



ORIGINAL ARTICLE

A comparative study of the effects of obesity on menarche in rural and urban school girls in Paschim Medinipur, West Bengal

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ABSTRACT

Background: Menarche is called the first menstrual bleeding. In this period, an adolescent girl signifies the transition from girlhood to womanhood, and various physiological, social, and mental changes occur in this age group. This study was conducted to find out the effect of menarche on obesity among the rural and urban secondary schoolgirls in Paschim Medinipur district, West Bengal.

Methods: This study was conducted on 160 secondary school girls whose having an age range of 10 to 14 years in rural and urban areas, from Paschim Medinipur, West Bengal. A questionnaire and anthropometric measurements are used for data collection.

Results: Girls with high class BMI, waist circumference, waist-height ratio, hip circumference, hip-height ratio, body fat percentage, and MUAC are more likely to attain early menarche. It is important to control the occurrence of obesity, particularly central obesity, by monitoring the change in waist circumference, hip circumference, body fat percentage, BMI, and MUAC. There was a significant correlation of body growth with the age at menarche, indicating early onset of menarche in obese girls as compared to lean ones.

Discussion: The findings of this study provide a reference for the age at menarche to determine trends and also emphasise the need for the development of strategies to reduce and prevent excessive weight gain in our paediatric population, with special attention being paid to the eating and living style habits of our children.

Keywords: Menarche, Obesity, BMI, Body Fat Percentage.

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INTRODUCTION

Menarche is called the first menstrual bleeding, and age at menarche is the most significant period of a girl's life. In this period, an adolescent girl has been recognised as a special period that signifies the transition from girlhood to womanhood, and various physiological, social, and mental changes occur in this age group.^[1] Early menarche is associated with a higher risk of breast cancer, increased endometrial cancer and adult obesity.^[2-7] On the other hand, delayed menarche is a risk factor for adult oligomenorrhea and cardiometabolic abnormalities, irregular menstrual cycles and lower peak bone mass.^[8-9] Menarche is influenced by hereditary, race, natural conditions, nourishment, physical movement, geographic area, metropolitan or rustic habitation, wellbeing status, mental variables, weight record, family size, financial status, parental instructive level, control of guardians, loss of guardians, youngster sexual maltreatment, physical pressure and inactive smoking.^[10-11] High socioeconomic status is also related to the early period of menarche.^[12,13] The fluctuation in the mean period of menarche likewise exists dependent

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on nation, recommending the potential for hereditary or potentially environmental causes.^[14] Age at menarche is a significant indicator of growth and sexual maturation in girls.^[15] Much as the secular trend in human size has been an adaptive response to a nutritionally rich environment, the receding age of adolescence and pubertal development has been an adaptive response to positive environmental

cues in terms of energy balance.^[16] During adolescence, growth and nutritional status are heavily influenced by the sexual maturation process, and thus cannot be accurately assessed without knowledge of the degree of sexual maturation.^[17] Nutrition influences growth and development throughout infancy, childhood and adolescence; however, during the period of adolescence that nutrient needs are the greatest.^[18] Menarcheal age is the most widely used indicator of sexual maturation and can be used as an indicator of female health, growth and development and the capacity to reproduce. Onset of maturation and age at menarche are influenced by several factors, e.g., genetics, ethnicity, height, weight, body mass index (BMI), and socioeconomic circumstances. Several studies from various developed countries worldwide have shown a systematic decrease in median age at menarche in the past 160 years.^[19] Malnutrition, which refers to an impairment of health from a deficiency or imbalance of nutrients, is of public health significance among adolescents all over the world.^[20] This study aims to find the effect of menarche on obesity among the rural and urban school-going girls in Paschim Medinipur district, West Bengal.

MATERIAL AND METHODS

Study design

This study was a cross-sectional study from June 2024 to November 2024. About 160 sample of 160 girls from rural and urban secondary schools girls of Paschim Medinipur, West Bengal. Samples were randomly selected from different secondary schools that have an age range of 10 to 14 years.

Evaluation of Socioeconomic status

The subjects' socioeconomic status was determined using Kuppuswamy's socioeconomic status scale.^[21] It is an important tool in community-based research in India. A worksheet to determine the socioeconomic status was used to mark the score against each item in the table. The scores were used to compute a resultant score of the components, and finally, the status of the respondents was determined. From the computed resultant scores, the following socioeconomic classes were determined according to the cut-off scores of each class.

