AN ATTEMPT TO DETERMINE THE REFERENCE FOR HEIGHT, WEIGHT AND NUTRITIONAL STATUS OF ADOLESCENTS IN KOLKATA

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Adolescent period is a crucial phase in the life cycle because it offers the last chance of catch-up growth. Achievement of optimum growth during this period is of utmost importance in maintaining good health thereafter. Growth monitoring during adolescence is not only an important health indicator but also a predictor of various morbidity in the community. World Health Organization (WHO) Expert Committee suggested that regionwise progressive monitoring of height and weight serves as reliable means to evaluate the growth pattern in children and adolescents. Non-availability of height and weight reference for adolescents in Kolkata prompted us to undertake the present study to determine the reference of height and weight for adolescents in Kolkata, to compare them with National Centre for Health Statistics (NCHS) and Indian Council of Medical Research (ICMR) references and also to determine the nutritional status of adolescents in Kolkata. Studies were conducted on 9488 boys and 9091 girls in the age group of 10 to 16 years studying in various schools located in different regions of Kolkata. Age of the students was verified from the school records. Their height to the nearest centimeter, weight to the nearest 0.5 kg while the subjects wore their normal school uniform without shoes and mid-arm circumference (MAC) to the nearest centimeter were measured. Their BMI was calculated as kg/m^2. Girls in the age group of 11 and 12 year are taller where as, girls in the age group of 14 to 16 year are shorter than the boys. Girls at the age of 11 to 14 year are heavier and at 15 and 16 year are having less body weight than the boys. These differences may be due to girls attaining puberty on an average at the age of 11 year and boys at the age of 14year. Boys and girls in the age group of 10 to 16 year of Kolkata are taller than the Indian reference but shorter than the NCHS reference. They are heavier than the Indian reference but having less weight than the NCHS reference. Nutritional status of the present study population judging from their BMI is more or less satisfactory. Resulfant percentile graphs of height and weight of the present study may be used as reference to find out the growth pattern and the BMI percentile graphs may be used as reference to find out the nutritional status in the age group of 10 to 16 years for Kolkata adolescents.

Adolescents are persons aged 10-19 years. The period of adolescence is a crucial phase of growth and offers the last chance of catch-up growth. Achievement of optimum growth during this period is of utmost importance in maintaining good health thereafter. Simple measurement of height and weight serve as reliable means to evaluate the growth of a child and also to detect gross abnormalities even when no other clinical sign of illness is manifested (Khadgavat *et al.* ,1998). In 1993 a World Health Organization (WHO) Expert Committee made provisional recommendations for the interpretation of anthropometric data during adolescence (WHO, 1995).

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Growth monitoring by anthropometric measurement during this period, is not only an important health indicator but also a predictor of various morbidity in the community. Though the anthropometry is universally applicable, simple, inexpensive and non-invasive technique, it is still an underutilized tool for guiding public health policy as well as individual clinical decision. WHO Expert Committee recommended the use of the National Center for Health Statistics (NCHS, 1987) reference population to be consistent with the currently advocated international growth reference for children. These reference data were proposed for identifying individuals and populations at risk, assessing response to interventions, and facilitating international comparisons.

In a country like India with wide variation in the growth determinants, it is essential that the normal values are developed region-wise and are redefined from time to time (Singh *et al* 1992; Mandowara, 1986). Most of the attempts of generating anthropometric profile have so far focused on pre-school children and a very few have dealt with adolescents age groups (Qumra,1990). Non-availability of an anthropometric reference for adolescent of Kolkata especially for lower socio-economic class and lower middle class prompted us to undertake this study. It has been carried out to develop the mean, standard deviation and percentile values for weight, height, BMI and mid-arm circumference for studied population and to compare them with national standards projected by Indian Council of Medical Research (ICMR, 1989; ICMR, 1995) and NCHS (Hamill *et al*. 1979; NCHS, 1987) standards.

MATERIALS AND METHODS

Study protocol

The study was carried out in 27 boys and 33 girls of high schools, located in various regions of Kolkata, selected by stratified random sampling technique. A total number of 18561 adolescents (boys, 9470 and girls, 9091) in the age of 10 to 16 years studying in standard V to VIII were included in this study. They were grouped according to their age considering each year as a group. Prior permission was obtained from the school authorities. The purpose and the method of the study were explained to all the participants and their teachers'. Age of the adolescents was verified from the school records and recorded in completed years.

