PHYSICAL GROWTH PATTERN OF BENGALEE BOYS AND GIRLS DURING CHILDHOOD AND ADOLESCENCE

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The differential physical growth rate pattern of the lower socioeconomic strata of the Bengalee population is apparent but has not yet been looked into in a systematic manner.So cross-sectional study on physical growth rate has been conducted on Bengalee boys and girls (aged 5 to 15 years) of lower middle socioeconomic group (LMIG) of West Bengal for a period of one year.Anthropometric measurements were performed on randomly selected 255 school-going children and adolescents (123 females and 132 males) and their nutritional status was assessed by 24 hours recall method.Age and sex-specific sitting height velocity, leg length velocity, maximum height and body weight difference, body mass index(BMI), along with their bicep and subscapular skinfold thickness were observed to vary significantly($p<0.05$) in Bengalee population of LMIG. Skinfold thickness of LMIG Bengalee boys and girls indicated thinning of fat layer of upper limb and lower trunk during adolescent growth spurt for both sexes. Different grades of malnutrition were reflected from the LMIG children and they were mostly on high-cereal based diet. So, moderate to chronic undernutrition was observed among Bengalee boys and girls during their growth period. So the growth pattern of Bengalee boys and girls during childhood and adolescence in LMIG showed peak annual incremental growth in 9 -10 year-old girls and 11 -12 year old boys which is about a year earlier than the well-off urban Bengalee as well as Indian boys and girls. Moreover, comparison of differential growth of sitting height and leg length velocity indicated shorter adult height among Bengalee as well as Indian population.

The health of children is a matter of great concern all over the world and WHO, UNO as well as UNESCO have been emphasizing on the importance of development in the children and adolescent worldwide as they have potential and are the greatest resource for future. Physical growth of a child is a dynamic statement of his or her general health and it is a continuous and quantitative change referring to an increase in physical size of the whole body or any of its parts.The growth process is a resultant of the complex interaction of genetic influence, type and quality of nutritional intake and also their socio-economic status and association of physical activity (Wiley &Sons Inc, 1975), which represents the standard of living and nutritional status of the population (Saibaba *et al*, 2002). Nutritional status refers to the state of health of an individual as it is affected by the intake and utilization of nutrients and its assessment signifies the severity and magnitude of nutritional problems prevalent in communities due to faulty intake and utilization of nutrients (Srilakshmi B, 2005). The physical growth and nutritional status in childhood and adolescence is the most sensitiveindicator of well-being as this period consists nearly half of the growing

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period of any individual.The school age period has been called the latent time of growth (Srilakshmi B,2005) where the rate of growth slows and body changes occur gradually. At the later part of this period,transition from childhood to adulthood happens which is referredto as Puberty. During this period, girls usually overtake boys and the final growth spurt occurs. The growth and development of the school-going children and adolescent is marked by rapid changes in body size, shape, and composition, all of which are sexually dimorphic.This change can be determined by a set of standard physical or anthropometric measurements of various physical growth traits. (WHO 1995; Bose & Mukhopadhyay, 2004).Monitoring the physical growth pattern of children and adolescents by anthropometric measurementacross a variety of populations at different periods reflects population specific growth pattern and also can act as models for the nutritional status assessment of the population(Agarwal *et al*,1992; Satake *et al*, 1993).Different longitudinal and cross sectional investigations have indicated differences in growth rhythm of several traits and a wide variation in the size and proportions of different body segments within and between populations.

The differential physical growth rate pattern of different socio-economic strata of the Bengalee population is apparent but has not yet been looked into in a systematic manner. So, this study was conducted among lower middle income group (LMIG) boys and girls of 24-Parganas to understand the growth pattern and the influence of socio-economic and nutritional status on lower middle income society of West Bengal. This group was chosen as it encompasses the major population of the state/country.

