

Association of Age at Menarche with Anthropometric Measures in Punjabi Bania Girls

PRATIBHA GOYAL¹, ZORA SINGH², GURMEET KAUR SETHI³

ABSTRACT

Introduction: Menarcheal age is the age at which menstruation begins. Menarcheal age is regarded as a sensitive indicator of physical, biological and psychological environment.

Aim: 1) To determine the menarcheal age and to examine the relationship between current age at menarche with anthropometric measures in Punjabi bania girls. 2) To develop maturity standards for Bania girls.

Materials and Methods: The present cross-sectional survey was carried out on 200 bania girls at the age of onset of menarche. Menarcheal data was obtained by status quo method by asking about whether menarche has been experienced or not. In the present survey adolescent girls were interviewed with the help of

pre-designed questionnaire. Statistical analysis was carried out in SPSS software, version 16.0. The data were analysed using descriptive statistics and one-way ANOVA. Pearson's correlation coefficient was used for correlation studies.

Results: A total of 200 Punjabi bania girls were examined in the study. The median age of onset of menarche in these girls was 12.3 years. Menarcheal age was positively associated with bi-acromial width, bi-iliac width and arm span.

Conclusion: The present research has revealed secular trend in the age of onset of menarche as indicated by median age of 12.3 years in Bania girls. The bi-acromial width, bi-iliac width and arm span were also correlated with the age of menarche.

Keywords: Arm span, Bi-acromial width, Maturity indicators

INTRODUCTION

Menarche is an important milestone in a woman's life, usually follows approximately 1 year after the growth spurt begins [1]. Age at menarche is more closely related to exogenous factors such as living conditions, nutrition, diseases, body composition, physical activity and psychological stress while age at menopause appears to be more sensitive to intrinsic parameters such as reproductive history of an individual [2]. In most of the European countries, the age at menarche is advancing over the successive generations by about 3-4 months per decade [3].

So, studies on physical growth and maturation of children are very important in understanding the nature and magnitude of human variations as they are the normal physiological processes that are essential for the well being of the human organism. Sexual maturity pertains to the maturation of gonads and development of secondary sexual characters [3]. These changes occur during adolescent period. The period when an individual matures sexually is also called pubertal period. Characteristics in girls include the development of breast, pubic hair, axillary hair and onset of menarche [3]. Based on the research work, Lee et al., suggested that increasing rates of obesity in United States of America may result in earlier average age of onset of puberty for US girls [4].

Delgado and Hurtado reported that the age at menarche is positively associated with anthropometric measures such as weight, height, arm circumference and body composition i.e., Body Mass Index (BMI) suggesting that both physical characteristics and sexual maturation are interacting processes of same phenomenon known as developmental age [5].

Gupta et al., treated adolescent girls to be the future mothers. According to them, height less than 145cm and weight less than 45 kg are considered to be high gynaecological risk factor for maternal or perinatal outcome including low birth weight [6].

There are numerous studies regarding age at menarche in India and all over the world. Age at menarche is different among various

ethnicities. The age at menarche was reported 13.25±0.08 years in Burma and 13.21±0.11 years in Assam in girls from privileged section of society [7], 13.21±1.33 years in urban areas of Markazi province of Iran [8], 11.8 years in Sri Lankan girls [9].

India has population groups having diverse life styles. Excellent opportunities for growth studies exists in India, as different population groups have contrasting nutrition, socio-economic status and a host of other conditions which influence growth and development of children. Because of the fast changing scenario in the income sources, food habits, health care facilities and type of social life people are living, it is necessary to have a baseline data on Punjabi bania girls of middle class families to find out correlation between various maturity indicators.

The parameters of growth studies have not been thoroughly explored so far for bania girls and hence, the present study was designed.

The aim of this study was to evaluate the age of menarche in Punjabi bania girls population and also to examine the relationship between current age at menarche and anthropometric measures in bania girls.

MATERIALS AND METHODS

This was a cross-sectional study conducted on 200 Punjabi bania girls. In all, 20 schools were visited. Maximum girls were measured from Sarv Hitkari Utch Vidya Mandir, Barnala. Data were collected from various schools of the Barnala, Tapa, Dhanula, Faridkot, viz, Sarvhitkari Vidya Mandir at Barnala, Amandeep Model School at Barnala, NMSD School at Barnala, YS Public School at Barnala, Baba Farid Public School at Faridkot and Sarvhitkari Utch Vidya Mandir at Sangrur etc. The data were collected in the school hours from above mentioned places and period of data collection ranged from May 2012 to Oct 2014.

