche was found to be influenced by factors such as socioeconomic status, BMI and physical activity.

Keywords: Menarche, Socioeconomic status, Physical activity, BMI

INTRODUCTION

Menarche, marked by the first appearance of the menstrual period in girls, is the culmination of a series of physiological and anatomic processes of puberty and is an important event in girl's reproductive life. It has been frequently used as a marker of the timing of puberty in epidemiological studies to explore the association between developmental tempo and later disease risk. Researchers have suggested that age at menarche represents a distinct, easily remembered event in the process of female sexual maturity, and therefore is a well-validated and convenient, non-invasive indicator of pubertal timing.[1]

Age at menarche is influenced by both genetic and non-genetic factors. Even though menarche has a strong genetic component and follows a familial pattern, environmental factors have gained increased attention, as most of them are controllable and likely to improve future health outcomes of this population. Factors such as BMI and physical activity levels have also been reported to influence the age at menarche. Sedentary behaviour such as less participation in sports and excessive screen time has been shown to increase body weight and body fat

percentage and may result in early menarche. On the other hand, participation in very demanding sporting activities has also been reported to be a causative factor in late onset of menarche. Socio-economic factors such as household income, family size, parental occupation have been reported to have a significant impact on menarcheal age as better socio-economic status ensures food availability and access along with an improvement in general health and nutritional status, increased access to health care systems and better standards of sanitation and hygiene.[2,3]

Secular trend has demonstrated a decline in the age of onset of menarche across different populations in developing countries.[4] However, developed countries with lower mean ages at menarche as compared to developing nations have demonstrated little or no changes in these values for a long time. This could be attributed to good sanitation, better socio-economic status and educational opportunities.[5] In the Indian context secular declining trends in mean age at menarche have been observed. The findings have indicated a decline of one month per decade in the mean age at menarche in India. Also, a glaring spatial heterogeneity has been found in mean menarcheal age across birth cohorts of women in India along with sharp socioeconomic and contextual pattering in mean menarcheal age among women. Women who were better educated, economically well-off and from forward/general caste groups experienced a higher mean age at menarche. Women residing in urban areas, from north-eastern/southern/eastern regions, speaking non-Hindi languages experienced a relatively early mean age at menarche.[6,7]

Early or late onset of menarche has been associated with numerous adverse outcomes. Early age at menarche has been found to be an established risk factor in the development of breast cancer, uterine leiomyomata and endometrial cancer. It has also been associated with obesity, cardiovascular disease, type 2 diabetes mellitus, thereby demonstrating potential long-lasting effects of the timing of pubertal development on health. Girls with early menarche exhibit elevated blood pressure and metabolic syndrome compared with later maturing girls, independent of body composition.[8-10] Early menarche in low- and middle-income countries is associated with early marriage as a cultural rite of passage and marker of adulthood.[11] On the other hand, late menarche is associated with Alzheimer's disease.[12] Retrospective epidemiological studies have shown that an inverse relationship exists between bone mineral density, peak bone mass and age at menarche indicating that longer the duration of sex hormone exposure, the higher peak bone mass will be reached. Studies have also shown that both early or late menarche is associated with adverse effects on moods, behaviour and academic performance of girls.[13,14]

Considering the inter-related influences of these factors on age at menarche and their eventual effect on adolescent and adult health across socioeconomic groups, this study was undertaken with the objective of assessing their association with age at menarche in urban school-going girls in our socio-cultural context.

METHODS

This is a cross-sectional study of 200 school-going girls between the ages of 10-15 years selected by stratified random sampling from municipal, government-aided, private-aided and private unaided schools in Mumbai. Data was collected from August 2019 to January 2020 after approval from the Institutional Ethics Committee of Dr BMN College of Home Science, Mumbai and Principals of the shortlisted schools. On obtaining consent for participation, screening sessions were arranged to elicit information on the present menstrual status of the girls, which was recorded by the status quo method. Girls who met the inclusion criteria of being apparently healthy and having attained menarche only in the last three months were selected to be included in the study.

Data was collected using a validated questionnaire to elicit information regarding 1) socio-demographic profile including date of birth, current age in years and months, month and year of menarche, age at menarche, medical history, socio-economic status using the Modified Kuppuswamy Scale for SES, 2019.[15] 2) physical activity (using modified PAQ for older children and adolescents).[16] 3) anthropometric details of weight(kg), height(cm), waist circumference(cm), hip circumference(cm). BMI kg/m^2 and WHR were calculated using the above measurements. Height was measured using a portable stadiometer, weight was recorded using a digital weighing machine.