Evaluation of Menarche Stage

The menarche stage was determined from the secondary school girls in the urban and rural areas in Paschim Medinipur district.

Measurement of Anthropometric Parameters

Some anthropometric measures were also taken. During the measurement, standard landmarks and measuring techniques were followed.^[22]

Weight (kg)

Weight was taken by a portable human weighing machine with an accuracy of 0.5 kg. The machine was placed on the plane surface, and then the subject was asked to stand erect on the machine, wearing minimal clothing.

Height (cm)

Height was measured with the help of an anthropometric rod. The subject was asked to stand erect on the floor, and then the vertical distance from the ground to the vertex of the subject was measured.

Body Mass Index (BMI) (kg/m²)

Nutritional status was evaluated using internationally accepted World Health Organisation BMI (kg/m²) guidelines.

Body Surface Area (BSA)

The body surface area was also calculated from the collected height (m) and weight (kg).^[23-24]

$$BSA (m^2) = 0.20247 \times \text{height (m)}^{0.725} \times \text{weight (kg)}^{0.425}$$

Waist Circumference

A good quality non-stretchable measuring tape was used to view the subject from the front. Locate the narrowest point between the ribs and the iliac crest. Waist circumference was measured and stated the measurement correctly to the nearest centimetre.

Hip Circumference

Hip measurement was taken at the widest lateral extension of the hips. Hip circumference was measured and stated the measurement correctly to the nearest centimetre.

Waist-hip ratio (WHR)

The waist girth was divided by the hip girth to find the waist-hip ratio.

Mid upper arm circumference (MUAC)

The subject should be with the arm hanging loosely and comfortably at the side. MUAC was measured at the midpoint between the tip of the shoulder and the tip of the shoulder and the tip of the elbow (olecranon process and the acromion) with the elbow fixed at 90°.

Forearm circumference

The forearm circumference was measured by wrapping

the tape around the maximal bulge of the forearm, and the reading was taken from the tape.

Head circumference

The head circumference was measured at the largest area of a subject's head or the distance around the back of the head with the tape measure held above the eyebrows and ears.

Hip breadth

Hip Breadth was measured with a beam calliper. The subject stands erect with the heels together and the weight distributed equally on both feet.

Bi deltoid diameter

The bi deltoid diameter was *measured on the subject's shoulders in order to determine the seat position.*

Body Composition

The body composition of the subject was determined by the skin-fold method. The skinfold caliper (Holtain) was used for these measurements. The measurements were taken under standardized conditions and using proper landmarks.^[25]

The anatomic sites that were used for skin fold measurements are as follows:

Triceps

On the back of the arm, midway between the acromion process and the olecranon process. The skin fold was taken parallel to the long axis of the arm.

Abdomen

A vertical fold about 1-cm to the right of the umbilicus.

Supra-iliac

Just above the crest of the iliac at the midaxillary line. The fold was lifted diagonally, following the natural line of the iliac crest.

Thigh

With the subject's weight on the left foot, a vertical fold on the front of the right thigh halfway between the hip and the knee. From the skin fold data total weight of body fat and lean body weight was determined by calculating the body density and percentage of body fat of adult male and female subjects.^[26-27,28] The following formulae were used:

Body density (gm/cc) for women

$= 1.0994921 - 0.0009929 (\text{sum of triceps, suprailliac and thigh skin folds}) + 0.0000023 (\text{sum of the same three skin folds})^2 - 0.0001392 (\text{age in years}).$

Percentage of fat

$= \{(4.95 \div \text{Body density}) - 4.50\} \times 100$

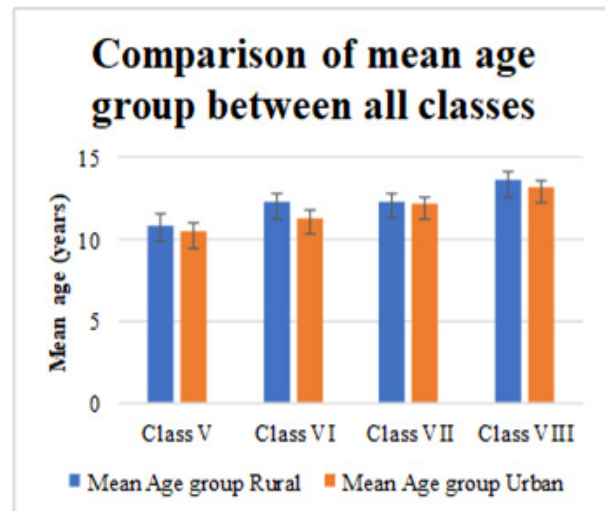


Figure 1: Comparison of mean age group between all classes

Total weight of fat

$= (\text{Weight in kg} \times \text{Percentage of fat}) \div 100$

Lean body weight

$= \text{Total weight (kg)} - \text{Total weight of fat (kg)}$

The subjects were classified into normal weight and overweight using the values of body fat %. For this purpose, the WHO cut-off values of body fat percentage (BF %) for female subjects is employed to categorize the subjects (WHO, 2004), as shown below:

