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Growth in height, weight and skinfold thickness of Bengali boys of Calcutta, India

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With 9 figures and 5 tables in the text

Summary: This is the first comprehensive growth study of male children of Bengali parentage. The cross-sectional survey was undertaken in an urban high school situated in the north of the Metropolitan City of Calcutta during 1982 and 1983. The sample consisted of 815 healthy Bengali boys aged 7–16 years. In this paper, data on height, weight, and skinfold thicknesses are presented including patterns of change in these physical traits with increasing age.

Mean values of height or weight of the boys – not representative for all school-going boys of Calcutta – are distinctly above the national standards given by the Indian Council of Medical Research. They are, however, shorter and lighter than the well-off boys of India but have a similar magnitude of subcutaneous fat on arm. Peak annual incremental growth in height and weight occurs in Bengali boys at 12–13 years and 14–15 years, respectively. This is about one year earlier than in the well-off Indian, British, or American boys.

Zusammenfassung: Bei der vorliegenden Untersuchung handelt es sich um die erste intensive Untersuchung des Wachstums von Knaben bengalischer Herkunft. Sie wurde in den Jahren 1982 und 1983 an Absolventen Höherer Schulen im Norden von Calcutta durchgeführt. Hier werden die Ergebnisse der Körperhöhen- und Gewichtsverteilung sowie der Hautfaltendickenvariabilität mitgeteilt, desgleichen die beobachteten sozio-ökonomischen Unterschiede. Die Körperhöhen- und Gewichtsmittelwerte der untersuchten Knaben liegen deutlich über den nationalen Standardwerten für Indien. Sie sind allerdings nicht charakteristisch für alle männlichen Schüler von Calcutta. Während sich in der Körperhöhe und im Körpergewicht die untersuchten Schüler durch geringere Werte von sozial vergleichbaren anderer indischer Gebiete unterscheiden, liegen in der Hautfaltendicke keine wesentlichen Unterschiede vor. Der Wachstumsspurt für die Körperhöhe liegt zwischen dem 12.–13. Lebensjahr, für das Gewicht zwischen dem 14. und 15. Lebensjahr. Diese Werte liegen ca. ein Jahr unter denen anderer vergleichbarer indischer, englischer oder US-amerikanischer Knaben.

Introduction

In the national survey on growth and physical development of Indian children, children of Bengali parentage were not included (ICMR 1972). Consequently, for suitable data on growth of the children of West Bengal, one has to depend upon a few smallscale local studies made within the jurisdiction of Metropolitan Calcutta (Chatterjee 1938; Mukherjee 1951; Banerjee 1976; Hauspie et al. 1980; Bandyopadhyay et al. 1981). These studies, except those by Banerjee (1976) and Hauspie et al. (1980), deal with cross-sectional data on height, weight, chest-girth, length of

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upper and lower extremities. The subjects measured varied in age from birth to 22 years, but it was not indicated how the ages were ascertained. As the correctness in age is essential in a growth study the usefulness of conclusions on the basis of the said cross-sectional data may be questioned. Because of the lack of reliable data and also because, in all probability, due to secular shift the available data may not be useful anymore even for purposes of comparison, an anthropometric survey of healthy Bengali boys has been carried out in north Calcutta in order to study the pattern of change in growth and physique. The material presented in this paper constitute part of the comprehensive cross-sectional study. Presented are data on height, weight, triceps and subscapular skinfold thicknesses of the Bengali boys nurtured in the city environment. The present study may provide important information as to the nutritional and health status of the Bengali urban community at large.

Subjects and methods

The anthropometric survey was carried out from April 1982 through September 1983 in a century old missionary high school located within one of the densely populated areas of north Calcutta. The students belonged, in general, to the Bengali-speaking families, who had lived in the area for a number of generations. Their father's education varied between school and graduate level, but showing the major concentration at the undergraduate level. Only a little more than one-third among them were graduates and some had postgraduate degrees also. Occupations of the fathers were diverse. According to National Classification of Occupations (Govt. of India 1969) it is found that the occupation-categories 0–1 and 2 which cover professional, technical, administrative, executive, managerial workers do not include more than 25 % of the fathers. For the purpose of the study the incumbents of these two national categories are considered to form the social class I. Similarly, in 32 % cases they reported to be sales workers (category 4), while in 28 % cases the fathers were employed as clerks or related workers (category 3). The earners of both the categories 3 and 4 are taken to constitute the social class II. The rest of the fathers who were manual workers as production & service workers, transport equipment operators and labourers (categories 6–9) are treated as the members of the social class III.