The collected data was entered into Microsoft Excel 2013 master chart and the statistical software statistical package for social sciences version 22.0 was used for data analysis. Statistical significance was assessed at $p<0.001$ (99% confidence interval)

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented as Mean±Standard deviation and results on categorical measurements in numbers.

Pearson's correlation coefficient has been used to find the correlation between the age at menarche, socio-economic status, anthropometric parameters, and physical activity levels of the subjects in the study.

RESULTS

A total of 200 school-going girls who had attained menarche in the last three months, in the age-group of 10-15 years participated in the present study.

Of the 200 subjects included in the present study, 34.50% (n=69) subjects belonged to the upper middle class

followed by 28.50% (n=57) in upper lower class as per the Modified Kuppuswamy SES scale, 201915 (Figure 1).

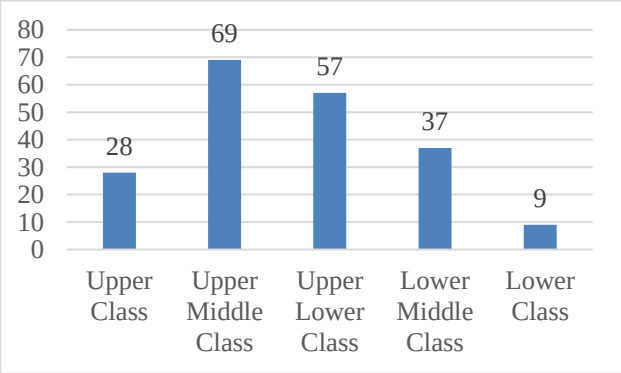

Figure 1: Socio-economic classification of study sample.

The mean age of the sample was 12.96±0.76 years (Figure 2) and the mean menarcheal age of the population was 12.68±0.77 years (Figure 3)

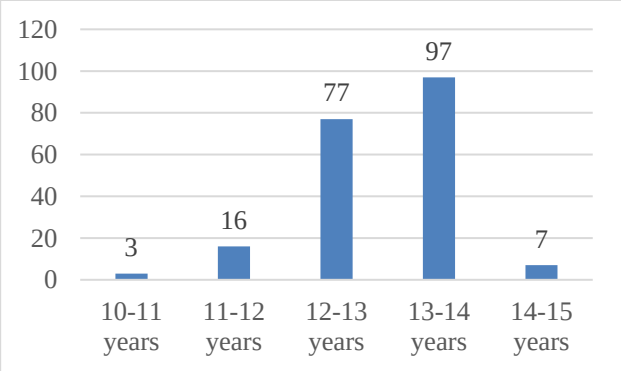

Figure 2: Age distribution of the study sample.

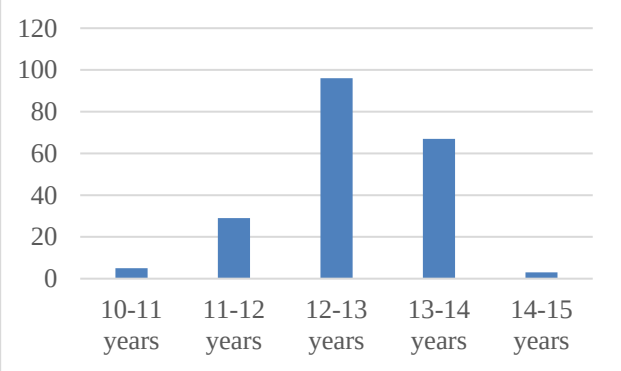

Figure 3: Menarcheal age distribution of the study sample.

Higher mean age at menarche was found in the lower socio-economic group and it steadily decreased with the improvement in the socioeconomic status of the study sample. One-way ANOVA revealed a statistically significant ($p<0.001$) difference between the mean ages at menarche between the socio-economic groups indicating that socio-economic status was an important determinant of age at menarche in the present study sample (Table 1).

Table 1: Age at menarche across socio-economic classes.

Socio economic classes	N	Mean Menarcheal age (years)±Std deviation
Upper class	28	12.38±0.47
Upper middle	69	12.51±0.78
Lower middle	37	12.73±0.89
Upper lower	57	12.92±0.76
Lower	9	13.30±0.24
Total	200	12.68±0.78

Family size

A statistically significant correlation ($p<0.001$) was found between family size and age at menarche. It was observed that girls belonging to larger families showed a higher mean age at menarche when compared to girls belonging to smaller families (Table 2, 3).

Table 2: Frequency distribution of age at menarche with respect to family size.