Normal weight

Women BF% <25

Overweight

Women BF% ≥25

Statistical Analysis

Data was summarised into mean and standard deviation values using Microsoft Excel. The comparison of different anthropometric parameters like height, weight, BMI, BSA, MUAC, waist-hip ratio, body fat%, waist circumference, hip circumference, etc, among of girl students of class V,

Table 1: Mean ± SD value of age (year) of school girls at Paschim Medinipur District

Class	Mean Age group	
	Rural	Urban
Class V	10.85 ± 0.67	10.5±0.51
Class VI	12.25±0.55	11.35±0.49
Class VII	12.3±0.47	12.2±0.41
Class VIII	13.6±0.5	13.2±0.41

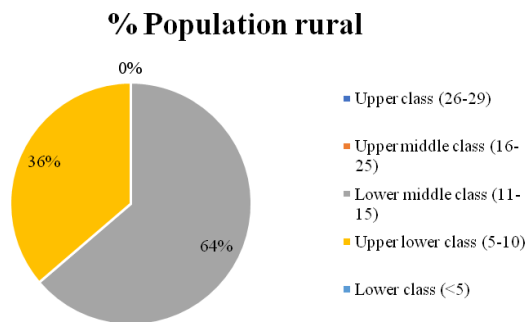


Figure 2: Pie diagram represents the percentage of socioeconomic status of rural region between girls

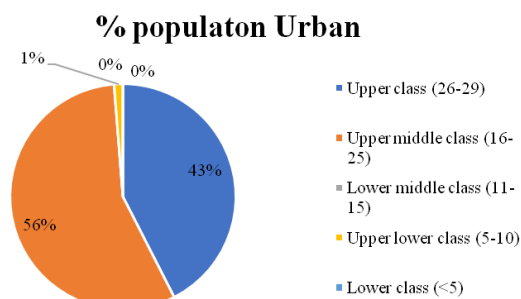


Figure 3: Pie diagram represents the percentage of socioeconomic status of urban region between girls .

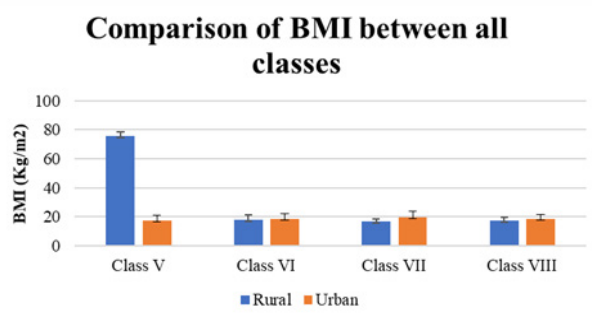


Figure 4: Comparison of BMI between all classes among the rural and urban regions

class VI, class VII and class VIII will be measured by one-way ANOVA. The Student t-test analysed the comparison between pre-menarche and post-menarche.

RESULT

Mean age group

From Table 1, it has been noted that the present study was conducted on 160 girl subjects(80 Urban and 80 Rural) of school students of Paschim Medinipur in West Bengal,

Table 2: Socioeconomic Status of school girls of rural and urban regions in Paschim Medinipur District

Socioeconomics class	% population	
	rural	urban
Upper class (26-29)		42.5 (34)
Upper middle class (16-25)		56.25 (45)
Lower middle class (11-15)	63.75 (51)	
Upper lower class (5-10)	36.25 (29)	1.25 (1)
Lower class (<5)		

Table 3: Comparison of BMI (Mean± SD) between school girls among the rural and urban region

Class	BMI		t test
	Rural	Urban	
Class V	75.75±2.93	17.46±3.42	1.70
Class VI	17.83±3.59	18.63±3.58	0.71
Class VII	16.64±1.51	19.76±3.84	3.38**
Class VIII	17.03±2.58	18.55±2.91	1.75