Anthropometric measurements

Height of the adolescents was recorded to the nearest centimeter by using an anthropometer rod. The adolescents were weighed using a lever-actuated platform type balance to the nearest 0.5 kg while they wore their normal school uniform. Body Mass Index (BMI), which is weight in kg/height^2 in meter, were calculated, because the relationship between weight and height is best expressed by this variable. Mid-arm circumference (MAC) of the adolescents was measured to the nearest centimeter using a flexible measuring tape.

Statistical analysis

Data entry was made using Excel 2000 ™ Software (Microsoft Inc, USA). Statistical analysis of the data was done by using Stat View ™ Software (SAS Institute, USA). Mean with standard deviation (SD) and some selected percentile values (5th, 10th, 25th, 50th, 75th, 85th, 90th and 95th) were calculated for weight, height, BMI and MAC for all ages. Mean values thus obtained in each age group of both the sexes, were compared with that of ICMR (including all socio-economic classes of various states of India) and NCHS

references. In order to test the significance of the differences between the values of one age group and those of the immediate lower age group, unpaired t-test was used.

RESULTS

Physical characteristics

Physical characteristics including height, weight, MAC and BMI of the study population is reflected in Table 1. Each age group from 10 to 16 years of both sexes was represented by good number (n) of subjects. With the advancement of age, noteworthy increase in height, weight, MAC and BMI was observed in both sexes. At the age of 10 years, height and weight of the boys and girls are almost at par. At the age of 11 and 12 years, girls are significantly taller and heavier than the boys. At the age of 13 years, though the height of the boys and girls is almost same but the girls are significantly heavier than the boys. At the age of 14 years, boys are significantly taller than the girls but the girls are significantly heavier than the boys. At the age of 15 and 16 years, boys are significantly taller and heavier than the girls. MAC is significantly higher in girls than the boys in the age group of 10 to 14 years, whereas this is almost same in both sexes at 15 and 16 years. BMI is significantly higher in girls than the boys in all the age groups.

Table-1
Physical characteristics of the study population
(Values are Means ± SD)

AGE (yr)	Boys					Girls				
	n	Height (cm)	Weight (kg)	MAC (cm)	BMI (kg/m²)	n	Height (cm)	Weight (kg)	MAC (cm)	BMI (kg/m²)
10	1613	131.2 ± 8.0	25.8 ±5.9	17.1 ±2.2	14.9	1598	131.8 ±8.2	26.8 ±6.6	17.5[a] ±2.2	15.3[a] ±2.6
11	1649	136.4 ±7.7	28.3 ±6.2	18.1 ±2.6	15.1 ±2.2	1613	139.1[a] ±8.2	32.1[b] ±6.6	18.7[b] ±2.2	16.4[b] ±2.6
12	1687	141.8 ±8.5	31.9 ±7.6	18.8 ±2.6	15.7 ±2.6	1599	144.6[a] ±7.4	35.9[b] ±8.5	19.4[b] ±2.5	17.1[b] ±3.2
13	1475	148.1 ±9.0	35.4 ±8.3	19.2 ±2.6	16.0 ±2.5	1450	148.3 ±6.3	39.9[b] ±8.9	20.4[b] ±2.8	18.1[b] ±3.5
14	1328	155.3[b] ±8.5	40.6 ±8.8	20.3 ±2.6	16.7 ±2.7	1219	150.3 ±6.2	43.0[a] ±9.2	21.1[b] ±2.8	19.0[b] ±3.7
15	1055	160.7[b] ±7.5	45.4[b] ±8.9	21.4 ±2.5	17.5 ±2.7	1007	151.0 ±5.8	3.8 ±9.4	21.6 ±2.8	19.2[b] ±3.8
16	663	162.6[b] ±7.3	47.6[b] ±9.0	21.9 ±2.5	17.9 ±2.8	605	151.6 ±5.2	44.7 ±8.6	21.7 ±2.7	19.4[b] ±3.6

a= $p<0.05$, b=$p<0.01$ (as compared to the opposite sex of the same age group)

Comparison with ICMR reference and NCHS

Comparison of height of the study population with ICMR reference and NCHS reference is depicted in Fig.1. Both boys and girls in all the age groups of 10 to 16 years are taller than the Indian reference but shorter than the NCHS reference.