During survey in many cases reliable information on family income was not available and as such we have utilized the data on *per capita* expenditure to understand the relative spending capacity and thereby income potential of the families in question. It is, of course, well-known that family expenditure has lesser reporting bias than income. On the basis of *per capita* expenditure we find that only 41 % of the families had higher spending capacity (more than Rs. 250/=) and these families may be considered to possess better economic condition ensuring greater nourishment to the children and other members. It may be noted here that average family sizes for the classes I, II, and III are found to be 5.4, 6.4, and 5.4, respectively. It is thus noted that the majority of the subjects (60 %) came from the social class II and belonged to those families which had lower *per capita* expenditure capacity. In general the students were from educated, high-middle to middle class families. In respect of food habits they are mostly non-vegetarian.

On the other hand, the students' mothers were found in large majority cases to possess education upto school level. Among them a little less than one-fifth were, of course, graduates. They were engaged most commonly in household activities as housewives. As a matter of fact, less than one-tenth of the mothers were gainfully employed.

In this context the distribution of the sample boys by age, social class and family expenditure capacity is shown in Table 1 to indicate their over-all socioeconomic characteristics.

At the very outset of the study, with the cooperation of the school authority a family schedule was given to every boy of each class for getting his true date of birth, and socioeconomic and demographic particulars recorded by his parents. Those who furnised the requisite information were included in the study. To cross-check the dates of birth as reported, the parents/guardians were requested by the school authorities to submit documentary evidence in support of their written statements, in the form of a birth certificate issued from maternity ward of hospital or nursing home, family horoscope, personal note book or diary.

Finally 856 boys, with true birth records and without pathological development were included in the sample. The sample covers the age range 7.0 upto 16.0 years. The exact sample size per age-point is given in the Tables 2 to 5. On further scrutiny, 31 family schedules with incomplete information were detected; these cases were excluded. We took anthropometric measurements in all 825 boys. But the students were not equally cooperative. As a result, unequal numbers of boys had to be left out unmeasured. Accordingly, the data cover for stature 813, for weight 815, for triceps thickness 804 and for subscapular thickness 782 boys.

The target date for measuring was the birthday. In a large majority of cases (80 %) the boys were examined within three days around their birthday. Accordingly, the results discussed refer to exact age-points (7.0 years, 8.0 years etc.) not to age classes. All measurements were made according to the recommendations of the International Biological Programme (Weiner and Lourie 1969), and were taken by a single observer (PDG). Though 25 measurements were taken on each boy here only data on height, weight, triceps and subscapular skinfold thicknesses are presented. The measurements were taken generally between 8 am and 3 pm during school hours.

Stature was recorded by an anthropometer rod to the nearest centimeter. Weight was measured using a lever actuated balance to the nearest 0.5 kg, with the boys in minimal clothing (light pants only). Skinfold thickness was examined to the nearest 0.5 mm with a Lange caliper having a pressure of 10 g/mm^2 of contact surface area.

Frequency tables and basic descriptive statistics (mean, medain, s.e., etc.) were computed from the raw data, separately for each age. The data were not smoothed before computations; smoothing would only decrease the heterogeneity of values, which is undesirable in the context of this paper. To examine the normality of the data, histograms were drawn and skewness kurtosis coefficients were also computed. Increments in height, weight, and skinfold thickness are calculated for the one-year period, covering, say, 7.0–8.0 years. These whole-year increments in mean values are plotted to get an annual growth rate. Per year increments in median values are also shown.

For appropriate evaluation of the skinfold data log transformation of the same have been made and the log values are given in the tables. Processing of all anthropometric data, tabulations, and necessary statistical analyses are made with the help of a Russian third generation computer (EC 1033).

Results

A few general remarks may be made before the presentation of the results. Except for stature, the other characters are non-normal for most age-groups. For age-group 9 years, even stature is non-normal (see the skewness and kurtosis values in Tables 2 and 3). Mean, as is well-known, is not a good measure of central tendency for a non-normal distribution, while median is more representative. We have, there-

Table 1. Distribution of the subjects by age, social class and family expenditure capacity (per capita)

Age (years)	I	II	III	Total	Per capita expenditure capacity		
					High (above Rs. 250/–)	Low (Rs. 250/– and less)	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
7.0	13	24	24	61	28	34	62
8.0	19	27	40	86	38	48	86
9.0	24	27	43	94	34	61	95
10.0	12	25	38	75	29	46	75
11.0	16	24	56	96	34	63	97
12.0	18	35	41	94	34	61	95
13.0	30	27	41	98	44	54	98
14.0	27	19	47	93	38	55	93
15.0	23	21	31	75	34	41	75
16.0	13	10	13	36	25	11	36
All ages	195	239	374	808	338	474	812
%	(24.1)	(29.6)	(46.3)	(100.0)	(41.6)	(58.4)	(100.0)