Results are express as Mean± SD; **p<0.05, **p<0.01between Rural and Urban school girl

Table 5: Comparison of W/H Ratio between school girls in the rural and urban regions

Class	W/H Ratio		t test
	Rural	Urban	
Class V	0.9±0.05	0.89±0.06	0.20
Class VI	0.9±0.04	0.92±0.05	0.66
Class VII	0.94±0.09	0.89±0.04	2.06*
Class VIII	0.9±0.05	0.91±0.06	0.60

Results are express as Mean± SD; *p<0.05 between Rural and Urban school girl

Table 4: Comparison of BSA between school girls among the rural and urban region

Class	BSA		t test
	Rural	Urban	
Class V	1.06±0.16	1.16±0.16	2.12*
Class VI	1.28±0.16	1.32±0.14	0.64
Class VII	1.23±0.1	1.37±0.15	3.45**
Class VIII	1.33±0.16	1.41±0.13	1.64

Results are express as Mean± SD; *p<0.05, **p<0.01 between Rural and Urban school girl

Table 6: Comparison of Body density between school girls among the rural and urban regions

Class	Body density		t test
	Rural	Urban	
Class V	1.05±0.01	1.04±0.02	3.32**
Class VI	1.04±0.02	1.04±1.01	0.77
Class VII	1.05±1.01	1.04±0.02	2.83**
Class VIII	1.05±0.01	1.03±0.01	3.35**

Results are express as Mean± SD; **p<0.01 between Rural and Urban school girl

Table 7: Comparison of the Percentage of fat between school girls in the rural and urban regions

Class	Percentage of fat		t test
	Rural	Urban	
Class V	20.16±5.84	27.12±7.01	3.07**
Class VI	24.92±7.96	27.42±6.87	2.66*
Class VII	21.6±4.57	28.25±10.18	1.07
Class VIII	23.42±3.75	28.66±6.61	3.07**

Results are expressed as Mean± SD; *p<0.06, **p<0.01 between Rural and Urban school girl.

having the age range 10 to 14 years. The subject is divided into two groups according to their residence. That is urban and rural. The mean value of age of class V student is 10.85 years (Rural) and 10.50 years (Urban), In class VI student is 12.25 years (Rural) and 11.35 years (Urban), In class VII

student is 12.30 years (Rural) and 12.20 years (Urban), In class VIII student is 13.60 years (Rural) and 13.20 years (Urban), respectively (Table 1 and Figure 1).

Socioeconomic Status

From Table 2, it is represented that the socioeconomic status of school girls in Paschim Medinipur. This result shows that the 63.75% school girls are Lower middle class (11–15) and 36.25% school girls are Upper lower class (5–10) in rural region where as 42.5% school girls are Upper class (26–29) and 56.25% school girls are Upper middle class (16–25) and 1.25% school girls are Upper lower class in urban region according to the Modified Kuppuswamy Scale. The person with a higher socioeconomic status (SES) may have higher purchasing capacity and better awareness about the food and nutrient intake than those with lower SES. The latter factor may have some positive influence on hand grip strength. (Table 2) (Figures 2 and 3)

BMI (Kg/m²)

Table 3 represents the mean value of BMI (kg/m²) of school girls of rural and urban regions in Paschim Medinipur. This result shows that the mean BMI of class V students is 75.75 (Rural) and 17.46 (Urban), class VI students is 17.83 (Rural) and 18.63 (Urban), class VII students is 16.64 (Rural) and 19.76 (Urban), class VIII student is 17.03 (Rural) and 18.55 (Urban). The result of the t-test shows that there was a significant difference in BMI of the girls. BMI was calculated from the height and weight using the equation: BMI (kg/m²) = weight (kg)/height² (m).²⁷ Weight status was determined using BMI.

A recent study demonstrated an inverse association between menarcheal age and BMI.²⁸ Our results also support

Table 8: Comparison of the Total weight of fat between school girls in the rural and urban regions.

