A STUDY OF ANTHROPOMETRIC AND SOCIO-ECONOMIC FACTORS ASSOCIATED WITH DELAYED MENARCHE IN A BENGALI INDIAN POPULATION WITH SPECIAL REFERENCE TO BMI AND 2D:4D RATIO

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"Factors affecting delayed onset of menarche has been a field of intense scientific research over the last few decades. The role of 2D:4D ratio in influencing delayed menarche adds an unprecedented dimension to existing knowledge in this field."

ABSTRACT

Introduction: The average age of menarche has declined over the last century but the magnitude of the decline and the factors responsible remain subjects of contention.

Aims and Objectives:

1. To study a group with delayed menarche in a cohort of Bengali Indian females with low to normal body weight.
2. To investigate anthropometric characteristics (height, mid-parental height,weight, BMI), Socio-economic Status, Sexual Maturity Rating (SMR) stages and 2D: 4D ratio (ratio of lengths of second and fourth digits of both hands) in those with delayed menarche.
3. To analyse the correlation of these factors with delayed age of menarche.

Materials and Methods: A total of 614 children , aged 11- 16 completed years, of low to middle income family groups and attending suburban schools, were evaluated on the basis of predetermined questionnaire and anthropometric measurements.

Correlation of factors with delayed age of menarche was done by appropriate statistical methods

Results and Analysis: Out of 190 children having delayed menarche (cases) and 424 children with normal age of menarche (controls) , the height percentile (p value: 0.642), BMI (p value: 0.091), weight (p value: 0.12)and Mid-Parental Height (p value: 0.26) had no significant correlation , while SMR (p value:0.00), 2D:4D ratio (p value:0.002) and low Socio-economic Status (p value: 0.00) had a significant correlation with delayed menarche.

Conclusion: This study is the first to examine such a wide variety of anthropometric and socio-economic factors at a time in a single cohort of females with delayed menarche.

Keywords: Menarche, anthropometric, socio-economic, 2D:4D ratio, SMR, BMI

INTRODUCTION

Menarche is the first menstrual cycle, or first menstrual bleeding, in female human beings. From both social and medical perspectives it is often considered the central event of female puberty, as it signals the possibility of fertility. Various factors have been postulated to affect the age at menarche like the socioeconomic status, diet, exercise, environment, family history, religion, genetic and hereditary factors, ethnicity, psychological stress, migration and chronic illnesses with opinions both supporting and rejecting it[1]. The average age of menarche has declined over the last century but the magnitude of the decline and the factors responsible remain subjects of contemption. Menarche occurs earlier than it once did in many parts of the world especially in Europe and North America [2,3,4]. This was attributed to better socioeconomic status and improved health & nutrition. This decline is expected in Indian girls considering the economic development of the country in past few decades. As the industrialization and hence the wealth is concentrated more in urban areas than the rural ones, its impact on the girls residing in urban areas is likely to be prompt.

The present study analyzes the demographic profile of a cohort of Bengali Indian females with delayed age of onset of menarche. A further attempt is made to evaluate the role of various anthropometric factors in influencing the delayed onset of menarche in the study population.

Aims and Objectives:

The study was conducted with a view:

1) To study a group with a delayed menarche in a cohort of Bengali Indian females with low to normal body weight.
2) To investigate weight, BMI ,anthropometric characteristics (height, mid-parental height, weight, BMI) and Socio-economic Status in those with delayed menarche and analyse the correlation of these factors with delayed age of menarche.
3. To investigate SMR stages and 2D: 4D ratio (ratio of lengths of second and fourth digits of both hands) in those with delayed menarche and analyse the correlation of these factors

MATERIALS AND METHODS

A questionnaire enquiring of the presence or absence of the first menstrual cycles was circulated to females between ages 11- 16 completed years in suburban schools attended by children of low to middle income family groups. A total of 600 children were targeted assuming a population incidence of 5% with delayed menarche. This would identify a cohort of 30 females with delayed onset of menarche (cases). Of the rest with normally timed menarche, every 6^{th} female was included in the study as controls.