Family size	N	Mean menarcheal age (years)±Std deviation
Less than 4 family members	18	12.07±0.77387
4-6 family members	150	12.71±0.77072
More than 6 family members	32	12.88±0.76907
Total	200	12.68±0.77707

Table 3: Correlation between age at menarche and family size.

Parameters tested	Correlation		
	Pearson correlation	Significance (2-tailed)	N
Family size	0.189 (*)	0.000	200

Anthropometric measures and age at menarche

The mean weight (47.81±11.28 kg), height (150.77±5.30 cm) and BMI 20.944±4.45 kg/m2 of the study sample respectively showed a statistically significant negative correlation ($p<0.001$) with the age at menarche indicating that heavier and taller girls reported lower ages of onset of menstruation (Table 4). The BMI-for-age z-score classification for children and adolescents of 5-18 years (WHO, 2007) revealed that 85.50% of the sample was well-nourished i.e. BMI-for-age z-score>-2 & <+1 while the remaining were either overweight or obese17 (Figure 4).

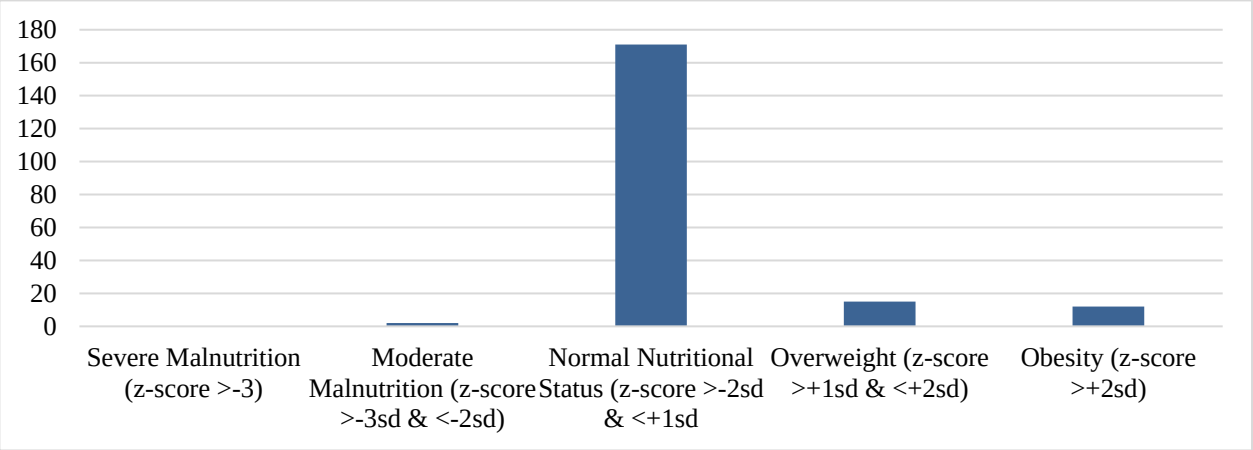

Figure 4: BMI-for-age z-score.

Physical activity and age at menarche

In the present study the level of physical activity was assessed with the help of physical activity questionnaire for older children and adolescents which classified the total physical activity in scores from 1-5 classifying it into different levels of intensity (Figure 5).

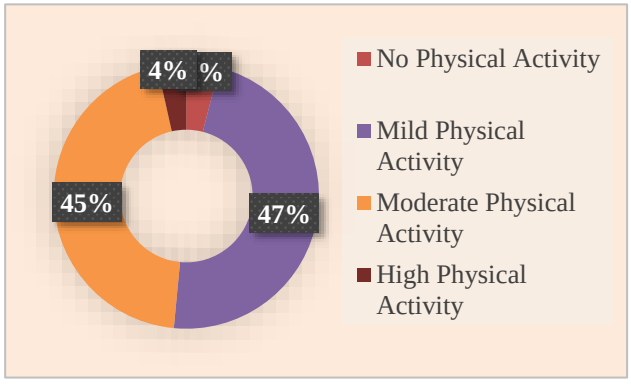

Figure 5: Intensity of physical activity.

An almost equal number of subjects were involved in mild to moderate intensity physical activity with the average physical activity score of the total sample being 2 i.e. mild physical activities. Very few subjects were involved in high intensity physical activities like sports i.e. 4% (n= 8).

A significant positive correlation was found between physical activity levels and age at menarche ($p<0.000$). This corroborated the fact that the level of physical activity does influence the age at menarche i.e. girls involved in regular exercise or high intensity physical activity experience menarche at a later age. Also, when level of physical activity was correlated with screen time it provided significant negative correlation ($p<0.000$). This shows that individuals exhibiting higher level of physical activity tend to spend less time in sedentary activities (Table 4).

