

# Cross-sectional Growth Curves for Height, Weight and Body Mass Index for Affluent Indian Children, 2007

VV KHADILKAR, AV KHADILKAR, TJ COLE AND MG SAYYAD

From Growth and Paediatric Endocrine Research Unit, Hirabai Cowasji Jehangir Medical Research Institute, Jehangir Hospital, 32, Sassoon Road, Pune, India.

Correspondence to: Dr Vaman Khadilkar, Consultant Paediatric Endocrinologist, Hirabai Cowasji Jehangir Medical Research Institute, Jehangir Hospital, 32, Sassoon Road, Pune 411 001. E-mail: akhadilkar@vsnl.net

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**Background:** The assessment of growth is crucial in child care and reference data are central to growth monitoring. As the pattern of growth of a population changes with time it is recommended that references be updated regularly.

**Objective:** To produce contemporary growth curves for Indian children from 5-18 years for height, weight and BMI.

**Design:** Cross-sectional.

**Setting:** Multicentric, School based. Participants: 19834 children were measured from 10 affluent schools from five major geographical regions of India. Data were analyzed on 18666 children (10496 boys and 8170 girls) using the LMS method and smoothed percentiles 2007 were produced.

**Results:** Compared to the 1989 data, median height at 18 years was 0.6 cm greater for boys but unchanged for girls, while the 97th height percentile had increased by 1.7 cm for boys and 2 cm for girls. Boys and girls were heavier and taller at almost all ages. The study also showed that boys and girls were taller at a younger age.

**Conclusions:** Contemporary cross sectional reference percentile curves for height, weight and body mass index for the assessment of physical growth of present day Indian children are presented.

**Key Words:** *Body Mass Index, Growth, Height, India, Weight.*

The assessment of growth by objective anthropometric methods (weight, length/height and body mass index) is crucial in child care to assess the nutritional status and for the identification of growth failure. Reference data are central to growth monitoring and they help doctors and policymakers to diagnose under nutrition, overweight and obesity, and other growth-related conditions.

The pattern of growth of a population of any age changes with time and hence it is recommended that references should be updated regularly(1). The 1977 National Center for Health Statistics (NCHS) growth curves for US children were revised in 2000, while the UK curves, first published in 1966, were revised in 1990(2-5). Nationwide growth surveys have been performed every 10 years in Mainland China since

1975(6). Reference values for children in Hong Kong first published in the 1960's, were updated in 1985, and were updated again in 1993(7).

India is in a phase of nutritional transition and thus it is vital to update growth references regularly(8). The currently available growth reference curves in use in India are based on the data collected by Agarwal, *et al.*(9,10) in 1989 which were published in 1992 and 1994 and were then adopted by the Indian Academy of Pediatrics for growth monitoring in 2007(9-11). These data are now 17 years old and there are doubts as to whether they are representative of the growth of present day

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Indian children. The populations of developed countries can generally be considered to have

achieved their full genetic growth potential, so there are no longer important socioeconomic gradients in growth, and a random sample of the population can be used for constructing growth curves(12). However, in a developing country such as India, children belonging to affluent families in urban areas have fewer constraints on growth than other children, thus making it necessary to measure these children for the purpose of reference curves(13).

The WHO has encouraged all countries and regions throughout the world to adopt the new WHO growth standards for children under 5 years of age published in April 2006, where the data collected were multi-country (including India) and community-based (Multicentre Growth Reference Study-MGRS)(14). Therefore, this current study excludes children under the age of 5 years. This study was planned to design new reference curves for height, weight and body mass index for affluent urban Indian children aged 5-18 years.

## METHODS

The study was initiated, coordinated and the data analyzed at the Hirabai Cowasji Jehangir Medical Research Institute, Pune in collaboration with the UCL Institute of Child Health, London. The study was approved by the Ethical Committee of the Hirabai Cowasji Jehangir Medical Research Institute, Pune.

*Selection of sites:* The Indian Academy of Pediatrics divides India into 5 zones, i.e. North, South, East, West, and Central. Ten study sites were selected from these regions (Delhi, Chandigarh, Chennai, Bangalore, Kolkata, Mumbai, Pune, Baroda, Hyderabad and Raipur). Investigators were identified at these sites and were provided with details about the study. The study staff identified the nutritionally well-off areas in their cities and made a list of schools catering to children of socioeconomically well-off families. The nutritionally well off areas were identified based on per capita income of cities (from IAP zones). Within the specified cities, affluent areas (i.e. areas without slum clusters, low income housing schemes and those with high land prices as published by Government agencies (Ministry of Urban

Development, Lands Division) were selected(15). Three schools were selected from those chosen by generating random numbers. The yearly fees of the selected schools were around Rs 10000 (Indian per capita income 2007-2008, Rs 2021/month)(16). Principals of the schools were approached and briefed about the study. Permission and informed consent were obtained from 2 schools each in east, north, central and south zones and at 3 schools in the west. Thus, a total of 11 schools were studied all over India.