Class	Total weight of fat		t test
	Rural	Urban	
Class V	6.32±3.77	9.9±4.6	2.69*
Class VI	10.5±5.75	11.87±5.41	0.77
Class VII	7.98±2.55	13.55±7.18	3.26**
Class VIII	9.58±2.69	13.36±5.4	2.79**

Results are express as Mean± SD; *p<0.05, **p<0.01 between Rural and Urban school girl

Table 9: Comparison of Lean body mass between school girls among the rural and urban region

Class	Lean body mass		t test
	Rural	Urban	
Class V	23.13±5.05	24.85±4.41	1.15
Class VI	29.2±4.72	29.82±4.59	0.42
Class VII	28.32±2.8	31.73±7.18	2.89**
Class VIII	31.02±6.62	31.84±4.09	0.47

Results are express as Mean± SD; **p<0.01 between Rural and Urban school girl

a significant inverse association between BMI and age at menarche. The BMI of the early menarcheal age group was significantly higher than ideal menarcheal age group. BMI was more than the 85th percentile for the early menarcheal group, between the 50th and 85th percentile for the mid menarcheal group and less than the 20th percentile for the late menarcheal group according to the WHO standard of age-related BMI. This observation suggests that overweight and obesity may be a cause of the early onset of menarche (Table 3 and Figure 4).

BSA

Table 4 represents the mean value of BSA of school girls of rural and urban regions in Paschim Medinipur. This result shows that the mean BSA of class V students is 1.06 (Rural) and 1.16 (Urban), class VI students is 1.28 (Rural) and 1.32 (Urban), class VII students is 1.23 (Rural) and 1.37 (Urban), class VIII students is 1.33 (Rural) and 1.41 (Urban). The result of a two-tailed t-test shows that there was a significant difference in the BSA of the girls (Table 4).

Waist to Hip Ratio

Table 5 represents the mean value of the W/H ratio of school girls of rural and urban regions in Paschim Medinipur. This result shows that the mean W/H Ratio of class V students is 0.9 (Rural) and 0.89 (Urban), class VI students is 0.9 (Rural) and 0.92 (Urban), class VII students is 0.94 (Rural) and 0.89 (Urban), class VIII students is 0.9 (Rural) and 0.91 (Urban). The result of two two-tailed t-tests shows that there was a significant difference in the W/H Ratio of the girls (Table 5).

Hip Breadth

Table 6 represents the mean value of the Hip breadth of school girls in rural and urban regions in Paschim Medinipur. This result shows that the mean Hip breadth of

Table 10: Comparison of menarche and non-menarchebetween school girls of the rural region

Anthropometric measurement	Menarche student	Non-Menarche student	T test
Height (cm)	151.11±6.73	142.71±9.64	4.39***
Weight (kg)	40.44±8.60	33.46±8.44	3.64***
BMI kg /m2	17.59±2.94	16.21±2.57	2.25*
BSA	1.31±0.15	1.16±0.17	4.14***
Waist circumference Cm	69.56±6.37	65.39±6.88	2.78**
Hip circumference cm	76.22±7.61	72.55±7.54	2.15*
W/H Ratio Cm	0.92±0.07	0.90±0.06	0.86
Hip breadth cm	28.91±3.66	26.62±2.99	3.08**
Bi deltoid cm	33.37±2.88	31.80±4.50	1.79
Head circumference cm	51.67±1.67	50.71±3.25	1.59
MUAC cm	20.01±2.26	19.04±2.83	1.66
Forearm circumference cm	18.19±1.88	17.69±2.54	0.97
BD gm/cc	1.05±0.01	1.05±0.01	0.93
% of fat	23.54±4.96	21.74±6.52	1.36
Total weight of fat	9.76±3.76	7.69±4.26	2.26
LMB	30.68±5.64	25.76±4.81	4.21***

Results are express as Mean± SD; *<0.05, **p<0.01, ***p<0.001between Rural and Urban school girl .

Table 11: Comparison of menarche and non-menarche between school girls of the urban region

<i>Anthropometric measurement</i>	<i>Menarche student</i>	<i>Non-Menarche student</i>	<i>T test</i>
Height (cm)	152.94±6.06	142.47±7.65	6.74***
Weight (kg)	45.40±9.30	35.28±7.49	5.00***
BMI kg /m ²	19.35±3.53	17.28±3.03	2.65**
BSA	1.39±0.14	1.19±0.14	6.12***
Waist circumference Cm	74.56±8.63	67.05±7.95	3.85***
Hip circumference cm	82.30±8.18	74.51±7.33	4.24***
W/H Ratio Cm	0.91±0.06	0.90±0.05	0.61
Hip breadth cm	28.55±3.89	27.53±6.68	0.87
Bi deltoid cm	32.85±3.36	31.17±6.66	1.50
Head circumference cm	52.55±1.84	51.72±1.48	2.08*
MUAC cm	21.92±2.92	19.46±2.62	3.76***
Forearm circumference cm	19.56±2.16	17.99±2.22	3.08**
BD gm/cc	1.03±0.02	1.04±0.01	2.22*
% of fat	29.25±7.96	25.42±6.60	2.19*
Total weight of fat	13.83±6.08	9.26±3.93	3.63***
LMB	31.57±4.36	26.02±4.58	5.37***

Results are express as Mean± SD; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ between Rural and Urban school girls.

class V students is 25.13 (Rural) and 26.68 (Urban), class VI students is 28.48 (Rural) and 27.64 (Urban), class VII students is 27.94 (Rural) and 29.50 (Urban), class VIII students is 28.96 (Rural) and 28.93 (Urban).