Objective

This study aims to evaluate thephysical growth pattern and the nutritional status among children and adolescents of 5 to 15 years of age belonging to lower middle class families of West Bengal with respect to the influence of socio-economic and nutritional status. The onset of growth spurt and the annual rate of increment in physical growth traits of lower middle class Bengalee boys and girls are also to be compared.

MATERIALS AND METHODS

A cross-sectional study was conducted on 255 school-going children and adolescents, aged 5 to 15 years, who were free from any type of physical and mental disorders. Among them, 123 were girls and 132 were boys of lower middle income group as they that had a monthly household income of INR 9,000 to INR 30,000 per month.After obtaining written consent from their guardians, the subjectswere randomly selected from two primary and secondary schools of 24-Parganas(South)and anthropometric measurements were taken for a period of one year. All subjects completed a pre-tested questionnaire on age, ethnicity, nutritional status, socio-demographic profile etc. before being subjected to anthropometric measurements like height, weight, sitting height, leg length, skinfold thickness of biceps, triceps, subscapular and suprailiacregion. Fourderived variablesi.e. Body Mass Index (BMI), Body Surface Area(BSA),Waist Hip Ratio(WHR) and body fat % were obtained. The body fat % was calculated by using Siri (1961) formula. All statistical analyses were conducted using Standard Deviation and student’s t-test was performed to test the level of significance between the anthropometric traits of different groups.

Their nutritional status was assessed by 24-hours recall method for 3 consecutive days.

RESULTS

The above-mentioned anthropometric variables were compared between Bengalee boys and girls belonging to lower middle income group (LMIG) and the following differences were observed.

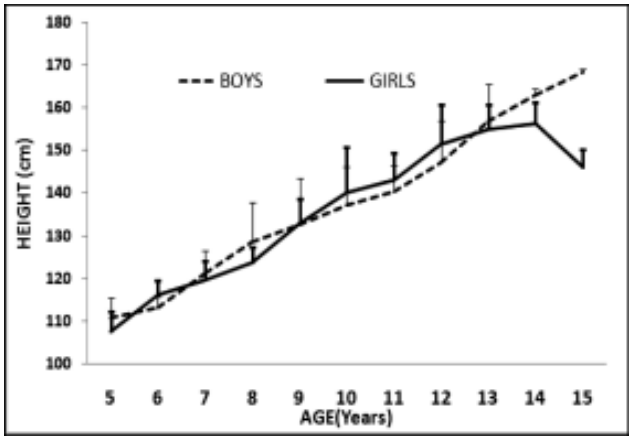

Fig.1 Comparison of height spurt between LMIG Bengalee boys and girls

The maximum height spurt among Bengalee boys was observed (Fig.1) at 11-13 years of age (6.71cm±5.97 in 11-12 years and 9.73cm±8.75 in 12-13 years). The height spurt of Bengalee girls was found to be at 9-10 years (7.10cm±5.60) and 11-12 years (8.35cm±6.12) of age. This difference is significant($p<0.05$). Though the height of girls was greater initially, it stabilized with the increasing age but the increase continued in case of boys.

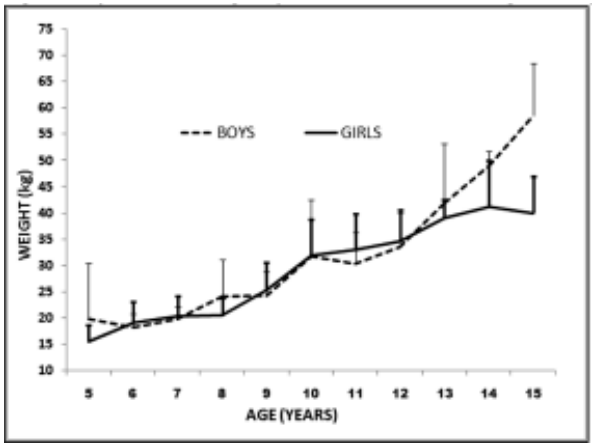

Fig.2 Comparison of mean weight of LMIG Bengalee boys and girls

In case of weight (Fig.2), the maximum increment in boys was found at 9-10 years (7.43kg±4.41) and 12-13 years of age(8.39kg±6.61) whereas the increment of girls' weight at 9-10 years was 6.75kg(±5.30; $p<0.05$).