In the study cases and controls, the following factors were assessed in association with the timing of menarche:

1. Height, mid parental height (by stadiometer), weight (by seca beam balance), BMI.
2. Length of 2^{nd} and 4^{th} digits and their ratio in both hands (2D: 4D ratio).
3. Family history of delayed menarche and possible constitutional delay of growth and puberty.
4. Maternal age at menarche by recall
5. History of maternal gestational diabetes and smoking in pregnancy, if any.
6. Stages of puberty (SMR) in the cases only.
7. Assessment of nutritional intake (study cases only).
8. Assessment of socioeconomic status.
9. Age recorded by decimal in years.

Statistical Methods:

Categorical variables are expressed as Number of patients and percentage of patients and compared across the 2 groups using Chi Square test for Independence of Attributes. Continuous variables have been converted to groups or percentile and are also expressed as Number of patients and percentage of patients and compared across the 2 groups using Chi Square test for Independence of Attributes. Age of menarche across the groups has been compared using ANOVA test. The statistical software SPSS version 16 has been used for the analysis. An alpha level of 5% has been taken, i.e. if any p value is less than 0.05 it has been considered as significant.

RESULTS

In this study, a total of 614 children were incorporated, out of which 190 children having delayed menarche were taken as cases and 424 children as controls, according to the inclusion criteria. The controls were designated as **"Attained menarche"**and the cases were designated as **"Delayed menarche".** These two groups were subsequently compared.

Demographic Profile Analysis:

Descriptive Profile in the Study Population:

The Table below shows the descriptive profile of the 'Attained Menarche" group (controls) and the "Delayed Menarche" group (cases) **(Table 1).**

The mean age in the attained menarche group (Group1) was 14.38 years + 1.66 years (max=16.90 yrs, min= 11.20yrs). The mean BMI was 18.6 kg/m^2 + 4.1 kg/m^2 (max=34.5 kg/m^2, min=9.7 kg/m^2) .Mean height in this group was 150.43cm + 7.92cm (max=197.50cm, min= 119.50cm), while mean weight was 41.98 kg + 10.92 kg (max=91kg, min= 19.5kg).

The mean age in the delayed menarche group (Group 2) was 15.71 years + 0.89 years (max= 16.90yrs, min= 14.10 yrs). The mean BMI of this group was 19.47 kg/m^2+ 3.36kg/m^2 (max= 32.45kg/m^2, min= 14.01kg/m^2). Thus BMI in the delayed menarche group is normal. Mean height in the delayed menarche group was 151.35cm$\pm$ 5.63cm(max=165.20cm,min=137.0cm) while mean weight was 43.65kg $\pm$ 9.20kg (max=68kg, min= 13kg).

Age of menarche in cases and controls:

The mean age of attainment of menarche according to different age groups in the controls as well

as the in the cases is shown in the table below: **(Table 2).**

The mean age of attainment of menarche across all age groups in the controls was 11.56 yrs $\pm$ 0.726 yrs. The mean age of attainment of menarche across all age groups in the cases was 15.61 yrs $\pm$ 0.89 yrs.

Evaluation of factors influencing delayed onset of menarche:

We further investigated the parameters of height, mid-parental height, weight, BMI, 2D:4D ratio (ratio of the length of 2^{nd} and 4^{th} digit in both hands)and Socio-Economic Status(SES) in the group with delayed menarche (cases) and analysed the correlation of these factors with delayed age of onset of menarche in this group.

The findings are depicted in the table below: **(Table 3)**

This table shows height percentile had no significant relation with the age of menarche (p value >0.05). The weight (in kgs) did not have any significant correlation with the age of onset of menarche (p value- 0.12), and neither was the BMI(kg/m^2) significantly associated (p value-0.09). The mid-parental height also failed to show any significant correlation with the age of menarche.in the case group (p value- 0.26).

On the contrary, SMR stages, 2D:4D ratio and age (age at inclusion in the study) were all significantly related (p value<0.05 for all three parameters) with the age of onset of menarche in the case group.