A written, informed consent was obtained from all the participants and the study was approved by Institutional Ethical Committee. Each girl was given a printed preliminary consent proforma to take

home and was asked to get the consent of parents also. The girls included in the sample were born and brought up in Punjab state. The sample included 200 healthy, unmarried school going bania girls belonging to middle class families who were in their premenstrual phase of development.

Exclusion Criteria

Subjects having a history of malnutrition, anaemia or having history of menstrual disorder were excluded from the present study. Accurate date of birth of selected candidates was ascertained from school records and girls were asked to tell their date of birth accurately. From the date of birth and date of examination of the girls, age of each individual was calculated up to three decimal places according to the decimal age calendar given by Tanner [10]. The findings on the various parameters were recorded in the designated proforma. The standard techniques by Singh and Mehta were followed to study various parameters [11].

Height or Stature was measured by anthropometer rod. It is the most commonly used instrument for many of the anthropometric measurements of human body. It consists of four segments which when joined together form a rigid rod of 200cm. There is a fixed sleeve on the top of the rod. An adjustable graduated cross bar, which registers the height measurements. The subjects were asked to stand erect on a horizontal surface. Care was taken that the heels should not touch each other and slight upward pressure was applied below the mastoid process in order to help in stretching to the fullest. The head should be held so that her Frankfurt plane becomes horizontal. The anthropometric rod had been held vertically and the horizontal arm was brought down so that it touches the highest point on the head in the mid sagittal plane.

Body Weight: It was the measurement of weight without any item located on the person. Practically though, body weight was measured with clothes on, but without shoes or heavy accessories such as mobile phones and wallets. It was measured by weighing machine.

Arm Span: It measures the straight distance between two dactylia from each other, when arms were fully stretched and were parallel to the floor measured with anthropometer.

Bi-iliac Width: It measured the straight distance between the two iliac crests measured by first segment of anthropometer or rod compass.

Bi-acromial Width: It measured the straight distance between two acromia measured by first segment of anthropometer.

Based on the decimal age of the girls they were put in to year groups as per the method given by Singh et al., [3]. All girls for example, from the age group of 11.500 years to 12.499 years were put in to the group of 12-year-old and so on. In the present study 200 girls were examined who fell in the 11.500 to 15.499 years. These girl students were put into 4 groups of yearly intervals which have been shown in [Table/Fig-1].

STATISTICAL ANALYSIS

For statistical analysis of the data SPSS version 16.0, Illinois, Chicago was used. ANOVA was applied to see the significance of anthropometric measures on menarcheal age. Statistical significance was determined at $p < 0.05$. Pearson's correlation was used to see the correlation between anthropometric measurements.

RESULTS

The present study was conducted on a total sample of 200 girls. Bania girls were divided in yearly interval age groups as given in [Table/Fig-1]. The most common age group for the onset of menarche was 12 years (11.500-12.499) (55%) however, second

most common age was 13 years (12.500-13.499 years) (37%). Eight cases (4%) had their onset at the age of 14 years. Thus, we can see that majority of the bania girls experienced the onset of menarche in the age group of 12 and 13 years as shown in [Table/Fig-1]. Thus, it tells about the current age of menarche in Punjabi Bania girls.

Sr. No.	Yearly Interval Age Groups	Number of Girls in the Group	Mean Age (years)	Median Age (years)
1	11 (10.500-11.499)	8	11.18	11.13
2	12 (11.500-12.499)	110	12.01	12.07
3	13 (12.500-13.499)	74	12.87	12.80
4	14 (13.500-14.499)	8	13.80	13.50
	Total	200	12.36	12.3

[Table/Fig-1]: Year age-groups distribution (decimal age) of bania girls who experienced menarche.

The means, standard deviations and median for five anthropometric measurements (body weight, height, bi-acromial width, bi-iliac width and arm span) are presented in [Table/Fig-2].

Weight: Mean value of weight for menstruating girls was 41.08 ± 3.9 kg and median value was 40kg. Differences were statistically non significant at different ages.