By comparing data of the body mass index (BMI) of boys and girls group, it has been seen that both boys and girls of LMIG showed significantly ($p<0.05$) greater BMI value at 10 years of age (16.58±4.06 and 16.29±2.95 respectively), after which the distance curve (Fig. 3) declined and then rose again at 14 years of age when adolescent boys showed greater BMI than adolescent girls.

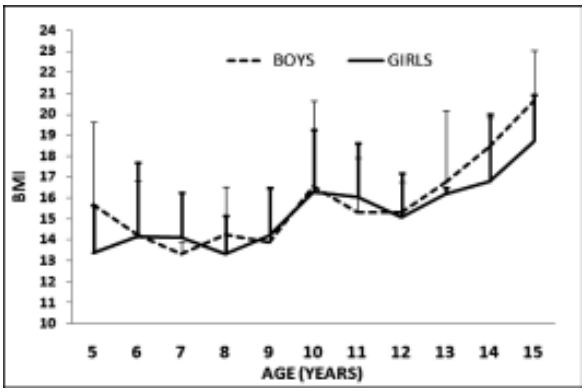

Fig. 3 Comparison of mean BMI between LMIG Bengalee boys and girls

The body surface area (BSA) of both boys and girls has been found to increase from 10 years of age but the differences were not significant at that age. Adolescent girls showed higher BSA than adolescent boys at 10-12 years of age.

Although the present study did not show significant variation in WHR between boys and girls but the maximum increase in WHR was seen among LMIG Bengalee boys at 11-12 years of age. After 12 years, the adolescent girls showed gradual increasing trend than boys of same age.

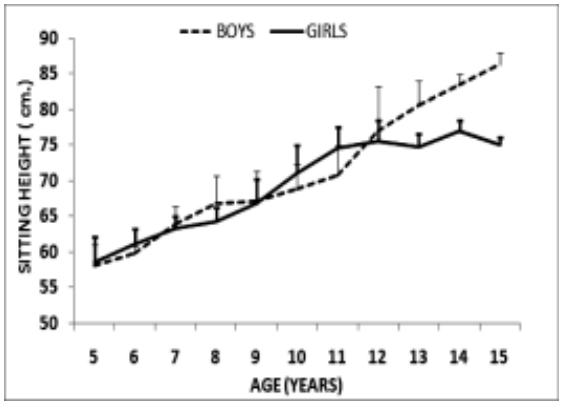

Fig.4 Comparison of mean sitting height between LMIG Bengalee boys and girls

The peak sitting height velocity was reached at 10 years of age by LMIG Bengalee girls (71.00cm±3.92) and at 11 years (70.81cm±4.08) by Bengalee boys (Fig. 4). The peak leg length velocities (Fig. 5) were attained by the age of 11-12 years for girls (76.13cm±9.80) and 12 -13 years for boys (76.28cm±5.99). So the peak leg length velocity was delayed than the sitting height for both sexes.

Fig.5 Comparison of mean legtength between LMIG Bengdlee boys and girls

The skinfold thickness at biceps, triceps, subscapular and suprailiac of LMIG Bengalee boys and girls showed some fluctuated data which may be due to individual variations. Maximum increase in skinfold thickness at biceps was found at 10 years of age ($p<0.05$) for both sexes (girls=11.66mm±3.49 and boys=11.11mm±3.39) after which it gradually decreased and again increased at 14 years of age for both sexes (girls=13.04 mm±2.07 and boys=13.9 mm±0.71) (Fig. 6).