Table 1: Descriptive profile in 'Attained Menarche" group (controls) and the "Delayed Menarche" group (cases)

DESCRIPTIVE STATISTICS IN CASE AND CONTROL GROUPS						
GROUP	PARAMETERS	N	Minimum	Maximum	Mean	Std. Deviation
Attained Menarche	AGE(years)	424	11.20	16.90	14.38	1.66
	HEIGHT (cm)	424	119.50	197.50	150.43	7.92
	BMI(kg/m^2)	424	9.73	58020.00	155.42	2816.80
	WEIGHT (kg)	424	19.50	91.00	41.98	10.92
	2D (cms)	424	3.00	9.50	6.82	0.64
	4D(cms)	424	2.50	9.00	7.01	0.68
	MPH (cms)	424	140.00	179.00	163.28	5.27
Delayed Menarche	AGE(years)	190	14.10	16.90	15.71	0.89
	HEIGHT (cm)	190	137.00	165.20	151.35	5.63
	BMI(kg/m^2)	190	14.01	32.45	19.47	3.36
	WEIGHT (kg)	190	13.00	68.00	43.65	9.20
	2D (cms)	190	6.00	8.70	6.97	0.45
	4D (cms)	190	5.00	8.90	7.25	0.50
	MPH (cms)	190	147.90	174.00	164.94	3.86

Table 2: Mean age of attainment of menarche in cases and controls

GROUP	AGE GROUPS (yrs)	MEAN AGE OF MENARCHE (yrs)	STD. DEVIATION
Attained Menarche	12 - < 13	11.73	.896
	13 - < 14	11.58	.524
	14 - < 15	11.51	.801
	15 - < 16	11.44	.769
	16 - < 17	11.61	.730
	Total	11.56	.726
GROUP	AGE GROUPS (yrs)	MEAN AGE OF MENARCHE (yrs)	STD. DEVIATION
Delayed Menarche	14 - < 15	14.44	.207
	15 - < 16	15.44	.245
	16 - < 17	16.40	.238
	Total	15.61	.890

Table 3: Correlation of factors affecting delayed age of menarche

GROUP	PARAMETER	AGE OF MENARCHE(YEARS)	STD. DEVIATION	p Value	SIGNIFICANCE
	Height percentile groups	**Mean**	**Std. Deviation**	**p Value**	**Significance**
Delayed Menarche	<5	15.68	.832	0.640	Not Significant
	5-50	15.57	.931		
	50-95	15.40	1.155		
	Total	15.61	.890		
	BMI percentile	**Mean**	**Std. Deviation**	**p Value**	**Significance**
Delayed Menarche	<5	15.21	.967	0.091	Not Significant
	5-84	15.67	.868		
	85-95	16.00	.424		
	Total	15.61	.890		
	SMR stages	**Mean**	**Std. Deviation**	**p Value**	**Significance**
Delayed Menarche	1	14.70	.535	**0.000**	**Significant**
	2	15.04	.976		
	3	14.43	.219		
	4	15.77	.935		
	5	15.97	.628		
	Total	15.61	.890		
	2D:4D	**Mean**	**Std. Deviation**	**p Value**	**Significance**
Delayed Menarche	2D>4D	15.10	1.017	**0.002**	**Significant**
	2D<4D	15.69	.848		
	Total	15.61	.890		
	Age at inclusion (years)	**Mean**	**Std. Deviation**	**p Value**	**Significance**
Delayed Menarche	14 - < 15	14.44	.207	**0.000**	**Significant**
	15 - < 16	15.44	.245		
	16 - < 17	16.40	.238		
	Total	15.61	.890		
GR	**Weight percentile**	**Mean**	**Std. Deviation**	**p Value**	**Significance**
Delayed Menarche	<5	15.81	.721	0.120	Not Significant
	5-50	15.47	.960		
	50-95	15.64	.937		
	>95	15.30	.001		
	Total	15.61	.890		
Delayed Menarche	**Mid-Parental height**	**15.61**	**.890**	**0.26**	**Not Significant**

Table 4: Correlation of Socio-Economic Status with delayed age of menarche.

PARAMETER		GR		Total	p Value	Significance
		Attained Menarche	Delayed Menarche			
SOCIO-ECONOMIC STATUS (SES)	Low	102	27	129	0.001	Significant
		24.1%	14.2%	21.0%		
	Lower-Middle	50	13	63		
		11.8%	6.8%	10.3%		
	Upper-lower	272	150	422		
		64.2%	78.9%	68.7%		
Total		424	190	614		
		100.0%	100.0%	100.0%		

The findings are depicted in the table below: **(Table 3)**

This table shows height percentile had no significant relation with the age of menarche (p value >0.05). The weight (in kgs) did not have any significant correlation with the age of onset of menarche (p value- 0.12), and neither was the BMI(kg/m^2) significantly associated (p value-0.09). The mid-parental height also failed to show any significant correlation with the age of menarche.in the case group (p value- 0.26).