Height: Mean value of height for 200 girl's was 149.67 ± 4.41 cm and median value was 150 cm. Although there is continuous increase in height with advancing age but statistically significant differences were seen at the age of 14 years when compared with height at 11 years ($p < .018$).

Bi-acromial Width and Bi-iliac Width: Slight increase in bi acromial width was seen but statistically significant differences were seen when bi-acromial width at the age of 12 years was compared with 13 and 14 years. Similarly differences in biiliac width were statistically significant at different ages. In our study, mean bi acromial width for 200 girls' was 32.05cm and median value was 32 cm.

Arm Span: Continuous increase in arm span is seen with advancing age of menarche. Differences were found to be statistically significant when arm span at 14 years was compared with arm span at 11 years as indicated by p-value (.008).

A total of 200 cases were studied and ANOVA was applied for different parameters such as body weight, height, bi acromial width, bi-iliac width, arm span and chronological age (menarcheal age) presented in [Table/Fig-3].

Correlation of bi-acromial width, bi-iliac width, arm span was found to be highly significant with chronological age, whereas, correlation of chronological age and height was significant [Table/Fig-4].

DISCUSSION

Age at Menarche

In the present study, the median age for menarche was 12.3 years. This is in close agreement with ages as reported by earlier studies [12,13]. They found the median age at menarche to be 12.88 ± 0.72 years and 12.8 years in upper socio-economic status respectively. Thus, this population based study on bania girls demonstrates a trend over time of decreasing age at menarche from 12.8 to 12.3 in the past 15 years when compared with earlier study on bania girls [12].

The possible cause of earlier maturation in bania girls as compared to other Indian girls probably due to the fact that, bania girls of middle socio-economic status had their sedentary life style and non-involvement in strenuous physical activities.

Menarche is delayed in rural areas than urban areas as these girls are exposed to strenuous physical activity [14]. Similar findings were also reported by Sharma and Shukla, Sidhu and Grewal, Ajita and

Anthropometric measurements\	Menarcheal Age	Year age Groups	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.	Median
						Lower Bound	Upper Bound			
Body Weight (kg)	11 yrs	8	43.99	4.16	1.47	40.51	47.46	38.0	50.0	45
	12 yrs	110	41.22	4.08	0.39	40.45	41.99	32.0	63.0	40.25
	13 yrs	74	40.59	3.63	0.42	39.75	41.43	35.0	56.6	40
	14 yrs	8	40.94	2.53	0.89	38.82	43.05	36.5	45.0	41.25
	Total	200	41.09	3.90	0.28	40.54	41.63	32.0	63.0	40
Height (cms)	11 yrs	8	146.66	8.73	3.09	139.37	153.96	127.0	155.0	149.15
	12 yrs	110	149.46	3.94	0.38	148.72	150.21	139.4	159.0	150
	13 yrs	74	149.94	4.24	0.49	148.96	150.92	140.0	162.0	150
	14 yrs	8	153.19	4.67	1.65	149.29	157.09	144.1	160.0	152.90
	Total	200	149.67	4.41	0.31	149.06	150.29	127.0	162.0	150
Bicromial Width (cms)	11 yrs	8	31.55	1.47	0.52	30.32	32.78	30	34	31.80
	12 yrs	110	31.73	1.69	0.16	31.41	32.05	29	42	32
	13 yrs	74	32.43	1.78	0.21	32.02	32.84	29	40	32.04
	14 yrs	8	33.53	1.18	0.42	32.54	34.51	32	36	33.10
	Total	200	32.05	1.75	0.12	31.81	32.30	29	42	32
Bi-iliac Width (cms)	11 yrs	8	24.35	2.01	0.71	22.67	26.03	22	26	25.30
	12 yrs	110	24.31	1.67	0.16	24.00	24.63	21	28	24.21
	13 yrs	74	24.90	1.96	0.23	24.44	25.35	21	32	24.75
	14 yrs	8	25.73	1.88	0.67	24.16	27.29	24	30	25.15
	Total	200	24.59	1.83	0.13	24.33	24.84	21	32	24.50
Arm Span (cms)	11 yrs	8	145.79	9.25	3.27	138.05	153.52	127.0	155.0	149.15
	12 yrs	110	149.23	4.27	0.41	148.42	150.03	131.0	159.0	150
	13 yrs	74	150.03	4.07	0.47	149.09	150.98	140.0	162.0	150
	14 yrs	8	153.09	4.68	1.66	149.17	157.01	144.1	160.0	152.90
	Total	200	149.54	4.59	0.32	148.90	150.18	127.0	162.0	150

[Table/Fig-2]: Mean±S.D. and median for five anthropometric measurements of bania girls.