Bi deltoid diameter

Table 7 represents the mean value of the Bi deltoid diameter of school girls in rural and urban regions in Paschim Medinipur. This result shows that the mean hip breadth of class V students is 29.54 (Rural) and 30.55 (Urban), class VI students is 34.08 (Rural) and 31.3 (Urban), class VII students is 32.73 (Rural) and 33.59 (Urban), class VIII students is 33.59 (Rural) and 33.54 (Urban).

Head Circumference

Table 8 shows the mean value of Head circumference of school girls in rural and urban regions in Paschim Medinipur. From the result, it has been found that the mean head circumference of class V student is 50.06 (Rural) and 51.71 (Urban), class VI student is 51.48 (Rural) and

52.07 (Urban), class VII student is 50.96 (Rural) and 52.64 (Urban), class VIII student is 52.02 (Rural) and 52.59 (Urban).

Mid-upper arm circumference

Table 9 represents the mean value of MUAC of school girls of rural and urban regions in Paschim Medinipur. This result shows that the mean MUAC of class V students is 17.98 (Rural) and 19.55 (Urban), class VI students is 20.46 (Rural) and 21.24 (Urban), class VII students is 19.43 (Rural) and 21.32 (Urban), class VIII students is 20.00 (Rural) and 22.00 (Urban).

Forearm circumference

Table 10 represents the mean value of the Forearm circumference of school girls of rural and urban regions in Paschim Medinipur. This result shows that the mean Fore-arm circumference of class V students is 16.85 (Rural) and 18.23 (Urban), class VI students is 18.92 (Rural) and 19.26 (Urban), class VII students is 17.63 (Rural) and

Table 12: Comparison of anthropometric changes between school girls of different classes of the rural region.

<i>Anthropometric Measurement</i>	<i>Class</i>				<i>F value</i>
	<i>V</i>	<i>VI</i>	<i>VII</i>	<i>VIII</i>	
Height (cm)	135.62 ± 7.22	148.73 ± 6.52	147.51 ± 5.80	153.70±7.46	25.53***
Weight (kg)	29.45 ± 8.58	39.70 ± 9.73	36.30 ± 4.74	40.60±8.73	7.68***
BMI kg /m2	15.75 ± 2.93	17.83 ± 3.59	16.64 ± 1.51	17.03 ± 2.58	1.94
BSA	1.06 ± 0.16	1.21 ± 0.16	1.23 ± 0.10	1.33 ± 0.16	13.14
Waist circumference Cm	62.05 ± 7.54	70.90 ± 6.71	67.65 ± 5.48	68.26±4.98	7.07***
Hip circumference cm	69.32 ± 7.73	78.62 ± 7.41	72.34 ± 5.76	76.36±6.86	7.04***
W/H Ratio Cm	0.90 ± 0.05	0.90 ± 0.04	0.94 ± 0.09	0.90 ± 0.05	2.25
Hip breadth cm	25.13 ± 2.87	28.41 ± 3.26	27.94 ±3.00	28.96±3.59	5.77**
Bi deltoid cm	29.54 ± 2.80	34.08 ± 5.24	32.73±2.83	33.59±2.78	6.53***
Head circumference cm	50.06 ± 3.20	51.48 ± 3.73	50.96 ±1.04	52.02±1.71	1.96
MUAC cm	17.98 ± 2.30	20.46 ± 3.52	19.43 ±1.95	20.00±1.89	3.69*
Forearm circumference cm	16.85 ± 1.94	18.92 ± 3.14	17.63 ±1.74	18.25±1.56	3.27*
BD gm/cc	1.05 ±0.01	1.04 ±0.02	1.05 ±0.01	1.05 ±0.01	2.40
% of fat	20.16 ±5.84	24.92 ±7.96	21.60 ±4.57	23.42 ±3.75	2.62
Total weight of fat	6.32 ±3.77	10.50 ±5.75	7.98 ±2.55	9.58 ±2.69	4.43**
LMB	23.13 ±5.05	29.20 ±4.72	28.32 ±2.80	31.02 ±6.62	9.22***