On the contrary, SMR stages, 2D:4D ratio and age (age at inclusion in the study) were all significantly related (p value<0.05 for all three parameters) with the age of onset of menarche in the case group.

Low socio-economic status also had a significant correlation (p value-0.001) with delayed age of menarche as shown in the table below: **(Table 4)**

The results thus show that SMR stages, 2D:4D ratio , age at inclusion and low socio-economic status had a significant correlation with delayed age of onset of menarche, whereas height percentile, weight, BMI and mid-parental height had no significant relation with delayed onset of menarche.

DICUSSIONS

In this study, age at menarche in Bengali girls(mean 11.56 years)was somewhat lower than affluent Indian girls(mean age 12.6 years)[5].The decrease in menarcheal age is likely to due to the variability in methods of recording but also may reflect a secular downward trend over a decade. Study undertaken by the Indian Council of Medical Research (ICMR 1972) reported the mean menarcheal age for Maharashtrian girls as 13 years and 9 months. Kundalkar (1981) reported it to be 13 years and 2 months, and the present study maintains the same trend showing a still lowering of age at menarche. From 1962 to 1991, in three decades, the age at menarche in Maharashtrian girls has lowered by about two years. In Hungary, too, the median menarcheal age as reported by national surveys of 1959-61 has decreased at a rate of 2.6 months per decade by linear regression as of 1998[4]. This however needs confirmation in a larger population .

Our study did not reveal a significant relation with menarcheal age.BMI is age dependent in adolescence and menarche is dependent on the stage of puberty.

The results did not suggest that BMI at menarche was significantly associated with age at menarche.This is in keeping with the results of the FELS longitudinal study,which examined a six 10-year birth cohorts and concluded that population shifts in BMI and the timing of menarche are largely independent[6]. However, results in the present study are in contradiction with that of certain large studies, albeit in a different population,which found an inverse correlation with BMI. However the latter observations were retrospective in nature and therefore unlikely to represent truly the BMI at the time of menarche. As BMI increases through adolescence [7,8] it would be incorrect assumption to extrapolate BMI data in adult life back to the time of menarche. The group of children of delayed menarche had normal BMI with a maximum of 3.4SD. It is possible that the inclusion of heavier girls would have altered the present findings. However it would be unrealistic to expect BMI values in Bengali population to be similar to western standards[7].Although a reasonable tool to estimate adiposity in the community [9], it is only a ratio and therefore an abstract index. Nevertheless BMI SD as a surrogate marker of body fat is a more refined method than simple weight measurement, which is liable to be influenced by stature.

In our cohort we could not find any relation with the age of menarche and Mid-Parental Height (MPH). However, our study relied on reported rather than measured parental heights. It has been suggested that adults tend to overestimate their height (and underestimate their weight), although a recent British study found the average bias to be less than 1 cm [10,11]. Thus data on MPH needs to be judged with caution. The ratio of the lengths of the second to fourth digits (2D:4D) is a sexually dimorphic trait that is on average a quarter of a standard deviation lower in males than in females [12,13,14,15]. Given the practical and ethical difficulties inherent in measuring testosterone exposure in the developing fetus, many researchers have adopted 2D:4D as a noninvasive retrospective biomarker for prenatal androgen exposure [16], although its use as such is controversial.

Our cohort study showed that those who had 2D<4D had a significant positive relation with the delayed menarche group.In females, the digit lengths are equal and hence the ratio is closer to 1.0.In males exposed to normal androgen in utero,the ratio of 2D:4D <1.0.Therefore our study showed that females with lower 2D:4D ratios had delayed menarche suggesting excess prenatal androgen exposure as a putative factor in the timing of menarche.

In the present study we had significant impact of low socio-economic status on delayed menarche group,to be precise on the age of menarche. This has been validated in a number of studies [4,18] , the most notable of them being the study on the relationship between age at menarche and socioeconomic status investigated in India (ICMR 1972) which revealed that the mean menarcheal age steadily increased with the decrease in per capita income.

