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RESEARCH ARTICLE

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## A COMPARATIVE STUDY OF THE EFFECTS OF OBESITY ON THE MENARCHE OF RURAL AND URBAN SCHOOLGIRLS IN PASCHIM MEDINIPUR, WEST BENGAL

Sujaya De\*, Shyamali Bera and Sanhita Santra

Department of Physiology, Midnapore College (Autonomous), Midnapore, West Bengal, India, 721101

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\*Corresponding author: Sujaya De

### ABSTRACT

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 schoolgirls in Paschim Medinipur, West Bengal. This study was conducted on 160 school girls having an age range of 10-14 years in rural and urban areas of Paschim Medinipur. A questionnaire and anthropometric measurements are followed for data collection. Girls with high class BMI, waist circumference, waist-hip 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. 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. 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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## 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 (Mallick et al., 2022). Early menarche is associated with higher risk of breast cancer, increased endometrial cancer and adult obesity (Kelsey et al., 1993; Heitmann, 1990; Wernli et al., 2006; Xu et al., 2004; Pettersson et al., 1986; Harris et al., 2008). On the other hand, delayed menarche is a risk factor for adult oligomenorrhea and cardiometabolic abnormalities, irregular menstrual cycles and lower peak bone mass (Glueck et al., 2013; Anai et al., 2010). 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 (Mane et al., 2016; Tehrani et al., 2014). High socioeconomic status is also related to the early period of menarche (Wronka et al., 2005; Berkey et al., 2000). The fluctuation in the mean period of menarche likewise exists dependent on nation, recommending the potential for hereditary or potentially ecological causes (Thomas et al., 2001). Age at menarche is a significant

indicator of growth and sexual maturation in girls (Onyiriuka and Egbagbe, 2013). 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 (Hochberg and Belsky, 2013). 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 (Sizonenko and Himes, 1993). Nutrition influences growth and development throughout infancy, childhood and adolescence; however, during the period of adolescence that nutrient needs are the greatest (Heitmann, 1990). 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 (Odongkara et al., 2014). 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 (De and Bose, 2016). 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.

## MATERIALS AND METHODS

**Study design:** This study was a cross-sectional study. One sixty sample was collected from rural and urban secondary schools girls of Paschim Medinipur, West Bengal. Samples were randomly selected from different secondary schools having an age range of 10-14 years.

**Evaluation of Socio-economic status:** The subjects' socioeconomic status was determined using Kuppuswamy's socioeconomic status scale (Kuppuswamy, 1981). It is an important tool in community-based research in India. A worksheet to determine the socio-economic 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.

### Socio-economic class Cut-off scores

Class I (upper):	26-29
Class II (upper middle):	16-25
Class III (lower middle):	11-15
Class IV (upper lower):	5-10
Class V (lower) :	<5

**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 (Ermakova et al., 1985)

**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 minimum 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/m<sup>2</sup>):** Nutritional status was evaluated using internationally accepted World Health Organisation BMI (kg/m<sup>2</sup>) guidelines.

**Body Surface Area (BSA):** The body surface area was also calculated from the collected height (m) and weight (kg).<sup>23-24</sup>

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

**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 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 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 elbow (acromion and the olecranon process) with the elbow fixed to 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:** Bi deltoid diameter was measured of the subject's shoulders in order to determine the seat position.

**Body Composition:** The body composition of the subject was determined by skin-fold method. The skinfold caliper (Holtain) was used for these measurements. The measurements were taken under standardized condition and using proper landmarks.<sup>25</sup>

**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.
- **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 female subjects.<sup>26-27,28</sup> The following formulae were used:
  - **Body density (gm/cc) for women** =  $1.0994921 - 0.0009929$  (sum of triceps, suprailliac and thigh skin folds) +  $0.0000023$  (sum of the same three skin folds)<sup>2</sup> -  $0.0001392$  (age in years).
  - **Percentage of fat** =  $\{(4.95 \div \text{Body density}) - 4.50\} \times 100$
  - **Total weight of fat** = (Weight in kg X Percentage of fat) ÷ 100
  - **Lean body weight** = Total weight (kg) - Total weight of fat (kg)

The subjects were classified into normal weight and overweight using the values of body fat %. For this purpose, 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, class VI, class VII and class VIII will be measured by one way-ANOVA. The comparison between pre-menarche and post-menarche was analysed by the Student t-test.