Table 4: Correlation between physical activity, screen time and age at menarche.

Parameters tested	Correlation		
	Pearson correlation	Significance (2-tailed)	N
Physical activity and age at menarche	0.388(*)	0.000	200
Physical activity and screen time	-0.288(*)	0.000	200

DISCUSSION

Mean age at menarche

The mean age at menarche in the present study was found to be 12.68±0.77 years and a majority of the subjects had attained menarche between 12-14 years of age. Similar trends have been reported by various workers in the Indian population. A cross-sectional community-based study carried out in West Bengal reported a mean menarcheal age of 12.24±0.7261 years. Bharatalakshmi and co-workers (2014) reported 12.9±1.2 years as the mean menarcheal age in Chidambaram while 12.98±0.77 was the mean age at menarche reported by Verma and his colleagues. Sachan et al (2012) reported 12.08±1.06 years in girls from rural and urban schools in Lucknow.[18-20]

Age at menarche and socio-economic status

The age at menarche is a complex interplay between genetic differences and environmental influences like socio-demographic profile of populations, health and hygiene conditions, nutritional status and varied environmental elements. Socio-demographic factors have been found to have a significant impact on the age at menarche, especially in developing countries. These factors include family size, type of residence, family income, parental education and occupation.

Though some studies have reported an association between lower SES and early menarche due to limited access to healthful foods and fewer opportunities for safe physical activity.[21,22] Most studies have found that developing countries or countries in economic transition have reported that improvement in socio-economic conditions have led to a decreasing trend in age at menarche.[3,7,23]

These facts have been substantiated in the present study where mean age at menarche followed the gradient of socioeconomic status characterized by markers like family income and family size i.e. better family incomes and smaller family sizes were found to be significantly associated with higher mean ages at menarche and vice-versa.

The ambiguous or equivocal findings from various studies may be attributed to the variability of the SES indicators used across populations.

Age at menarche and anthropometric measures

Anthropometric indices have been known to be an important determining factor in the onset of puberty and menarche. Previous studies have reported an inverse relationship between age at menarche and weight, height, BMI, waist circumference and waist-to-height ratio. Lee et al have reported a significant association between menarcheal age and height of their study sample. Majority of the studies have found an association between weight, height, BMI along with body fat distribution as measured by waist circumference and age at menarche. High BMI percentile values, a large waist circumference and greater waist-to-hip ratios have been suggested as key influencing factors for age at menarche.[3,24-26] The present study also brought out significant negative correlations between weight, height, BMI and waist-to-hip ratio in the present study population outlining the fact that anthropometric indices play a significant role in the onset of menstruation.

Age at menarche and physical activity

Regular physical activity is known to improve the quality of life and health status across age groups. Young children and adolescents achieve better bone health, improved weight status, better cardiovascular and muscular fitness and improved cognition by undertaking physically demanding activities.[27] It is therefore also a major influencing factor for age of onset of menarche as it influences the body fat percentage and thereby weight, height, BMI, waist circumference and waist-to-hip ratio. A number of studies have observed delayed menarche in girls involved in athletic or sporting activities and early menarche in study populations reporting higher levels of sedentary physical activity such as television watching.[28]

The results of the present study also found a significant positive correlation ($p<0.001$) between age at menarche and physical activity levels, as measured by the PAQ-A. A significant negative correlation was observed between time spent on sedentary activities like screen time and sleep duration, and age at menarche highlighting the fact that greater involvement in physical activity leads to lesser time spent in pursuing sedentary lifestyle choices.

CONCLUSION

In conclusion, the present study observed higher mean age at menarche among subjects belonging to the lower socio-economic strata of the study population. It was also found that lower levels of physical activity and higher mean weights, mean heights and BMI were important influencing factors in determining the age at onset of menarche in the current study population. These observations are in consonance with many studies carried out in this important area of health of young female children and adolescents and offer insights into the prognostic health outcomes of this population in the later years.

Though the present study has contributed to knowledge on association of various factors with age at menarche in the Indian context, there are some limitations that need to be considered while summarizing the outcomes of the study. The study could only identify an association between socio-economic status, anthropometric parameters, physical activity levels and menarcheal are among a limited sample of school-going girls in the urban context and could not establish any causal relationship between the variables. It is therefore suggested that large-scale, longitudinal studies across socio-economic strata should be taken up to generate a clear understanding and identification of causal risk factors influencing age at menarche among young Indian girls. It is imperative to focus on this preventive health aspect of the young population in order to devise strategies aimed towards the reduction of the non-communicable disease burden and better prognostic health outcomes in the developing nations of the world.

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