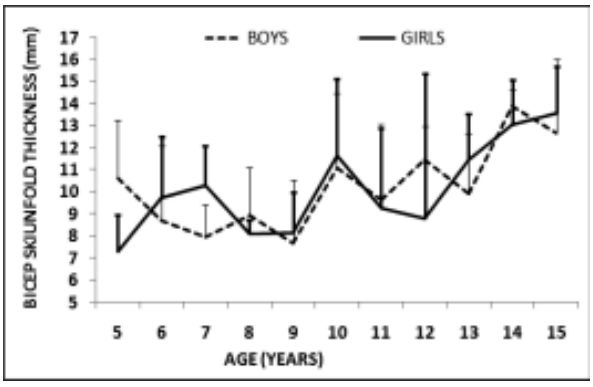

Fig.6 Comparison of bicep skinfold thickness of LMIG Bengalee boys and girls

In case of subscapular skinfold thickness, girls were found to have greater skinfold thickness than boys of all age groups as shown in Fig.7. The subscapular skinfold thickness increased significantly ($p<0.05$) with increasing age for both boys and girls except at 12 years of age which showed lower skinfold thickness at subscapula for both boys and girls.

The tricep and suprailiac skinfold thickness also increased in an irregular manner with the increasing age for both boys and girls but did not show significant changes. However, from 10-13 years of age tricep skinfold thickness increased markedly in these boys and girls. Maximum differences of suprailiac skinfold thickness of Bengalee girls were noticed at 10 and 11 years of age (1.42 mm±3.27 and 2.43 mm±4.42) then it decreases and again increases at 14 years of age but in case of boys,suprailiac skinfold thickness gradually increases and reaches highest at 15 years of age.

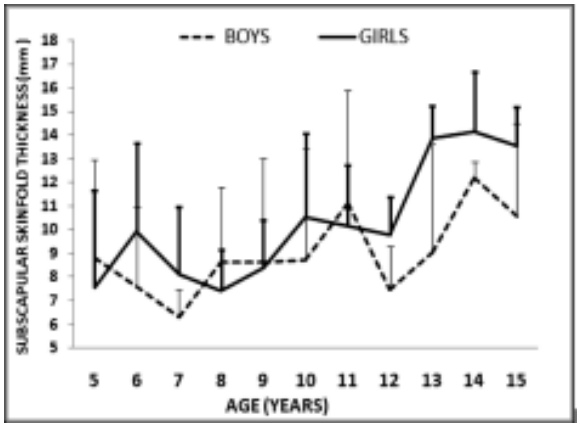

Fig.7 Comparison of subscapular skinfold thickness of LMIG Bengalee boys and girls

So, in the current study, with increasing age, LMIG Bengalee girls showed higher skinfold thickness at bicep, tricep, subscapular and suprailiac region than that of LMIG Bengalee boys during adolescence period, which indicates that Bengalee girls have greater body fat% than boys in the later phase of adolescence(Fig. 8).

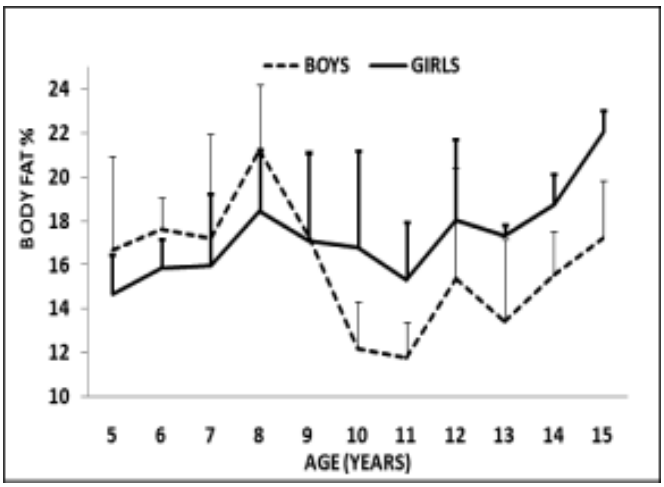

Fig.8 Comparison of body fat percentage between LMIG Bengalee boys and girls

The nutritional status assessment of the LMIG Bengalee boys and girls were done by 24 Hours Recall method for 3 consecutive days, where their age specific nutrient consumption showed that the daily calorie consumption of Bengalee boys and girls was low considering ICMR 2010 recommendation. Major portion of their diet is occupied by high-cereals and low-protein food. Though subjects belonging to lower middle income group were able to consume more fresh and nutritious food,very few consumed proper balanced diet which is probably due to their high concern about certain body type.