Table 2. Means (M), standard errors (SE), standard deviations (SD), medians (Md) and yearly increments for age and height. (Measures of asymmetry (skewness) and peadedness (kurtosis) of the distribution of height are shown, the values of coefficient, significant at the 5 % level, are marked by * sign)

Age (years)	N	Range (Cm.)	M (Cm.)	SE	SD	Md (Cm.)	Per year increment (Cm) M	Md	Skew.	Kurt.
7.0	62	104.3–138.7	119.3	0.85	6.73	118.8			0.34	0.46
							4.8	5.4		
8.0	86	108.7–138.6	124.1	0.57	5.31	124.2			–0.02	0.09
							4.4	3.8		
9.0	96	115.4–152.3	128.5	0.62	6.04	128.0			0.69*	1.58*
							4.5	4.4		
10.0	75	119.9–146.1	133.0	0.63	5.50	132.4			0.14	–0.63
							5.4	4.7		
11.0	97	125.7–154.8	138.4	0.70	6.94	137.1			0.43	–0.50
							4.6	6.4		
12.0	95	123.7–166.1	143.0	0.90	8.77	143.5			0.15	–0.37
							8.5	7.9		
13.0	98	128.6–174.2	151.5	0.79	7.85	151.4			–0.02	0.27
							5.6	6.5		
14.0	93	134.2–174.9	157.1	0.90	8.64	157.9			–0.26	–0.40
							5.3	4.3		
15.0	75	148.4–177.4	162.4	0.72	6.23	162.2			0.14	–0.40
							3.3	2.5		
16.0	36	157.0–176.5	165.7	0.87	5.23	164.7			0.25	–0.90

Table 3. Means (M), standard errors (SE), standard deviations (SD), medians (Md) and yearly increments for age and weight. (Measures of asymmetry (skewness) and peakedness (kurtosis) of the distribution of weight are shown, the values of coefficient, significant at the 5 % level, are marked by * sign).

Age (years)	N	Range (kg)	M (kg)	SE	SD	Md (kg)	Per year increment (mm) M	Per year increment (mm) Md	Skew.	Kurt.
7.0	63	14.0 −39.0	20.3	0.56	4.47	19.5			1.50*	3.75*
		(1.15− 1.59)	(1.30)	(−0.25)	(0.09)	(1.29)				
							1.7	1.7		
							(0.03)	(0.03)		
8.0	84	15.0 −38.5	22.0	0.48	4.37	21.2			1.42*	3.04*
		(1.18− 1.58)	(1.33)	(−0.32)	(0.08)	(1.33)				
							3.0	1.8		
							(0.06)	(0.04)		
9.0	97	16.5 −57.5	25.0	0.63	6.21	23.0			2.31*	7.56*
		(1.22− 1.76)	(1.39)	(−0.20)	(0.09)	(1.36)				
							1.0	2.5		
							(0.03)	(0.05)		
10.0	75	17.5 −43.5	26.0	0.67	5.78	25.5			0.96*	0.36
		(1.24− 1.64)	(1.42)	(−0.17)	(0.09)	(1.41)				
							3.8	3.0		
							(0.04)	(0.04)		
11.0	97	18.5 −68.0	29.8	0.80	7.91	28.5			1.67*	−4.64*
		(1.27− 1.83)	(1.46)	(−0.09)	(0.10)	(1.46)				
							2.4	2.5		
							(0.04)	(0.03)		
12.0	95	21.0 −59.5	32.2	0.82	8.02	31.0			1.04*	0.85
		(1.32− 1.77)	(1.50)	(−0.09)	(0.10)	(1.49)				
							4.3	5.2		
							(0.06)	(0.07)		
13.0	98	22.0 −54.5	36.5	0.65	6.41	36.2			0.14	−0.44
		(1.34− 1.74)	(1.56)	(−0.19)	(0.08)	(1.54)				
							3.9	3.8		
							(0.04)	(0.04)		
14.0	95	24.0 −72.0	40.4	0.86	8.35	40.0			0.89*	1.47*
		(1.38− 1.86)	(1.60)	(−0.06)	(0.09)	(1.60)				
							5.2	4.0		
							(0.05)	(0.04)		

Table 3. cont.