		Sum of Squares	Df	Mean Square	F	Sig.
Body Weight	Between Groups	87.992	3	29.331	1.955	0.122
	Within Groups	2940.676	196	15.003		
	Total	3028.668	199			
Height	Between Groups	181.594	3	60.531	3.214	0.024
	Within Groups	3690.844	196	18.831		
	Total	3872.439	199			
Bi-cromial Width	Between Groups	41.314	3	13.771	4.756	0.003
	Within Groups	567.521	196	2.896		
	Total	608.835	199			
Bi-iliac Width	Between Groups	26.199	3	8.733	2.690	0.048
	Within Groups	636.242	196	3.246		
	Total	662.441	199			
Arm Span	Between Groups	242.372	3	80.791	4.006	0.009
	Within Groups	3952.538	196	20.166		
	Total	4194.910	199			

[Table/Fig-3]: ANOVA showing comparisons of anthropometric measurements at different age groups.

Jiwanjot, Mathur and Torila, who found delay in menarcheal age of physically active girls than those who are not involved in any kind of physical stress [15-18]. [Table/Fig-5] shows the comparison of menarcheal age among different populations in India [19-31], whereas, [Table/Fig-6] shows menarche in foreign girls [32-40].

The median age of menarche in bania girls from Punjab was 12.3 years, significantly less than other endogamous groups of Punjabi girls as well as from other Indian girls. This might be due to their genetic background and nutritional status responsible for lower age of menarche.

Relationship between Menarcheal Age and Anthropometric Measures

In our study, mean weight at the onset of menarche was nearly same irrespective of the age except at the age of 11 years when girls were found to be overweight that might be related with earlier onset of menarche. In 1971, Frisch and Revelle put forth the

		Chronological Age
Body weight	Pearson Correlation	-0.073
	Sig. (2-tailed)	0.306
	N	200
Height	Pearson Correlation	0.170*
	Sig. (2-tailed)	0.016
	N	200
Bi-cromial Width	Pearson Correlation	0.310**
	Sig. (2-tailed)	0.000
	N	200
Bi-iliac Width	Pearson Correlation	0.252**
	Sig. (2-tailed)	0.000
	N	200
Arm Span	Pearson Correlation	0.198**
	Sig. (2-tailed)	0.005
	N	200

[Table/Fig-4]: Correlation of chronological age (menarcheal age) with five anthropometric measurements.

hypothesis "critical weight triggers menarche" [41]. Role of critical weight triggering menarche have been criticized by Cameron [42].

Mean values of weight for menstruating Brahmin girls of urban areas of Madhya Pradesh at the age of 12 years and 13 years were 30.4kg and 31.4kg respectively [43]. Thus, we found that bania girls were heavier than Brahmin girls at similar ages.

When heights and weights of bania girls are compared with Indian girls from well off families, bania girls were found to be lighter and shorter at all ages except at the age of 11 years when they were found to be heavier and taller as compared to other Indian girls [44] [Table/Fig-7,8].

A cross-sectional study by Garn et al., showed negative associations of both weight and BMI with age at menarche [45]. Okasha et al., also had similar findings but they showed positive association of age at menarche with height contrary to our findings in which menarcheal age showed positive association with bi-acromial width, bi-iliac width and arm span [46].