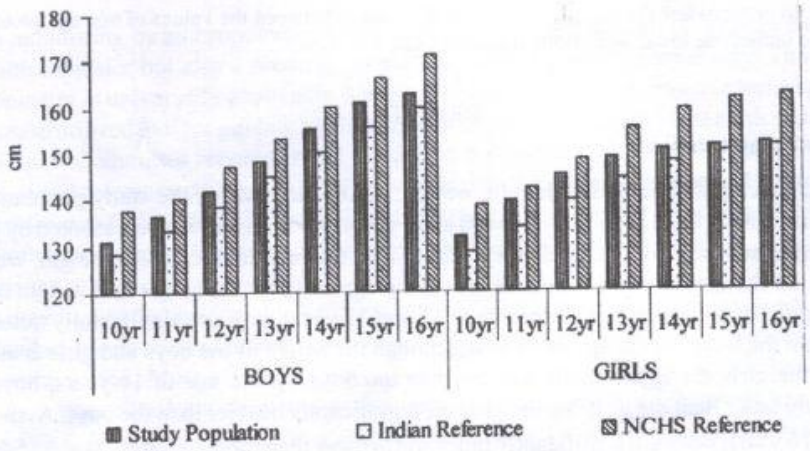

Fig. 1. Comparison of height of the study population with Indian reference and NCHS reference

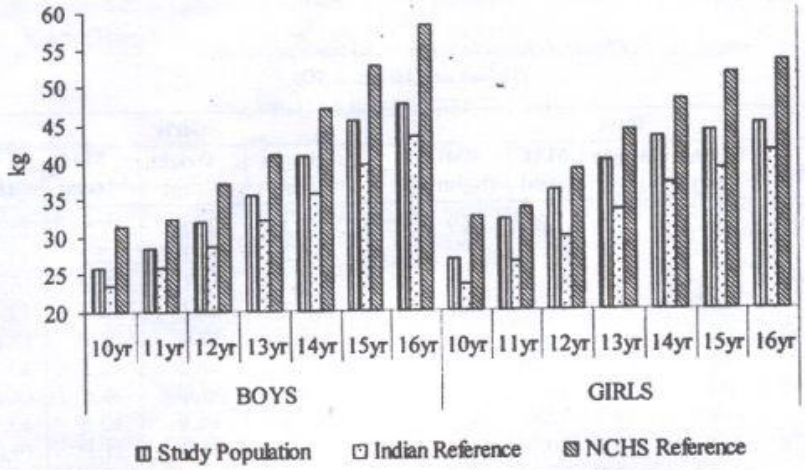

Fig. 2. Comparison of body weight of the study population with Indian reference and NCHS reference

Fig. 2 shows the comparison of body weight of the study population with ICMR and NCHS reference. Boys and girls in all the age groups of the study population are heavier than the Indian reference but having less body weight than the NCHS reference.

Comparison of BMI values of the study population with ICMR reference and NCHS reference is reflected in Fig.3. BMI values of both the sexes in the study population are higher as compared to the Indian reference but lower than that of NCHS reference.

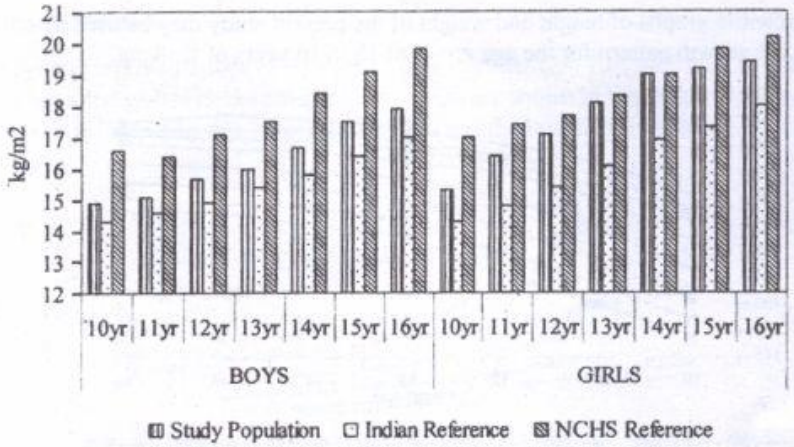

Fig. 3. Comparison of BMI of the study population with Indian reference and NCHS reference

Height and Weight status

Graphical representations of selected height percentiles (5th, 10th, 25th, 50th, 75th, 85th, 90th and 95th) of boys and girls with the advancement of age are shown in Fig.4 and Fig.5, respectively.