Age (years)	N	Range (kg)	M (kg)	SE	SD	Md (kg)	Per year increment M	Per year increment Md	Skew.	Kurt.
15.0	75	26.5 –73.0 (1.42– 1.86)	45.6 (1.65)	0.94 (–0.03)	8.19 (0.08)	44.0 (1.64)			0.70*	1.02
							3.4 (0.03)	3.5 (0.04)		
16.0	36	37.0 –85.0 (1.57– 1.93)	49.0 (1.68)	1.66 (0.22)	9.96 (0.08)	47.5 (1.68)			1.74*	3.60*

Figures in parentheses pertain to $\log_{10}$ weight

Table 4. Means (M), standard errors (SE), standard deviations (SD), medians (Md) and yearly increments for age and triceps skinfold thickness. (Measures of asymmetry (skewness) and peakedness (kurtosis) of the distribution of triceps thickness are shown, the values of coefficient, significant at the 5 % level, are marked by * sign)

Age (years)	N	Range (mm)	M (mm)	SE	SD	Md	Pear year increment M	Pear year increment Md	Skew.	Kurt.
7.0	62	3.5–20.0 (0.5– 1.3)	7.5 (0.85)	0.38 (0.20)	3.00 (0.15)	5.5 (0.8)			1.68*	3.59*
							0.7 (0.02)	0.5 –		
8.0	83	4.0–25.0 (0.6– 1.4)	8.2 (0.87)	0.44 (0.02)	4.00 (0.18)	7.0 (0.8)			1.95*	4.64*
							0.2 (0.02)	– –		
9.0	91	4.0–23.5 (0.6– 1.4)	8.4 (0.89)	0.37 (0.02)	3.50 (0.15)	7.0 (0.8)			1.93*	4.76*
							1.6 (0.06)	1.0 (0.1)		
10.0	76	4.0–32.0 (0.6– 1.5)	10.0 (0.95)	0.61 (0.02)	5.35 (0.20)	8.0 (0.9)			1.69*	3.05*
							0.2 (0.01)	– –		
11.0	97	4.0–33.0 (0.6– 1.5)	10.2 (0.96)	0.54 (0.02)	5.35 (0.20)	8.0 (0.90)			1.47*	2.50*

Table 4. cont.

Age (years)	N	Range (mm)	M (mm)	SE	SD	Md	Pear year increment (mm) M	Md	Skew.	Kurt.
							−0.9	–		
							(−0.03)	–		
12.0	95	3.0–25.0	9.3	0.43	4.23	8.0			1.11*	1.07*
		(0.5– 1.4)	(0.93)	(0.02)	(0.19)	(0.9)				
							–	–		
							(0.01)	–		
13.0	95	5.0–21.5	9.3	0.39	3.80	8.0			1.73*	2.74*
		(0.7– 1.3)	(0.94)	(0.0)	(0.15)	(0.9)				
							−0.5	−0.5		
							(−0.04)	–		
14.0	93	4.0–23.0	8.8	0.43	4.11	7.5			1.32*	1.26
		(0.6– 1.4)	(0.90)	(0.02)	(0.18)	(0.9)				
							0.5	0.5		
							(0.02)	–		
15.0	76	3.0–21.5	9.3	0.51	4.44	8.0			1.21*	0.73
		(0.5– 1.3)	(0.92)	(0.02)	(0.19)	(0.9)				
							−0.3	–		
							–	–		
16.0	36	5.0–22.0	9.0	0.65	3.93	8.0			1.17*	1.18
		(0.7– 1.3)	(0.92)	(0.03)	(0.17)	(0.9)				

Figures in parentheses pertain to $\log_{10}$ triceps skinfold thickness

Table 5. Means (M), standard errors (SE), standard deviations (SD), medians (Md) and yearly increments for age and subscapular skinfold thickness. (Measures of asymmetry (skewness) and peakedness (kurtosis) of the distribution of subscapular thickness are shown, the values of coefficient, significant at the 5 % level, are mared by * sign)

Age (years)	N	Range (mm)	M (mm)	SE	SD	Md	Per year increment (mm) M	Md	Skew.	Kurt.
7.0	62	3.0–13.0	5.8	0.27	2.12	5.0			1.51*	1.96*
		(0.5– 1.1)	(0.74)		(0.14)	(0.7)				
							0.6	0.5		
							(0.03)	–		
8.0	83	3.5–25.0	6.4	0.40	3.67	5.5			3.34*	12.65*
		(0.5– 1.4)	(0.77)		(0.17)	(0.7)				
							0.1	–		
							(0.01)	–		

Table 5. cont.