So the seven physical measurements of the present study showed that onset of growth spurt occurs during 9 to 10 years of age for LMIG Bengalee girls and 11-12 years of age for LMIG Bengalee boys that correspond to the adolescent growth spurt.

DISCUSSION

Although studies have been conducted earlier on the anthropometric assessment and nutritional status in school children and adolescents (de Onis & Blossner, 1997), there is sparse information on younger and older children and adolescents. Lack of information and difficulty in interpreting anthropometric data of this age group are the obvious reasons behind this.A secular trend which implies a consistent tendency to change in growth and development in a particular direction over a long period of time could be eminent indicator of improvement in socio-economic and socio-hygienic conditions of a population (Agarwal *et al*, 1992). In the past few decades, the children worldwide have become taller and heavier, indicating a clear secular trend, with increase in height and weight over time (Agarwal *et al*, 1992). In the present study subjects, secular trend in physical growth pattern was also observed when present data were compared with similar study done on South Indian and American boys and girls of same age group.

Analysis of the growth anthropometry among the lower middle income group children and adolescents of West Bengal revealed that onset of growth spurt of Bengalee boys and girls differed and that the rate of increase was however, not uniform for all the physical growth traits. Here the height spurt for girls of current study was seen at 9-12 years of age whereas that of boys occurred during 11-13 years, which indicates earlier growth spurt when compared with similar study done on high income group (HIG)Bengalee boys and girls in Kolkata(Mukhopadhyay *et al*, 2005),where the maximum height spurt for girls was measured between 9-10 years (5.84cm) and 10-11 years (6.6 cm) and the maximum height increment in boys was found in between 12-14 years (7.51cm in 12 –13 years and 7.58 in 13 --14 years). Again, if the present data of LMIG Bengalee girls and boys are compared with the Indian girls and boys of same age group of upper socio-economic group of different zone of India (Vijayaraghavan *et al*, 1971),it showed similar trend of increment in height spurt for girls at 10-12 years of age (6.9cm and 6.4cm)and boys at 13-14 years of age (7.6cm).However, American boys (14 years, 8.4cm±0.83) and girls(11 years, 8.1cm±0.86) were found to be taller than the Bengalee boys and girls of current study in all age groups (CDC. 2002b. NHANES 1999-2002). The rapid increase of height in the age of 9 and 11 years for LMIG girls and boys respectively, corresponds to the adolescent growth spurt. Hence, in case of height, LMIG Bengalee boys as well as girls were found to be significantly ($p<0.05$) taller than their urban counterparts (Mukhopadhyay *et al*, 2005) but shorter than American adolescents.

In contrast, the age of peak weight increment for LMIG Bengalee boys and girls was observed at 9-10 and 12- 13 years of age, whereas the similar study done on HIG Bengalee boys and girls (Mukhopadhyay *et al*, 2005) reported the age of peak weight increment at 11-13 years(3.38kg and 3.99kg) and 10-11 years of age(10.51kg) respectively. So, it has been noticed that LMIG Bengalee boys and girls were heavier than Bengalee boys and girls of high socio-economic status.

From another point of view, the mean body weight of present study subjects corresponds to affluent Indian of same age group (Vijayaraghavan *et al*, 1971; Agarwal *et al*, 1992).Since, the maximum weight increment of Indian boys reported at 13 -15 years was measured as 4.9kg and 3.8kg and for Indian girls as 6.2kg at 11- 12 years of age, their maximum weight increment was delayed than the present study group.In reference to CDC.2002b NHANES 1999 – 2002 data,the maximum weight increment of American boys was found at 11-12 years (6.7kg±1.1) and 13-14 years of age (10kg±1.86) and that of American girls at 10-11 years (7.9kg±1.03) and 12-13 years of age (5.7kg±1.06).Thus, the mean body weight of LMIG and HIG Bengalee and affluent Indian children and adolescents was much lower than the mean body weight of American children of same age group but the growth pattern of Bengalee children and adolescents showed gradual improvement in relation to anthropometric reference data for American children and adults which may be due to their environment upliftment (Banerjee *et al*, 2009).