Authors	Year of Study	Caste/Place	Mean Age (years)	Median Age
Ghosh, Kochhar and Khanna [19]	1972	Poona girls	13.2±0.06	
Agarwal et al., [20]	1974	Varanasi and Ramnagar	12 years	
Kaul et al., [21]	1983	Jabalpur girls	13.57 years.	
Singh et al., [22]	1986	Agra girls	13.4 years	
Subba Rao [23]	1996	Viswa Brahmins	12.76 years	
Vaidya et al., [24]	1998	Mumbai girls	12.0 years	
Kaur and Singh [25]	1999	Punjabi girls	12.62 years	
Sidhu [26]	2002	Sikh Harijan Hindu Harijan	-----	11.88±1.16 12.23±1.43
Khanna and Kapoor [27]	2004	Punjabi arora girls	12.87 years	
Das gupta and Sarkar [28]	2008	Adolescent girls	12.8 years	
Rokade and Mane [29]	2009	Maharashtrian girls	12.62±1.05 years	
Prakash et al., [30]	2010	Uttarakhand girls	13.6±1.1 years	
Kaur, Mehta and Kaur [31]	2015	Punjabi adolescent girls	13±1.2 years	
Present study	2016	Punjabi bania girls	12.36	12.30

[Table/Fig-5]: Comparative table showing the age of menarche in Indian girls [19-31].

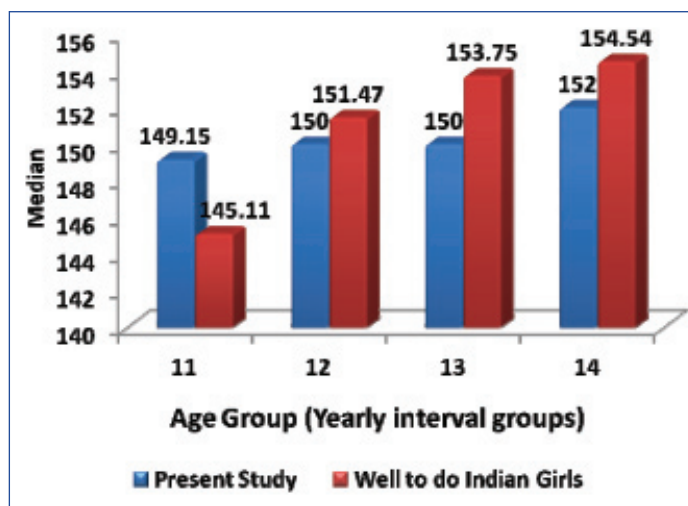
Authors	Year of Study	Caste/Place	Mean Age (years)	Median Age
Dacou-Voutetakis et al., [32]	1983	Greek girls	12.58±0.07 years	
Hosny et al., [33]	2005	Egyptian girls	12.44 years	
Fredriks et al., [34]	2003	Turkish girls living in Netherlands	12.8	
Semiz et al., [35]	2008	Turkish girls	13.4 years	14.8 years
Zegeye, Megabiaw and Mulu [36]	2009	North west Ethiopia		14.8 years
Asgharnia et al., [37]	2009	Northern Iran	12.99±1.33	
Bau et al., [38]	2009	Berlin girls	12.8	12.8 Years
Chumlea et al., [39]	2003	US girls	13.6±1.1 years	12.43
Al-Sahab et al., [40]	2010	Canadian girls	12.72	12.67
Our study	2016	Bania girls	12.3	12.3

[Table/Fig-6]: Comparative table showing the age of menarche in foreign girls [32-40].

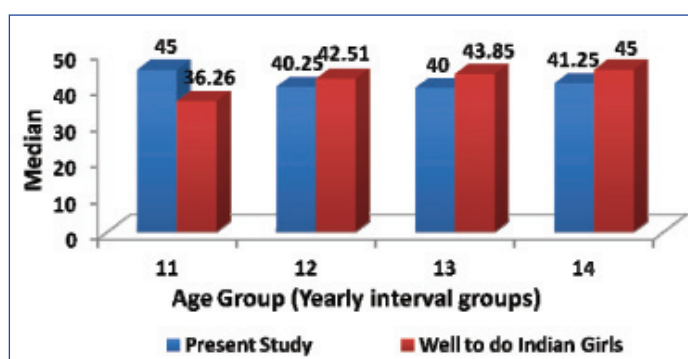
A recent survey by Gopalakrishna et al., showed no significant correlation between age at menarche and BMI and between waist-hip ratio and menarche too [47].

Bi-iliac width of Bengalee girls was 23.45cm, 24.56cm and 25.06cm for ages 12, 13, 14 years respectively. Bi-acromial diameter of Bengalee girls at the age of 12, 13, 14 years was 31.38, 32.42 and 32.94cm respectively. These values are nearly similar to our study. Thus, shoulder width and hip width is same in both Bengalee and Punjabi bania girls [48].