Age (years)	N	Range (mm)	M (mm)	SE	SD	Md	Per year increment (mm) M	Per year increment (mm) Md	Skew.	Kurt.
9.0	92	3.0–22.0	6.5	0.33	3.19	5.5			2.07*	5.24*
		(0.5– 1.3)	(0.78)		(0.17)	(0.7)				
							0.7	0.5		
							(0.04)	(0.1)		
10.0	72	3.5–20.0	7.2	0.43	3.68	6.0			1.63*	1.90*
		(0.5–1.3)	(0.82)		(0.18)	(0.8)				
							0.6	–		
							(0.03)	–		
11.0	91	3.0–22.0	7.8	0.40	3.88	6.0			1.65*	2.41*
		(0.5– 1.3)	(0.85)		(0.18)	(0.8)				
							–	0.5		
							(–0.01)	–		
12.0	90	3.0–21.0	7.8	0.45	4.28	6.5			1.73*	2.25*
		(0.5– 1.3)	(0.84)		(0.19)	(0.8)				
							–0.7	–		
							(–0.01)	–		
13.0	91	3.5–19.0	7.1	0.25	2.42	6.5			2.27*	7.27*
		(0.5– 1.3)	(0.83)		(0.12)	(0.8)				
							0.8	–		
							(0.03)	–		
14.0	92	4.0–30.0	7.9	0.42	4.06	6.5			2.66*	9.40*
		(0.6– 1.5)	(0.86)		(0.17)	(0.8)				
							0.6	1.5		
							(0.04)	(0.1)		
15.0	73	4.0–20.5	8.5	0.41	3.55	8.0			1.28*	1.42*
		(0.6– 1.3)	(0.90)		(0.16)	(0.9)				
							0.7	–		
							(0.03)	–		
16.0	35	4.5–20.0	9.2	0.64	3.78	8.0			0.95*	0.22
		(0.6–1.3)	(0.93)		(0.17)	(0.9)				

Figures in parentheses pertain to $\log_{10}$ subscapular skinfold thickness.

fore, presented the median values also, for stature and weight. For skinfold thicknesses, we have also made the widely-used logarithmic transformations, which render the distributions closer to normality. Descriptive statistics for the logarithmically transformed data are also presented in Tables 4 and 5. The discussion that follows is mainly based on mean values of the untransformed data. It may also be noted that most distributions considered here are positively skewed and leptokurtic.

Table 2 reveals the continuous increase in height with increase in age. The difference between values at age 7.0 and age 16.0 accounts for 46 cm (Fig. 1). The tempo of growth happens to be more or less of the same order between ages 7.0 and 12.0, the growth rates being restricted between 4 and 5 cm. This agrees with normal pattern of growth reported in many countries. A marked acceleration of growth (8.5 cm) is found between 12.0 and 13.0 years and minimum (3.3 cm) between 15.0 and 16.0 years (Fig. 2). The standard deviation for the height measurement is highest (8.77 cm) at the age point 12.0 years and the next highest value (8.64 cm) at the age 14.0. After 14.0 years the values of standard deviation diminish to 6.23 cm at 15.0 years and more sharply to 5.23 cm at 16.0 years.

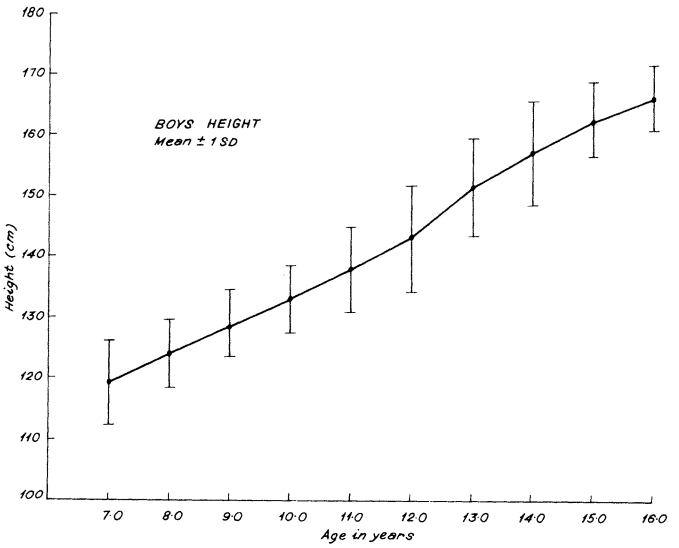

Fig. 1. Mean heights for Bengali boys of different ages in Calcutta. Bars show one standard deviation above and below the mean.

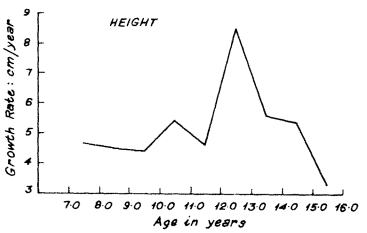

Fig. 2. Annual growth rate of height of Bengali boys aged 7—16 years.

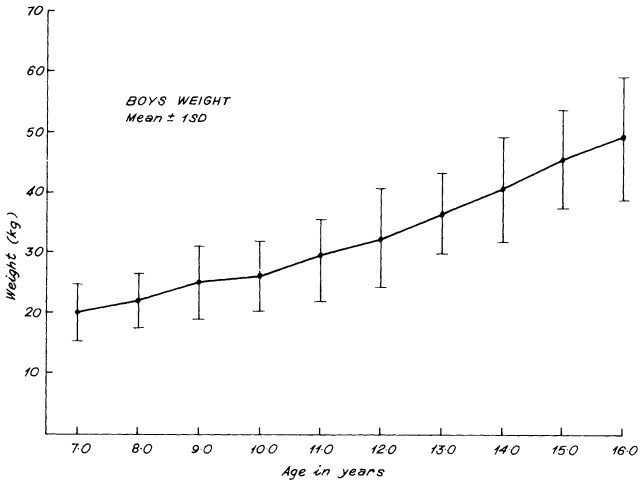

Fig. 3. Mean weights for Bengali boys of different ages in Calcutta. Bars show one standard deviation above and below the mean.