In the present study, mean BMI increased progressively for LMIG Bengalee boys and girls, from 10 years onwards. Despite similar trend in present study, comparison with HIG Bengalee boys and girls(Mukhopadhyay *et al*, 2005)showed maximum increment of BMI in HIG Bengalee boys at 12 years (16.12) and HIG Bengalee girls at 11years (16.91). In both LMIG and HIG, Bengalee boys had greater BMI than the Bengalee girls of all age groups, which may be due to self induced restriction of energy intake or self selection of certain body type by girls. This was more observed in girls than in boys (Rogol *et al*, 2000).Again in comparison with other Indian studies (de Onis *et al*, 2001; Marwaha *et al*, 2011), the mean BMI value of the present study subjects were far below than Indian affluent children and adolescents of both sexes. Among American boys and girls the BMI for age was higher than Bengalee and Indian boys and girls and reached 16.50kg/m^2±0.30 and 16.10kg/m^2±0.29 at 5 years of age in case of boys and girls respectively (CDC. 2002b NHANES 1999-2002). Based on WHO classification of malnutrition, LMIG Bengalee boys showed moderate malnutrition than girls during childhood but during adolescent period, girls showed chronic undernutrition, which indicated prevalence of thinness with increasing age.Similar findings were also reported among HIG Bengalee boys and girls (Mukhopadhyay *et al*, 2005).

This study revealed that the peak sitting height velocity was reached between LMIG Bengalee girls at 10 years and boys at 11 years and the difference was significant ($p< 0.05$) at that age.In comparison with the another Indian study on affluent children from different zones of India (Agarwal *et al*, 1992),peak sitting height velocity reached at 11 years for both girls (72.5cm)and boys (71.9cm) and the same trend was also found among well-off northwestern Indian children (Pathmanathan & Prakash, 1994)where peak sitting height velocity was reached at 11 years for girls but at 14years for boys.On the other hand, the peak leg length velocity in LMIG Bengalee girls was delayed at 11-12 years and for boys

12-13 years while leg length velocity of affluent children from different zones of India (Agarwal *et al*, 1992) was reached at peak value between 14-15 years in girls (75.2cm) and 13-14 years in boys (76.5cm). The peak leg length velocity of well-off northwestern Indian children was attained one year earlier in girls (10 years) than that of peak sitting height velocity but in boys at the same age as when maximum sitting height (Pathmanathan & Prakash, 1994) was attained.

Comparison of the attained mean values with the British standards (Buckler JMH, 1990) showed that while sitting height is shorter in the Indians throughout ages and the leg length is longer until 12 years in girls and until 14 years in boys, it is observed to be equal to that of the British.This differential growth of the two segments comprising stature produces shorter adult height among Bengalee as well as the Indian population.As the differences in stature of Bengalee, Indian and British children and adolescents occur due to differences in trunk growth, the British children and adolescents were found to be taller due to more trunk growth than Bengalee and Indian children and adolescents of same age group (Agarwal *et al*,1992). Moreover, maximum increment of the upper and lower segment of the body was reached at an earlier age in the present study than in a longitudinal analysis of Bengalee boys belonging to similar economic background of West Bengal. Socio-economic differences, environmental factors and secular trend might explain this earlier maturation (Dasgupta & Das, 1997).