A recent survey by Mittal et al., on bania girls from Punjab indicated mean values of anthropometric measurements (weight, height, bi acromial width and bi-iliac width) are much higher than mean values of bania girls from Delhi [49]. In our study, correlation coefficient between height and arm span was found to be highly significant with p-value < 0.001. A clear association exists between arm-span measurements and height in all groups. However, arm-span was found to be significantly different from height in two ethnic groups, the Afro-Caribbean's of both sexes and Asian males [50]. Thus, arm-span measurements may be an inappropriate proxy for height in certain populations whereas, Sathyavathi et al., revealed in their



[Table/Fig-7]: Comparison of height of bania girls with well to do Indian girls [44].



[Table/Fig-8]: Comparison of weight of bania girls with well to do Indian girls [44].

findings that both rural and urban girls demonstrated either equal or more values for arm span than boys [51].

Qamra, et al., revealed in their findings that menarche is achieved after attaining a minimum weight of 35kg, height 143cm and bi-iliac diameter of 24cm which are nearly similar with minimum values of height (127cm), weight (32kg) and biiliac diameter (21cm) in our study [52].

LIMITATION

In the present study, we had studied only schools so uneducated girls were missed completely, so in future we will recommend where these girls will be included. A further limitation of the study was its cross-sectional character. An urgent need for longitudinal study in Punjabi bania girls is felt as none has been done on this aspect.

CONCLUSION

Our data provides reference values for bania population. Menarcheal age was found to be positively associated with bi-acromial width, bi-iliac width and arm span. The median age of menarche in the present sample of bania girls was 12.3 years which is much earlier than the findings indicated by earlier studies conducted in Punjab. Thus, present study also supports the secular trend in the age of onset of menarche.

REFERENCES

- [1] Hada R, Shete S, Hamid M. Study to determine the menarcheal age of school going girls at Jhalawar district, Rajasthan. *International Journal of Medical Science and Public Health*. 2014;3(9):1115-19.
- [2] Thomas F, Renaud FO, Benefice E, Dee Meeus T, Guegan JFO. International variability of ages at menarche and menopause: patterns and main determinants. *Hum Biol*. 2001;73(2):271-90.
- [3] Singh SP, Sidhu LS, Singh J. Skeletal Maturity: Growth, Development and Physical Performance. Human Biology Publication Society, Punjabi University Patiala (PB). 1992:1-124.
- [4] Lee JM, Appugliese D, Kaciroti N, Corwyn RF, Bradley RH, Lumeng JC. Weight status in young girls and onset of puberty. *Pediatrics*. 2007;119(3):624-30.