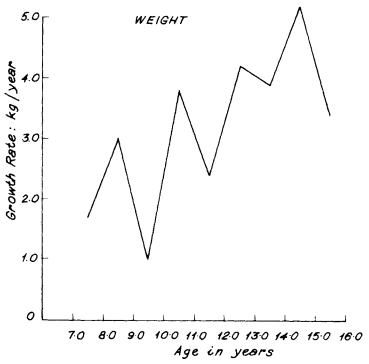

Fig. 4. Annual growth rate of weight of Bengali boys aged 7–16 years.

A high standard deviation at a particular age during growth denotes greater individual variation. This variation may be due to the fact that at that age some boys grow very fast and some grow slowly. In the present data high standard deviations are obtained at ages 12.0 and 14.0 years and this situation was no doubt due to discrepancy in growth between early and late maturers. At age 13.0 standard deviation is lower to indicate that all the boys were there somehow either at the end, the middle, or start of their spurt.

Body weight shows a slightly different pattern (Table 3). Annual gain in weight over the first eight years (7.0 to 14.0 years) was in gradual ascending order (Fig. 3). The difference between the values at 7.0 and 16.0 years as recorded in the study, is about 29 kg. The peak annual increment of 5.2 kg occurs between the ages 14.0–15.0 (Fig. 4). The normality of the distribution of weight was tested in each age by estimating the degree of asymmetry (skewness) and of peakedness (kurtosis). A

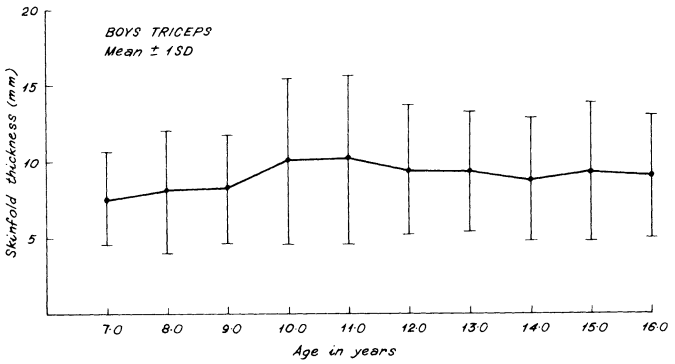

Fig. 5. Mean triceps skinfold thickness for Bengali boys of different ages in Calcutta. Bars indicate one standard deviation above and below the mean.

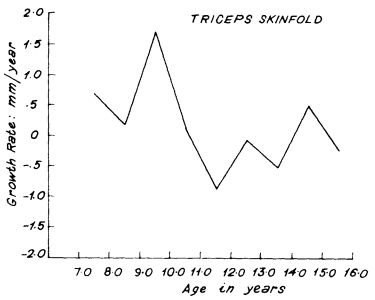

Fig. 6. Annual growth rate of triceps skinfold thickness of Bengali Boys aged 7–16 years.

significant value of the coefficient of skewness indicates that the distribution of weight is positively asymmetrical. A significant value of the coefficient of kurtosis indicates that the distribution has a high peak (positive value) or is flat topped (negative value), relative to a normal distribution.

With respect to triceps skinfold thickness it is found that the lowest mean value increases from age 7 slowly with the advancing ages till the peak values occurs at the age 11 (Table 4). Thereafter the thickness continues to decrease steadily with the increasing ages (Fig. 5). The annual increment in triceps skinfold is highest between the ages 9.0 and 10.0. Then growth in thickness decreases steadily with increasing age. Beyond 10.0 years the growth rate for triceps thickness is observed, in general, to be negative (Fig. 6).

Table 5 shows for subscapular skinfold that the mean thickness increases slowly over the given ages. The difference between the values yielded by the boys at 16.0 years (9.2) and 7.0 years (5.8) confirm the pattern of increase (Fig. 7). As a matter of fact, between the ages 10.0 and 14.0 growth in skinfold thickness does not vary much. But a sudden increase occurs after the age 14 and the maximum value is obtained for the boys at 16 years. Nevertheless, the peak growth occurs also, as in triceps, during the age interval 13.0–14.0 (Fig. 8).