CONCLUSION

The results thus show that SMR stages, 2D:4D ratio , age at inclusion and low socio-economic status had a significant influence on the delayed age of onset of menarche, whereas height percentile, weight, BMI and mid-parental height failed to significantly impact delayed onset of menarche in a cohort of Bengali girls.

This study is the first to examine a number of anthropometric and socio-economic parameters (including weight/BMI) at a time in a single cohort of females with delayed menarche .The results of this study will help to define more clearly the influence of height, weight, BMI and SMR on the timing of menarche. To the best of our knowledge this is the

first study of its kind from India to evaluate the correlation of 2D:4D ratio with delayed age of menarche.Alternative explanations like common genetic factors regulating weight and puberty needs to considered and addressed. Larger population studies might throw further light on this interesting anthropometric measure and substantiate its use as a novel indicator of menarcheal onset.

REFERENCES

1. Ghosh D, Kochhar, Khan SD. Study of puberty and after in 557 Indian school girls at Poona. *J Obst Gyn.* 1973; 23: 234-235.
2. Laslett P. Age at menarche in Europe since the eighteenth century. *J. Interdiscip. Hist*.1985;16: 221-236.
3. Tanner J. M. Trend towards earlier menarche in London Oslo, Copenhagen, the Netherlands, and Hungary. *Nature*.1973; 243: 95-96.
4. Bagga A, Kulkarni S. Age at menarche and secular trend in Maharashtrian (Indian) girls. *Acta Biologica Szegediensis* . 2000; 44 (1-4): 53-57.
5. Agarwal DK,Agarwal KN,Upadhyay SK,Mittal R,Prakash R,Rai S. Physical and sexual growth pattern of affluent Indian children from 5 to 18 years of age.*Indian Pediatr* 1992;29:1203-82.
6. Demerath EW,Towne B.Chumela WC,Sun SS ,Czerwinski SA, Remsberg KE et al. Recent decline in age at menarche : The FELS longitudinal study. *Am J Hum Biol* 2004;16:453-7.
7. Banerjee I,Ghia N,Sayed HN,Mukherjee D. Body mass index in Bengali adolescents. *Indian Pediatr* 2005;42:262-7.
8. Agarwal KN,Saxena A,Bansal AK,Agarwal DK. Physical growth assessment in adolescence. *Indian Pediatr* 2001;38:1217-35.
9. Pietrobelli A,Faith MS,Allison DB,Gallagher D,Chiumello G,Heymsfield SB. Body mass index as a measure of adiposity among children and adolescents:a validation . *J Pediatr* 1998:204-208.
10. Ziebland S, Thorogood M, Fuller A, Muir J. Desire for the body normal: body image and discrepancies between self reported and measured height and weight in a British population. *J Epidemiol Community Health* 1996;50:105–6.
11. Voss LD, Mulligan J, Betts PR, Wilkin TJ. Poor growth in school entrants as an index of organic disease: the Wessex growth study. *BMJ* 1992;305:1400–2.
12. Moisan J, Meyer F, Gingras S. Leisure physical activity and age at menarche. *Med Sci Sports Exerc,* 1991; 23(10):1170-5.
13. Wilson, G.D. Finger length as an index of assertiveness in women. *Pers. Individ. Dif*. 4, 111–112.
14. Manning, J.T. (2002). Digit Ratio: *A pointer to fertility, behavior, and health* (New Brunswick:Rutgers University Press).
15. Phelps, V.R. (1952). Relative index finger length as a sexinfluenced trait in man. *Am. J. Hum Genet*. 4, 72–89.
16. Singh G M P. Onset of menarche in girls of Ludhiana . *Indian Pediatrics* 1986; 23: 263.
17. Manning, J.T., Scutt, D., Wilson, J., and Lewis-Jones, D.I. The ratio of 2nd to 4th digit length: a predictor of sperm numbers and concentrations of testosterone, luteinizing hormone and oestrogen. *Hum. Reprod*. 13, 3000–3004.
18. A. Acharya,V. P. Reddaiah, N. Baridalyne. Nutritional Status and Menarche in Adolescent Girls in an Urban Resettlement Colony of South Delhi. *Ind. J.Com. Med*. 2006; 31;4:10-12.