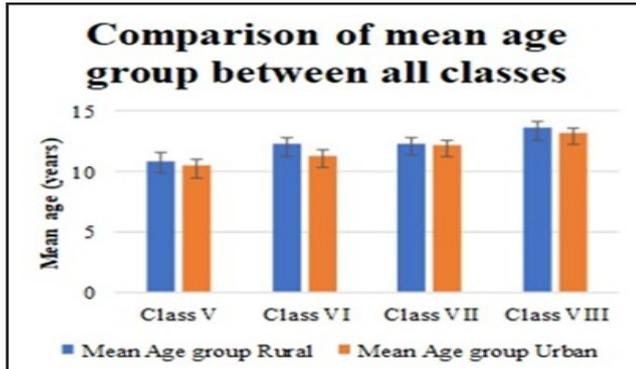
## RESULTS

**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 student of Paschim Medinipur in West Bengal, having the age range 10-14 years. The subject is divided into two groups according to their resident. ie 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. (Table1) (Figure 1)

**Table 1: Mean ± SD value of age (year) of school girls in rural and urban area of 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

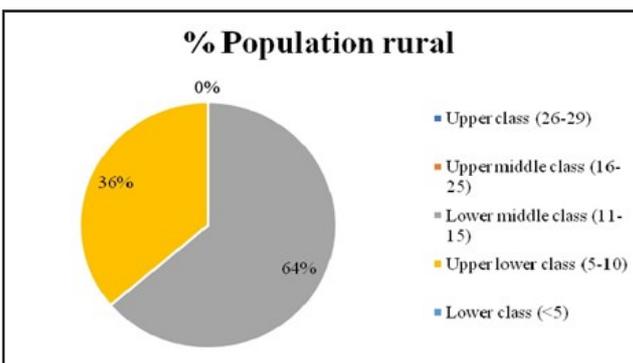


**Figure 1: Comparison of mean age group among all classes (class V to Class VIII) school girls**

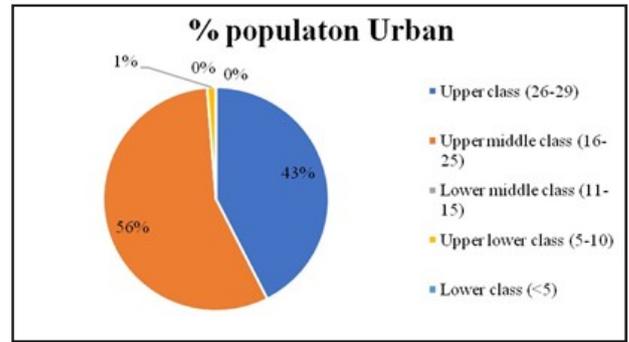
**Socioeconomic Status:** From table 2, it is represented that the socioeconomic status of school girls in Paschim Medinipur. This result shows that the 63.75% school girls are Lower middle class (11-15) and 36.25% school girls are Upper lower class (5-10) in rural region where as 42.5 %school girls 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 Kuppusswamy Scale. The person with 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) (Figure 2 and 3)

**Table 2: Socioeconomic Status of schoolgirls who are in menarche stage of rural and urban regions in Paschim Medinipur District**

Socioeconomics class	% population (n)	
	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)	-	-