- [5] Delgado HL, Hurtado E. Physical growth and menarche in Guatemalan adolescents. *Lanoam Nutr.* 1990;40(4):503-17.
- [6] Gupta N, Singh MP, Dhillon BS, Saxena NC. Preparing for adulthood patterns of physical growth, sexual maturity and menarche of adolescent girls in selected urban slums and rural areas. *J Ind Med Assoc.* 2007;105(4):230.
- [7] C.V. Foll. The age at menarche in Assam and Burma. *Arch Dis Child.* 1961;36(187):302-04.
- [8] Bayat P, Khazaei M, Ghorbani R, Amiri S. Age at menarche and related factors in girls of urban areas of Markazi (central) province of Iran. *Int J Morphol.* 2012;30(1):15-18.
- [9] Godawatta R, Wikramanayake TW. Some factors influencing the age at menarche of Sri Lankans. *Ceylon J Med. Sci.* 1988;31(2):53-69.
- [10] Tanner JM. *Foetus in to Man.* Harvard University Press Cambridge. 1978: 1-271.
- [11] Singh SP, Mehta P. *Human Body Measurements: Concepts and Applications.* Prentice Hall of India Pvt. Limited. 2009; 1-25
- [12] Talvar I, Kaur M. Growth pattern and age at menarche in Bania girls of Mandi Gobindgarh. *Anthropologist.* 1999;1(3):175-78.
- [13] Qamra SR, Mehta S, Deodhar SD A mixed longitudinal study on the pattern of pubertal growth: Relationship to socio-economic status and calorie intake –IV. *Ind Pediatr.* 1991;28:147-56.
- [14] Mokha R, Kaur AI, Kaur N. Age at menarche in urban-rural Punjabi Jat Sikh girls. *Anthropologist.* 2006;8(3):207-09.
- [15] Sharma SS, Shukla NB. Menarcheal age among Indian sportswomen. *Br J Sports Med.* 1991;26(2):129-31.
- [16] Sidhu LS, Grewal R. Age of menarche in various categories of Indian sports women. *Brit J Sports Med.* 1980;14(4):199-203.
- [17] Ajita A, Jiwanjot J. Overweight and physical activity as a measure of age at menarche in females. *American Journal of Sports Science and Medicine.* 2014;2(1):32-34.
- [18] Mathur DN, Toriola AL. Age at menarche in Nigerian athletes. *Brit J Sports Med.* 1982;16(4):250-52.
- [19] Ghosh D, Kochhar K, Khanna SD. The study of puberty and after in 557 school girls at Poona. *Journal of Obstetrics and Gynaecology of India.* 1972:716-723.
- [20] Agarwal KN, Sen S, Tripathi AM, Katiyar GP. Physical growth characteristics in relation to sexual growth. *Indian Pediatrics.* 1974;X(2):99-105.
- [21] Kaul KK, Mukerjee B, Sundaram KR, Sawhney KS, Parekh. A study of the development of secondary sex characters in Urban girls. *Indian Pediatr.* 1983;20:243-48.
- [22] Singh S, Kapoor N, Sarkar B, Pandey DN. A study of the development of secondary sex characters in urban girls. *J of Obstet and Gynaecol Ind.* 1986: 278-282.
- [23] Subba Rao I. A population genetic study of the Viswa Brahmins. PhD Thesis, Andhra University. 1996
- [24] Vaidya RA, Shringi MS, Bhatt MA, Gajjar M, Joshi JV, Galvankar P, et al. Menstrual pattern and growth of school girls in Mumbai. *The Journal of Family Welfare.* 1998;44(1):66-74.
- [25] Kaur R, Singh SP. Secular shift in age at menarche in Patiala women. *Anthropologist.* 1999;1(3):183-88.
- [26] Sidhu S. Age at menarche among scheduled caste girls of Punjab. *J Hum Ecol.* 2002;3(4):327-28.
- [27] Khanna G, Kapoor S. Secular trend in stature and age at menarche among Punjabi aroras residing in New Delhi. *India Coll. Antropol.* 2004;28(2):571-75.
- [28] Dasgupta A, Sarkar M. Menstrual hygiene: How hygienic is the adolescent girl. *Indian J Community Medicine.* 2008;33(2):77-80
- [29] Rokade SA, Mane AK. A study of age at menarche, the secular trend and factors associated with it. *The Internet Journal of Biological Anthropology.* 2009;3(2):
- [30] Prakash C, Srivastava B, Gaur S, Bala R, Rai A, Roham. Age of menarche in girls of Uttarakhand. *J Indian Acad Forensic Med.* 2010;32(1):49-51.
- [31] Kaur R, Mehta P, Kaur G. Growth status and menarcheal age among adolescent schoolgirls of Punjab. *International Journal of Recent Scientific Research.* 2015;6(7):5150-53.
- [32] Dacou-Voutetakis CD, Klontza D, Lagos P, Tzonou A, Katsarou E, Antoniadis S, et al. Age of pubertal stages including menarche in Greek girls. *Ann Hum Biol.* 1983;10(6):557-63.