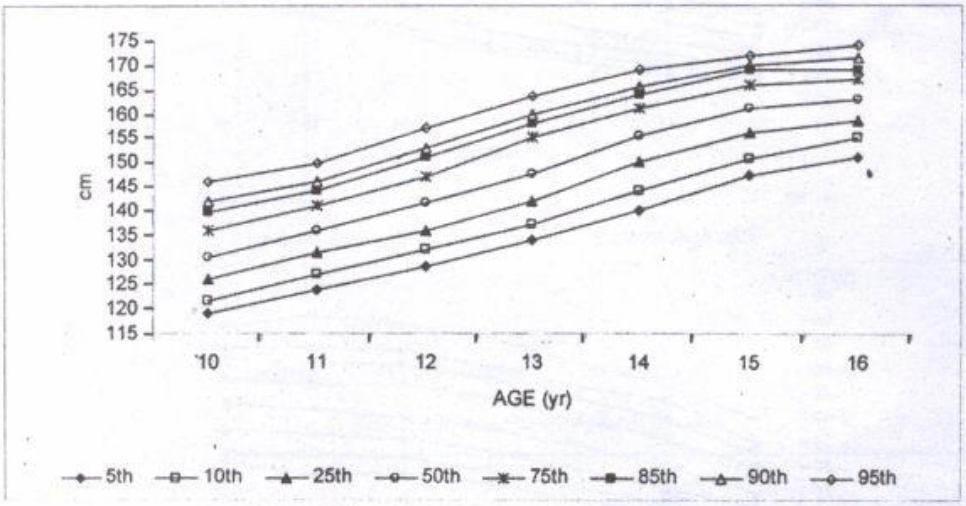

Fig. 4. Selected height percentile graph for boys

Graphical representations of selected body weight percentiles (5th, 10th , 25th , 50th 75th, 85th, 90th and 95th) of boys and girls with the advancement of age are shown in Fig.6 and Fig.7 Arespectively.

The percentile graphs of height and weight of the present study may be used as reference to find out the growth pattern for the age group of 10 to 16 years of Kolkata.