18.99 (Urban), class VIII students is 18.25 (Rural) and 19.49 (Urban). This result shows that the mean MUAC, triceps skin fold thickness, hip circumference and waist circumference were higher among menstruating girls

compared to non-menstruating girls. Anthropometric body fat indices like waist circumference, waist height ratio, hip circumference, hip height ratio, and waist hip ratio showed inverse correlation with age at menarche. Except waist-

Table 13: Comparison of anthropometric changes between school girls of different classes of the urban region

<i>Anthropometric Point</i>	<i>Class</i>				<i>F value</i>
	<i>V</i>	<i>VI</i>	<i>VII</i>	<i>VIII</i>	
Height (cm)	140.45 ± 8.16	149.26 ± 5.80	151.09 ± 6.08	155.77 ± 4.77	20.53***
Weight (kg)	34.75 ± 8.49	41.69 ± 9.13	45.28 ± 10.09	45.20 ± 8.69	5.88**
BMI kg /m ²	17.46 ± 3.42	17.51 ± 4.61	19.76 ± 3.84	18.55 ± 2.91	1.48
BSA	1.16 ± 0.16	1.27 ± 0.19	1.37 ± 0.15	1.41 ± 0.13	10.51***
Waist circumference Cm	66.53 ± 8.08	71.51 ± 8.67	75.20 ± 8.74	74.12 ± 8.94	4.03*
Hip circumference cm	74.50 ± 7.69	77.73 ± 9.01	84.13 ± 8.74	81.56 ± 6.41	5.57**
W/H Ratio Cm	0.89 ± 0.06	0.92 ± 0.05	0.89 ± 0.04	0.91 ± 0.06	1.18
Hip breadth cm	26.68 ± 7.83	27.64 ± 3.07	29.50 ± 4.41	28.93 ± 3.34	1.27
Bi deltoid cm	30.55 ± 8.05	31.30 ± 2.55	33.59 ± 1.91	33.54 ± 3.89	2.15
Head circumference cm	51.71 ± 1.44	52.07 ± 1.41	52.64 ± 2.38	52.59 ± 1.56	1.31
MUAC cm	19.55 ± 2.41	21.24 ± 3.33	21.32 ± 3.18	22.00 ± 2.83	2.47
Forearm circumference cm	18.23 ± 1.84	19.26 ± 2.48	18.99 ± 2.61	19.49 ± 2.18	1.14
BD gm/cc	1.04 ± 0.02	1.04 ± 0.01	1.04 ± 0.02	1.03 ± 0.01	0.31
% of fat	27.12 ± 7.01	27.42 ± 6.87	28.25 ± 10.18	28.66 ± 6.61	5.62**
Total weight of fat	9.90 ± 4.60	11.87 ± 5.41	13.55 ± 7.18	13.36 ± 5.40	1.73
LMB	24.85 ± 4.41	29.82 ± 4.59	31.73 ± 4.47	31.84 ± 4.09	11.11***

hip ratio, all these variables were significantly higher in the early menarcheal group than in the ideal group. Both waist circumference and waist-height ratio were above cut of level (75th percentile) of Indian girls.²⁹ Thus, central obesity may be a risk factor for early age at menstruation. The mean MUAC was higher among menstruating girls compared to non-menstruating girls. Our results support previous observations.

Body density

Table 11 represents the mean value of Body density of school girls of rural and urban regions in Paschim Medinipur. This result shows that the mean Body density of class V students is 1.05 (Rural) and 1.04 (Urban), class VI students is 1.04 (Rural) and 1.04 (Urban), class VII students is 1.05 (Rural) and 1.04 (Urban), class VIII students is 1.05 (Rural) and 1.03 (Urban). The result of two-tailed t-tests

shows that there was a significant difference in body density among the girls (Table 6).