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



**Figure 3: Pie diagram represents the percentage of socioeconomic status of urban region school girls**

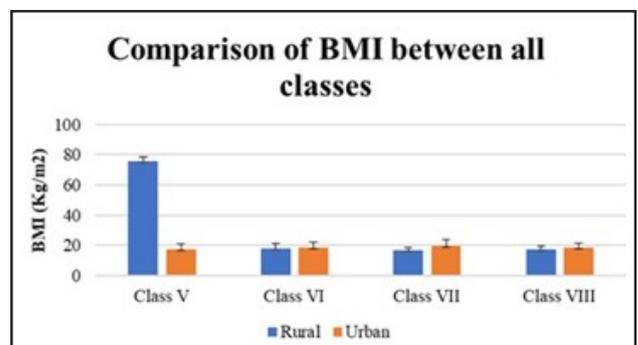
**BMI (Kg/m<sup>2</sup>):** Table 3, represent the mean value of BMI (kg/m<sup>2</sup>) of school girls of rural and urban region in Paschim Medinipur. This result shows that the mean BMI of class V student is 75.75 (Rural) and 17.46 (Urban), class VI student is 17.83 (Rural) and 18.63 (Urban), class VII student is 16.64 (Rural) and 19.76 (Urban), class VIII student is 17.03 (Rural) and 18.55 (Urban). The result of two tail 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 / m<sup>2</sup>) = weight (kg) / height<sup>2</sup> (m).<sup>27</sup> Weight status was determined using BMI.

A recent study demonstrated an inverse association between menarcheal age and BMI.<sup>28</sup> Our results also support a significant inverse association between BMI and age at menarche. BMI of early menarcheal age group was significantly higher than ideal menarcheal age group. BMI was more than 85th percentile for early menarcheal group, in between 50th and 85th percentile for mid menarcheal group and less than 20th percentile for late menarcheal group according to WHO standard of age-related BMI. This observation suggests that overweight and obesity may be a cause of early onset of menarche. (Table3) (Figure 4)

**Table 3: Comparison of BMI (Mean± SD) between schoolgirls in 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

w.r.t urban schoolgirls \*\*p<0.01



**Figure 4. Comparison of BMI among all classes (class V to Class VIII) school girls**

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

**Table 4: Comparison of BSA between school girls in 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

w.r.t urban school girls \*p<0.05, \*\*p<0.01

**Waist to Hip Ratio:** Table 5 represents the mean value of 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 student is 0.9 (Rural) and 0.89 (Urban), class VI student is 0.9 (Rural) and 0.92 (Urban), class VII student is 0.94 (Rural) and 0.89 (Urban), class VIII student is 0.9 (Rural) and 0.91 (Urban). The result of two tail t-test shows that there was a significant difference of W/H Ratio of the girls. (Table 5)

**Table 5: Comparison of waist-hip ratio between school girls in 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

w.r.t urban school girls \*p<0.05

**Hip Breadth:** This result shows that the mean Hip breadth of class V student is 25.13 (Rural) and 26.68 (Urban), class VI student is 28.48 (Rural) and 27.64 (Urban), class VII student is 27.94 (Rural) and 29.50 (Urban), class VIII student is 28.96 (Rural) and 28.93 (Urban).

**Bi deltoid diameter:** Result shows that the mean Hip breadth of class V student is 29.54 (Rural) and 30.55 (Urban), class VI student is 34.08 (Rural) and 31.3 (Urban), class VII student is 32.73 (Rural) and 33.59 (Urban), class VIII student is 33.59 (Rural) and 33.54 (Urban).

**Head Circumference:** From this 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:** This result shows that the mean MUAC of class V student is 17.98 (Rural) and 19.55 (Urban), class VI student is 20.46 (Rural) and 21.24 (Urban), class VII student is 19.43 (Rural) and 21.32 (Urban), class VIII student is 20.00 (Rural) and 22.00 (Urban).

**Fore-arm circumference:** This result shows that the mean Fore-arm circumference of class V student is 16.85 (Rural) and 18.23 (Urban), class VI student is 18.92 (Rural) and 19.26 (Urban), class VII student is 17.63 (Rural) and 18.99 (Urban), class VIII student 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 in 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 hip ratio all these variables were significantly higher in early menarcheal group than ideal group. Both waist circumference and waist- height ratio were above cut of level (75th percentile) of Indian girls.<sup>29</sup> Thus, central obesity may be a risk factor for early age at menstruation. The mean MUAC was higher among menstruating girls in compared to non-menstruating girls. Our results support previous observations.