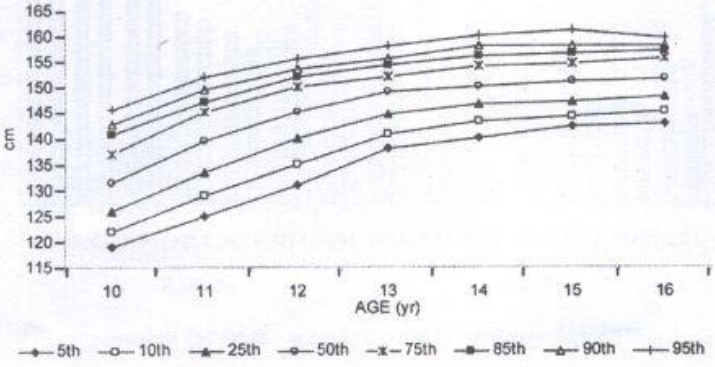

Fig. 5. Selected height percentile graph for girls

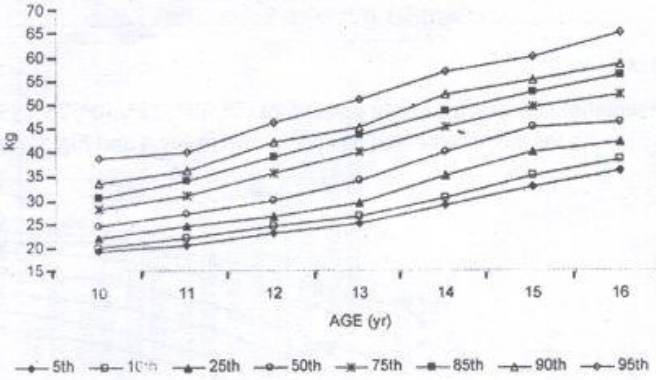

Fig. 6. Selected body weight percentile graph for boys

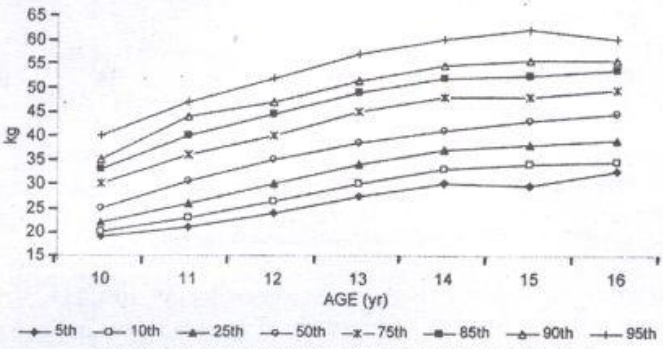

Fig. 7. Selected body weight percentile graph for girls

Nutritional status

Graphical representations of selected BMI percentiles (5th, 10th, 25th, 50th, 75th, 85th, 90th and 95th) of boys and girls with the advancement of age are shown in Fig. 8 and Fig.9, respectively. These percentile graphs can be utilized to find out the nutritional status of an adolescent in Kolkata.

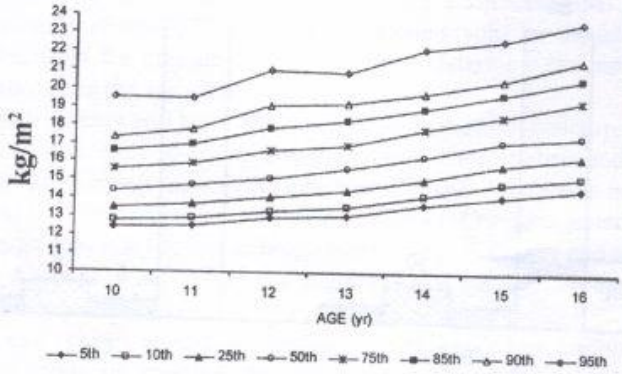

Fig. 8. Selected BMI percentile graph for boys

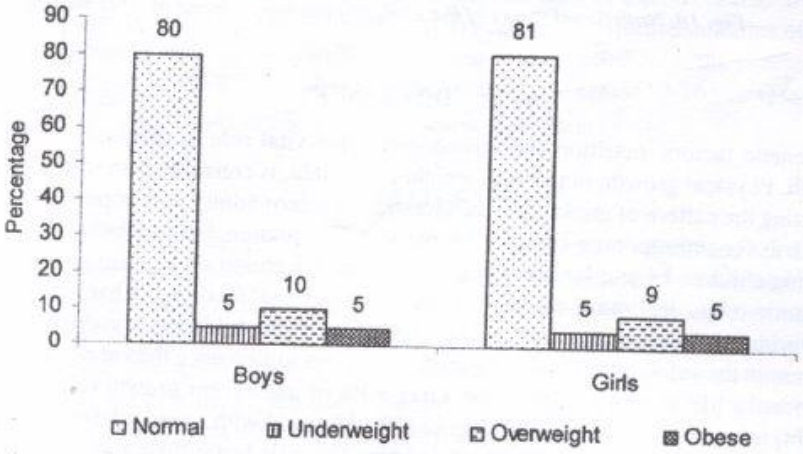

Fig. 9. Selected BMI percentile graph for girls

Nutritional status of the study population is reflected in Fig. 10. BMI values of 80% boys and 81% girls are between 5th and 85 th percentiles showing their normal nutritional status. Among the boys 20% and among the girls 19% are malnourished. Out of these, 5% each of boys and girls are underweight (BMI < 5th percentile), signifying that they are on regular energy-deficient diet. Overweight (BMI > 85th percentile to 95th percentile) is found to be 10%

among the boys and 9% among the girls, whereas 5% each of boys and girls are obese (BMI > 95th percentile). This result signifies that the overweight and the obese children are not either taking proper nutritionally balanced diet regularly or they are in the habit of consuming fast food and junk food with regular intervals.