The normality of the distribution of triceps thickness was tested in each age and the significant value of the coefficient of skewness shows that this distribution

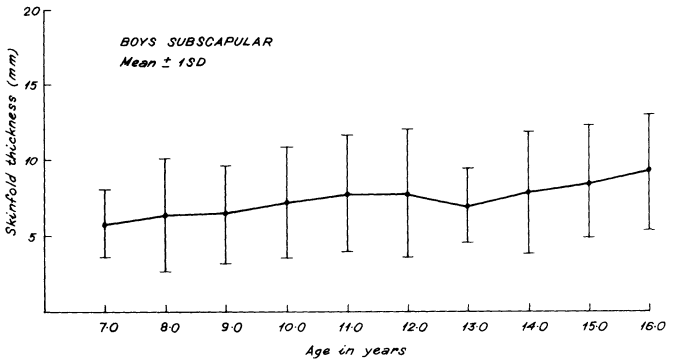

Fig. 7. Mean subscapular skinfold thickness for Bengali boys of different ages in Calcutta. Bars indicate one standard deviation above and below the mean.

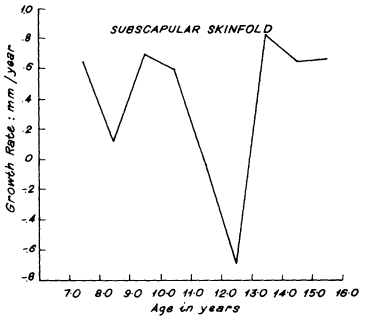

Fig. 8. Annual growth rate of subscapular skinfold thickness of Bengali Boys aged 7–16 years.

is positively asymmetrical. The significant value of the coefficient of kurtosis indicates that the distribution has a high peak (positive value), relative to a normal distribution. This development is also true for the distribution of subscapular thickness.

Discussion

In comparison with the mean values of height (stature) or weight obtained for Indian boys with verified ages in general, or for urban Indian boys with stated ages in general (ICMR 1972), the Bengali boys of Calcutta present higher values in each age within 7.0 to 16.0 years. But heights and weights for Indian boys with stated ages belonging to the socioeconomic class I agree well with the present series. The Bengali boys show however, lower mean values in both height and weight than the well-nourished Indian boys studied in some expensive residential schools from all over India (Raghavan et al. 1971). In a longitudinal study of Bengali boys living in a suburban muncipal area south of Calcutta city, the above fact had been confirmed already by Hauspie et al. (1980). These suburban boys are definitely shorter than the city boys of West Bengal. Not only the Calcutta boys appear to be taller and heavier than the national averages from India, but also they seem to have better growth in

both height and weight than the urban boys of the neighbouring states of Orissa and Assam in eastern India (Deka Mahapatra 1969; Das 1966; ICMR 1972). This sort of assessment of course, has its limitations since the data used for necessary comparisons are subject to the effects of secular shifts (Madhavan et al. 1964). But as the published data for the boys of contemporary India or neighbouring states of West Bengal are hardly available we have to depend upon old studies only to indicate generally the pattern of growth in the Bengali boys.

A closer look into other Indian data reveals more facts of interest: (1) as far as height is concerned the city boys of the Maharashtrian parentage in central India mark a trend of lower growth than the city boys of the Bengali parentage, but in weight they present difference in lesser degree (Sharma 1970); (2) the Calcutta boys maintain lower mean values in height and weight than the Coimbatore boys of high income group, but they have higher mean values than the boys of middle income group in southern India (Easwaran and Devadas 1984), (3) the Telugu-speaking boys of the Hyderabad city, south India, present a pattern of growth in height or weight that is broadly similar to that yielded by the Bengali-speaking boys of Calcutta (Murty et al. 1983); (4) the Bengali boys of Calcutta are distinctly shorter and lighter than the well-privileged boys studied in the Delhi city, north India (Datta Banik et al. 1973; Datta Banik 1982); (5) The Bengali boys of Calcutta possess higher mean values both in height and weight than the Punjabi Khatri and Arora boys of government schools, but they are shorter and lighter than those Punjabi boys studying in public schools (Sikri 1972).

Eveleth & Tanner (1976) already remarked that the peak height velocity of the adolescent spurt in height appears to occur at about the same time in well-off Indian boys as it does in European and American boys (13–14 years), while the velocity falls off more rapidly after the peak among the Indians. In the present study maximum increment in height occurs between the age points 12.0 and 13.0. The observation made by Eveleth and Tanner about the more rapid fall in velocity of height among the well-off Indians holds true also for the Bengali boys. As a matter of fact, the trend of decline in growth increment after peak is almost alike between the Bengali and well-off boys of India (Fig. 9).