**Body density:** From the table 6, represent the mean value of Body density of school girls of rural and urban region in Paschim Medinipur. This result shows that the mean Body density of class V student is 1.05 (Rural) and 1.04 (Urban), class VI student is 1.04 (Rural) and 1.04 (Urban), class VII student is 1.05 (Rural) and 1.04

(Urban), class VIII student is 1.05 (Rural) and 1.03 (Urban). The result of two tail t-test shows that there was significant difference of Body density of the girls. (Table 6)

**Table 6: Comparison of body density between school girls in 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**

w.r.t urban school girls \*\*p<0.01

**Percentage of fat:** From the table 7, represent the mean value of percentage of fat of school girls of rural and urban region in Paschim Medinipur. This result shows that the mean Percentage of fat of class V student is 20.16 (Rural) and 27.12 (Urban), class VI student is 24.92 (Rural) and 27.42 (Urban), class VII student is 21.6 (Rural) and 28.25 (Urban), class VIII student is 23.42 (Rural) and 28.66 (Urban). The result of two tail t-test shows that there was a significant difference of Percentage of fat of 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 95th percentile for the early menarcheal group, in between 75th and 85th percentiles for the ideal menarcheal group and below 25th percentile for the late menarcheal group according to a reference value of body fat indices for adolescents of Bengali ethnicity (Pramanik *et al.*, 2014). Thus, body fat percentage above 85th percentile value may be risk factor for early onset of menarche (Pramanik *et al.*, 2015). (Table 7)

**Table 7: Comparison of the percentage of fat between school girls who are in menarche stage 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	21.60±4.57	28.25±10.18	2.66**
Class VIII	23.42±3.75	28.66±6.61	3.07**

w.r.t urban school girls \*\*p<0.01

**Total Weight of Fat:** From the table 8, represent the mean value of 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 student is 6.32 (Rural) and 9.9 (Urban), class VI student is 10.5 (Rural) and 11.87 (Urban), class VII student is 7.98 (Rural) and 13.55 (Urban), class VIII student is 9.58 (Rural) and 13.36 (Urban). The result of two tail t-test shows that there was significant difference of Percentage of fat of the girls. (Table 8)

**Table 8: Comparison of the total weight of fat between school girls in 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**

w.r.t urban school girls \*p<0.05, \*\*p<0.01

**Table 9: Comparison of Lean body mass between school girls who are in menarche stage in 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

w.r.t urban school girls \*\*p<0.01

**Lean Body Mass:** From the table 9, represent the mean value of Lean body mass of school girls of rural and urban region in Paschim Medinipur. This result shows that the mean Lean body mass of class V student is 23.13(Rural) and 24.85(Urban), class VI student is 29.2 (Rural) and 29.82(Urban), class VII student is 28.32(Rural) and 31.73(Urban), class VIII student is 31.02(Rural) and 31.84 (Urban).The result of two tail t-test shows that there was significant difference of 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 rural region.The result of two tail t-test shows that there was significant difference of menarche and non-menarcheof the girls of rural region. Menarche is a vital incidence in a female 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).

**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 /m <sup>2</sup> )	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***

w. r. t non-menarche students\* <0.05, \*\*p<0.01, \*\*\*p<0.001

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

Anthropometric measurement	Menarche student	Non-Menarche student	t test
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 <sup>2</sup> )	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***

w. r. t non-menarche students \* <0.05, \*\*p<0.01, \*\*\*p<0.001

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

Anthropometric Measurement	Class				F value
	V	VI	VII	VIII	
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 /m <sup>2</sup> )	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***

\*p<0.05, \*\*p<0.01, \*\*\*p<0.001

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

Anthropometric Point	Class				F value
	V	VI	VII	VIII	
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 <sup>2</sup> )	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***

\*p&lt;0.05, \*\*p&lt;0.01, \*\*\*p&lt;0.001

Minimum age of menarche was 110 months, and 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 height than those who have a late menarche. Many evidences suggest that taller girls attain early menarche (Rana *et al.*, 1986). 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.*, 2013. Results of the study of Johnson *et al.*, 1969 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 urban region. The result of two tail t-test shows that there was significant difference of menarche and non-menarche of the girls of urban region.

**Anthropometric changes among the school going student of class V to Class 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, class VIII of 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 socio-economic 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. 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 prevalent 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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