Percentage of fat

Table 12 represents the mean value of the percentage of fat of school girls in rural and urban regions in Paschim Medinipur. This result shows that the mean percentage of fat of class V students is 20.16 (Rural) and 27.12 (Urban), class VI students is 24.92 (Rural) and 27.42 (Urban), class VII students is 21.6 (Rural) and 28.25 (Urban), class VIII students is 23.42 (Rural) and 28.66 (Urban). The result of two-tailed t-test shows that there was a significant difference in the percentage of fat in the girls. Body fat percentage showed a significant inverse correlation with age at menarche. Body fat percentage was significantly higher in the early menarcheal group than mid and late menarcheal groups. Body fat percentage was above the 95th percentile for the early menarcheal group, between the 75th and 85th

percentiles for the ideal menarcheal group and below the 25th percentile for the late menarcheal group according to a reference value of body fat indices for adolescents of Bengali ethnicity.³⁰ Thus, body fat percentage above the 85th percentile value may be a risk factor for early onset of menarche³¹ (Table 7).

Total Weight of Fat

Table 13 represents the mean value of the total weight of fat of school girls of rural and urban regions in Paschim Medinipur. This result shows that the mean Total weight of fat of class V students is 6.32 (Rural) and 9.9 (Urban), class VI students is 10.5 (Rural) and 11.87 (Urban), class VII students is 7.98 (Rural) and 13.55 (Urban), class VIII students is 9.58 (Rural) and 13.36 (Urban). The result of a two-tailed t-test shows that there was a significant difference in the percentage of fat of the girls (Table 8).

Lean Body Mass

Table 14 represents the mean value of lean body mass of school girls in rural and urban regions in Paschim Medinipur. This result shows that the mean lean body mass of class V students is 23.13 (Rural) and 24.85 (Urban), class VI students is 29.2 (Rural) and 29.82 (Urban), class VII students is 28.32 (Rural) and 31.73 (Urban), class VIII students is 31.02 (Rural) and 31.84 (Urban). The result of a two-tailed t-test shows that there was a significant difference in lean body mass of the girls (Table 9).

Menarche and non-menarche

Table 10 shows the different anthropometric changes between menarche and non-menarche students of a rural region. The result of a two-tailed t-test shows that there was a significant difference in the menarche and non-menarche of girls in the rural region. Menarche is a vital incidence in a female's life. The downward inclination of menarcheal age has been reported in countries. The mean age of menarche in the present study was 12.2 years (144 months). The minimum age of menarche was 110 months, and the maximum with 192 months. In our study subjects more than 21% of girls attained menarche at an early age. In order to find out the determinants of age at menarche correlation of menarcheal age with physical parameters of the subjects was studied. A general belief among paediatricians is that girls with early menarche are shorter in height than those who have a late menarche. Many evidences suggest that taller girls attain early menarche.³² But the results of our study suggest a positive correlation between height and age at menarche. Our results support the previous observation of Lee *et al.*³³ Results of the study of Johnson *et al.*³⁴ were against the "critical weight hypothesis. Our results were also

against the "critical weight hypothesis" (Table 10). Table 11 shows the different anthropometric changes between menarche and non-menarche students of the urban region. The result of a two-tailed t-test shows that there was a significant difference in menarche and non-menarche of the girls in the urban region.

Anthropometric changes among the school-going students of Class V to VIII

Table 12 shows the different anthropometric changes between the students of class V, class VI, class VII, and class VIII of a rural region. The result of one-way ANOVA shows that there was a significant difference between the girls of different classes in the rural region. Table 13 shows the different anthropometric changes between the students of class V, class VI, class VII, and class VIII of the urban region. The result of one-way ANOVA shows that there was a significant difference between the girls of different classes in the urban region.

DISCUSSION

The development of socioeconomic status resulted in an early onset of puberty, indicated by a fall in age at menarche. Menarcheal age has significant health implications as early menarche is associated with more cardiovascular incidents, type 2 diabetes and breast cancer, and let menarche is associated with osteoporosis and increased fracture risk. More girls attained menarche at an early age. A considerable inverse relationship was noted between menarcheal age with obesity, body fat percentage and mid-upper arm circumference and an insignificant positive relationship between menarcheal age and height. Girls with high class BMI, waist circumference, waist-height ratio, hip circumference, hip-height ratio, body fat percentage and MUAC are prone to attain early menarche. It is important to control the occurrence of obesity, particularly central obesity, through monitoring the change of waist circumference, hip circumference, body fat percentage, BMI and MUAC. There was a significant correlation of body growth with the age at menarche, indicating early onset of menarche in overweight/ obese girls as compared to lean ones.

The findings of this study provide a reference for the age at menarche to determine trends and also emphasise the need for the development of strategies to reduce and prevent excessive weight gain in our paediatric population, with special attention being paid to the eating and living style habits of our children.

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CONFLICT OF INTEREST

There is no conflict of interest.

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