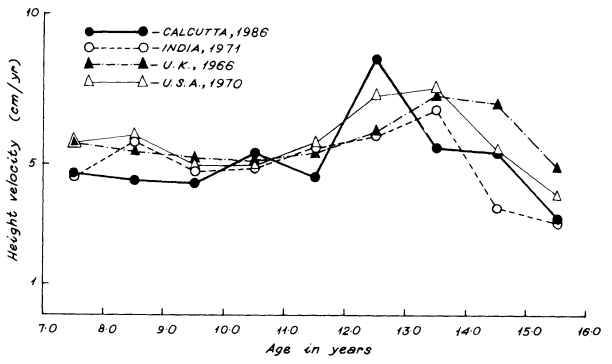

Fig. 9. Adolescent height spurt of boys based on cross sectional data. Samples are from the USA national survey (Hamill *et al.* 1970), London (Tanner *et al.* 1966), India well off (Raghavan *et al.* 1971) and the present study.

In another aspect the Bengali boys are found to have attained the maximum increment in height a little earlier than other Indian populations like the Pandit (Hindu) boys (14.5 years) in Kashmir (Kaul 1975), the urban boys (14.0 years) in Madhya Pradesh (Kaul et al. 1976) and in Maharashtra (Sharma 1970), the privileged boys (14.0) in Delhi (Datta Banik et al. 1978). Among the semiurban Bengali boys the peak height velocity is shown at the age of 14.0 (Hauspie et al. 1980).

With respect to weight the well-off Indian boys are observed to be at first as heavy or heavier than their European counterparts in London, Paris, the Netherlands, or Poland (Eveleth & Tanner 1976; Roede & van Wieringen 1985), but as with height, this resemblance disappears about the age of 12 after which time the Indian boys gain less. When the Bengali boys under study are always lighter than the well-off Indian boys in general, there is no point to go for any comparison with the European boys. But as far as peak weight increment is concerned the Bengali boys show firstly such increment a little later (14–15 years) than their European counterparts in London and the Netherlands (13.0–14.0 years), secondly, a little earlier than the Parisian boys (15.0–16.0 years), and thirdly, at the same time of the Polish boys (14–15 years). On the other hand, in comparison with the American boys (13.0–14.0 years) the Bengali boys enjoy the maximum yearly increment in weight one year earlier (Hamill et al. 1970).

In the Indian context the well-off boys in general attain maximum increment in weight in the interval 13.0–14.0 years and the same feature is seen among the privileged boys of Delhi. The Bengali boys differ thus distinctly from the said two Indian populations. In clear contrast, the urban boys of Maharashtra achieve peak weight velocity definitely earlier (12–13 years) than the Bengali boys of Calcutta. It is the urban boys of India at large concur with the finding of the present study. The Bengali boys differ from their counterparts in different States of India not only in the manifestation time of the maximum adolescent growth increment in weight but also in the magnitude of peak weight increase. Their magnitude is definitely lower than what is registered by the boys in other States of India in question.

It is already known that the well-off boys in India have the values for triceps fat thickness greater than their counterparts in London (Eveleth & Tanner 1976; Raghavan et al. 1974). The Calcutta boys show in lower ages (7–9 years) lesser arm fat than these well-off boys, but they maintain greater values in the next two higher ages to register the peak growth increment at 11 years. After the peak they present a trend in the growth of triceps skinfold which is somewhat similar to that shown by the well-off boys. In comparison with other Indian populations like the boys of middle income group of Coimbatore (Easwaran & Devadas 1984), Gaddi Rajputs (Singh 1980), the Bengali boys of Sodpur town, near Calcutta (Das & Mukherjee 1981), the Calcutta boys do have adipose fat accumulation at triceps in greater magnitude and thereby attest for better calorie reserves.

With respect to certain non-Indian populations it is interesting to note that the Bengali boys differ like the well-off Indian boys from the London boys in possessing higher values for triceps thickness. But for subscapular thickness they do not vary much in yielding almost similar values between 7 and 11 years, after which the Bengalis gain distinctly less. The peak growth in subscapular thickness occurs a little earlier in the Bengalis (13–14 years) than the Londoners (14–15 years). The values for the triceps skinfold as presented by the Bengali boys, are, of course, definitely lower than those of the American boys, where as in subscapular fat thick-

ness the latter group does not mark, especially after the age 11 years, any sharp variation.

In general, the foregoing analysis of age changes in adipose tissue thicknesses reveal that the Bengali boys in the City agree well with certain universal growth events like the following:

1. proportionately greater rate of increase after age 7 in external trunk fat than in limb (arm) fat,

2. occurrences of peak increment in arm fat a year before the maximum growth increment in height and actual 'thinning of fat ring' in the upper limbs (Tanner 1962) immediately after maximum increment,

3. manifestation of a loss or a check to the gain in skinfold size in the trunk after peak increment,

4. relatively greater loss of fat in the upper limbs than in the trunk after peak adolescent growth.

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