Skinfold thickness at biceps, triceps, subscapular and suprailiac manifested the presence of body fat% and also denoted loss in thickness during adolescence. The result identified that biceps skinfold thickness in LMIG Bengalee boys and girls increased gradually with minor irregularities in the means from 7 to 9 years and reached a peak value at 10 years for both sexes, which was one year earlier than that of peri-urban adolescent Bengalee girls as reported in the previous study (Banerjee *et al*, 2009).The mean values of biceps, triceps, subscapular and suprailiac thickness of current study subjects was increased at 10–11 years of age and then declined between 12–13 years,after which it again increased,indicating"pre-adolescent and post- adolescent fat wave." Similar thinning of fat layer of upper limb and lower trunk during adolescent growth spurt among LMIG Bengalee boys and girls showed the same trend as in upper class Kolkata boys (Dasgupta P, 1991) as well as Indian boys in general (Falkner F, 1975).The mean value of skinfold thickness when compared between both sexes,indicated upward trend from10 years onwards for both sexes like other studies on Bengalee children (Dasgupta P, 1991).The skinfold thickness in upper limb was seen at 10-11 years among girls whereas increase of those variables among boys' group was observed between 10 to 12 years of age which also corresponds to others' Indian studies among HIG adolescents. The skinfold thickness at different sites among Indian adolescents was observed to be much lower than that of Bengalee boys and girls (Agarwal *et al*, 1992; Dasgupta P, 1991). However American boys and girls have greater skinfold thickness than Bengalee and Indian boys and girls but girls have greater subscapular skinfold thickness than boys of all ages (CDC. 2002b. NHANES 1999-2002). Besides this, during childhood, it has been observed that initially boys have more body fat percentage than girls but with the increasing age girls gain greater body fat mass and boys gain greater muscle mass. This happens at a later stage of age specially after 15 years.

Since, the present study subjects consumed mostly high cereals based low protein diet daily so their calorie consumption was low in respect to ICMR 2010 during their growth period. In addition to this, low meal frequency or willful wastage of food or food avoidance may lead to moderate to chronic malnutrition among Bengalee boys and girls during childhood and adolescent period. Moreover, recent craze of self induced calorie restriction was observed among the LMIG Bengalee girls for maintaining ideal body image, which leads to moderate malnutrition in girls and less so in the boys.

A majority of the body measurements in the current study showed a high rate of increase in the age group of 9 and 11 years that corresponds to the adolescent growth spurt, which was earlier than the average age of onset of HIG Bengalee as well as Indian adolescence. It has been previously said that the physical growth and maturation in different age groups are influenced by different factors like genetic component, nutrition, physical activity and the environment etc, which may act independently or in concert (Qamra *et al*, 1990). As the lower middle income families get the benefits of both the urban and rural world, so they could afford fresh nutritious food at cheaper rate which may also have an impact on their physical growth which gets reflected in the growth pattern of LMIG Bengalee boys and girls. Besides this, association of physical activity, recent upgradation in environmental and socio-economic situation, better medical facilities, improved lifestyle, better living condition in lower middle income society of Bengal (Banerjee *et al*, 2009) was observed in the form of secular trend in their general health status and this could be a plausible reason attributed to the early onset of adolescence among the LMIG Bengalee boys and girls (Anderson JJB, 2000).

CONCLUSION

The results suggest that the growth pattern observed among the LMIG Bengalee children and adolescents show heterogeneity with respect to some traits and a majority of the physical measurements of the present study showed onset of growth spurt during 9 to 10 years of age for girls and 11-12 years of age for boys, which corresponds to the adolescent growth spurt. Interestingly, this is earlier than the average age of onset of Indian adolescents. Skinfold thickness of LMIG Bengalee boys and girls indicated thinning of fat layer of upper limb and lower trunk during adolescent growth spurt for both sexes. Moreover, moderate to chronic undernutrition was observed among Bengalee boys and girls during their growth period.

In view of the changing pattern of growth in a population over time, it is recommended that growth references be updated regularly.Further studies on these age-groups are necessary for comprehending growth as well as nutritional status of children and adolescents in areas where similar rural and semi-urban settings exist.

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