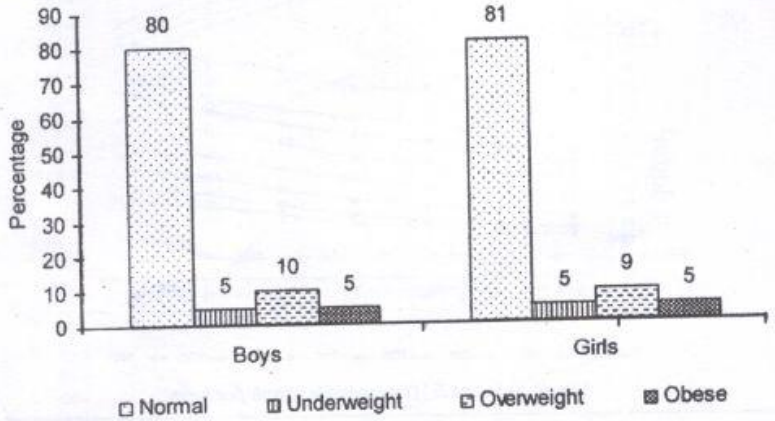

Fig. 10. Nutirtional status of the study population in terms of BMI volumes

DISCUSSION

Genetic factors, nutrition and environment play vital role in children's and adolescents' growth. Physical growth, in terms of weight and height, is considered an important parameter reflecting the pattern of growth and development in a community. It is important to set national standards for anthropometric profile for the growing children. In the developing countries, the growing children by and large are deprived of good nutrition on account of their poor socio-economic status, ignorance and lack of health promotional facilities (Khan *et al*. 1990).

During adolescence, the relatively uniform growth of childhood is suddenly altered by an increase in the velocity of growth. Growth is faster in adolescence than at any other time in the individual's life except the first year. Over 80% of adolescent growth (attained height and weight) is completed in early adolescence (10 - 15 years) with a marked deceleration in height and weight velocity in the post-pubertal phase. The girls begin their adolescent growth spurt at an average of about 10 years and grow at peak velocity at about 12 years. These ages vary from country to country, being lowest in developed countries and highest in underdeveloped countries. In the present study conducted on the adolescents of Kolkata we have observed that the height and weight of the boys and girls showed steady significant increase ($p<0.01$) in each year with the advancement of age from 10 years to 16 years. In case of BMI and MAC, steady significant increase ($p<0.01$) was observed in each year from 10 years to 14 years of age, and then after, though the increase was observed from 14 years to 15 years and from 15 years to 16 years but was not statistically significant.

BMI can be used as an index of thinness and overweight in children and is more easily obtained (Bileaucz *et al* 1962). This may be used as an indirect measure of obesity and correlated with the more direct measure of adiposity (Hammer *et al.* 1991). Adult BMI increases slowly with age so that the age-independent cut-off values can be used to grade obesity. In children and adolescents, however, BMI changes substantially with age, rising steeply in infancy, falling during preschool years and then again rising into adulthood (Cole *et al.* 1995). Because they have not long been available, child and adolescent BMI percentile graphs are relatively untried in clinical practice. BMI percentile graphs for the adolescents of both the sexes obtained from the present study may help to determine the nutritional status of the Kolkata population in the age group of 10 to 16 years.

In India short stature and low BMI may be determinants of concurrent functional impairment due to reduced lean body mass, changes in muscle metabolism and deficiencies in muscular strength and working capacity (Gupta *et al.* 1994) and reduction in higher mental functions (Agarwal *et al* 1998; Agarwal *et al.*1995). Adhikari (1999) suggested that it is high time to adopt BMI as an age-independent anthropometric data universally and as a routine for growing children. Agarwal *et al*, (2001) also suggested that children during adolescence period should be monitored for BMI.

India is a vast country with widely varied environment, where various ethnic groups with different food habits are residing. As such, it is important to set regional anthropometric standards for growing children. The present study indicates that adolescents of both sexes in the age group of 10 to 16 years of Kolkata are taller and heavier than the Indian reference but shorter and having less body weight than the NCHS reference. Nutritional status of the present study population is more or less satisfactory. It can be concluded from the present study that these results may provide the growth standards for the adolescents (10-16 years) especially for lower socio-economic class and lower middle class of Kolkata.

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