- [33] Hosny LA, El-Ruby MO, Zaki ME, Aglan MS, Zaki MS, Gammal IMAE, et al. Assessment of pubertal development in Egyptian girls. *Journal of Pediatric Endocrinology and Metabolism.* 2005;18(6):577-84.
- [34] Fredriks AM, Buuren SV, Jeurissen SER, Dekker FW, Verloove-vanhorick SP, Wit JM. Height, Weight, Body mass index and pubertal development reference values for children of Turkish origin in Netherlands. *Eu J Pediatr.* 2003;162:788-93.
- [35] Semiz S, Kurt F, Kurt DT, Zencir M, Sevinc O. Pubertal development of Turkish children. *Journal of Pediatric Endocrinology and Metabolism.* 2008;21(10):951-61.
- [36] Zegeye DT, Megabiaw B, Mulu A. Age at menarche and the menstrual pattern of secondary school adolescents in Northwest Ethiopia. *BMC Women's Health.* 2009;9(29):1-8.
- [37] Asgharnia M, Faraji R, Sharami H, Yadak M, Oudi M. A study of menarcheal age in Northern Iran (Rasht). *Oman Medical Journal.* 2009;24(2):95-98.
- [38] Bau AM, Ernert A, Schenk, Wiegand S, Martus P, Gruters, et al. Is there a future acceleration in the age at onset of menarche? A cross-sectional study in 1840 school children focusing on age and body weight at the onset of menarche. *European Journal of Endocrinology.* 2009;160(1):107-13.
- [39] Chumlea WC, Schubert CM, Roche AF, Kulin HE, Lee PA, Himes JH, et al. Age at menarche and racial comparisons in US girls *Pediatrics.* 2003;111(1):110-13.
- [40] Al-Sahab B, Arden CI, Hamadeh MJ, Tamim H. Age at menarche in Canada: results from the national longitudinal survey of children and youth. *BMC Public Health.* 2010;28(10):736.
- [41] Frisch RE, Revelle R. Height and weight at menarche and a hypothesis of menarche. *Arch Dis Child.* 1971;46:695-701.
- [42] Cameron N. Weight and skin fold variation at menarche and the critical body weight hypothesis. *Ann Hum Biol.* 1976;3(3):279-82
- [43] Adak DK, Tiwari MK, Randhawa M, Bharati S, Bharati P. Pattern of adolescent growth among the Brahmin girls-Rural urban variation. *Coll. Antropol.* 2002;26(2):501-07.
- [44] Vijaya Raghavan K, Singh D, Swaminathan MC. Heights and weights of well nourished Indian school children. *Indian J Med Res.* 1971;59(4):648-54.
- [45] Garn S, Lavelle M, Rosenberg K, Hawthorne V. Maturational timing as a factor in female fatness and obesity. *Am J Clin Nutr.* 1986;43(6):879-83.
- [46] Okasha M, McCarron P, McEwen J, Smith GD. Age at menarche: secular trends and association with adult anthropometric measures. *Ann Hum Biol.* 2001;28(1):68-78.
- [47] Gopalakrishna PK, Purushothaman S, Reghunath S, Pushkar B, King KI. Association of age at menarche with body mass index and waist-hip ratio. *Int J Med Sci Public Health.* 2016;5:1631-34.
- [48] Sen T. Growth and development of Bengalee girls. *Anthropological Survey of India.* 1988:1-125.
- [49] Mittal P, Chahal SMS, Nath S, Singh S. Assessment of growth patterns of the bania girls of Delhi and Punjab. *Journal Punjab Academy of Sciences.* 2015;13&14(1&2):65-68.
- [50] Reeves SL, Varakamin C, Henry CJ. The relationship between arm-span measurement and height with special reference to gender and ethnicity. *Eur J Clin Nutr.* 1996;50(6):398-400.
- [51] Sathyavathi K, Agarwal KN, Rao NSN, Reddy PR. Arm span and height measurement during adolescence. *Indian Pediatr.* 1979;XVI(10):839-47.
- [52] Qamra SR, Mehta S, Deodhar SD. A study of relation between physical growth and sexual maturity in girls-V. *Indian Paediatr.* 1991;28(3):265-72.

PARTICULARS OF CONTRIBUTORS:

1. Lecturer, Department of Anatomy, Guru Nanak Dev Dental College and Research institute, Sunam, Punjab, India.
2. Professor and Head, Department of Anatomy, Dashmesh Institute of Research and Dental Sciences, Faridkot, Punjab, India.
3. Professor and Head, Department of Paediatrics and Principal, G. G. S. Medical College, Faridkot, Punjab, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Pratibha Goyal,
Lecturer, Department of Anatomy, Guru Nanak Dev Dental College and Research institute, Sunam -148028, Punjab, India.
E-mail: goyalz.rajat1984@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Jun 21, 2016**

Date of Peer Review: **Jul 25, 2016**

Date of Acceptance: **Sep 07, 2016**

Date of Publishing: **Nov 01, 2016**