*Data collection:* Data collection lasted from June 2007 to January 2008. At each site, the measuring team consisted of two observers, a doctor, a nurse and two data recorders. At most centers, the measurements were coordinated with the routine school medical examination to minimize disturbance to regular classes. All sites used similar measuring equipments, which were calibrated daily. Standing height was measured using a portable stadiometer (Leicester Height Meter, Child Growth Foundation, UK, range 60-207cm). The child stood in socks on the flat base of the stadiometer with the back of the head, shoulder blades, buttocks and heels touching the vertical rod, and head in the Frankfurt plane. Gentle traction was applied to the mandibular process and the headboard lowered. The reading was taken to the last completed mm, avoiding parallax, and two such readings were averaged for analysis. Weight was measured using portable electronic weighing scales (Salter, India) accurate to 100 g. Children not wishing to take part were excluded, while children with major medical illnesses likely to affect growth were measured but excluded from analysis. Data were coded to maintain anonymity.

*Training:* Measurements were performed by 17 graduate observers acquainted with the cities and local language. They were trained as per study protocol, and given written instructions about the calibration of instruments, measurement techniques, and data entry formats. They were tested for height inter and intra observer variability, using 20 children and 12 stadiometers, each observer measuring four children four times. Inter-observer and intra-observer coefficients of variation were both <0.01(1%) and there were no significant differences between observers.

*Data entry:* On completion of the survey at each site, the data were sent to Pune for entry. Data were entered using Microsoft Excel 2003 for Windows, and errors were trapped using range checks. A total of 19834 children were measured. Queries about inconsistent data were checked against the original data collection forms, and obviously erroneous measurements were excluded (1.1%,  $n=221$ ). Subjects aged <5 years or >18 years were also excluded ( $n=922$ ), as were data where the Z score exceeded  $\pm 5SD$  ( $n=25$ ) (17). Body mass index (BMI) was calculated as weight in Kg/height in meters<sup>2</sup>.

*Data analysis:* The cleaned data were then analyzed using the LMS method, which constructs growth reference percentiles adjusted for skewness(18). Each growth reference is summarized by 3 smooth curves plotted against age representing the median (M), the coefficient of variation (S) and the skewness (L) of the measurement distribution(19). The L, M and S curves convert measurements to exact SD scores using the formula:

$$SD\text{-score} = \left( \frac{[measurement / M(t)]^{L(t)} - 1}{L(t) S(t)} \right)$$

where measurement is the child's measurement (height or weight) and L(t), M(t) and S(t) are values read from the smooth curves for the child's age  $t$  and sex. The models were checked for goodness of fit using the detrended Q-Q plot, Q Tests and worm plots(20).

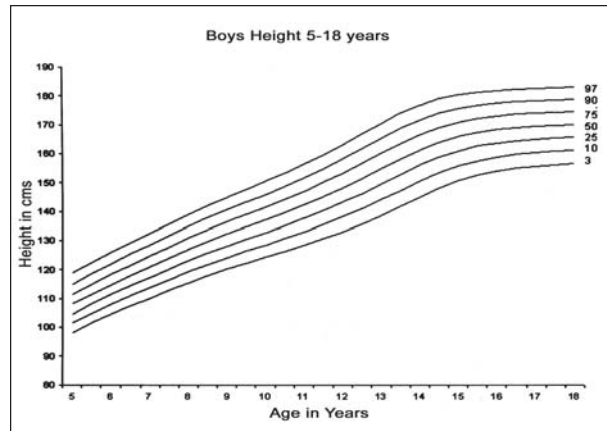
**RESULTS**

Of the 19834 children measured, measurements for 18666 were analyzed (10496 boys and 8170 girls) where 5184 (3218 boys, 1966 girls) 3000 (1678 boys, 1322 girls), 698 (696 boys, 1002 girls) 6920 (3837 boys, 3083 girls) and 1864 (1067 boys, 797 girls) children were from the North, South, East, West and Central zones, respectively. The differences between zones were not significant ( $P$  value: boys height 0.755, boys weight 0.722, boys BMI 0.48,  $P$  value: girls height 0.95, girls weight 0.14, girls BMI 0.11).

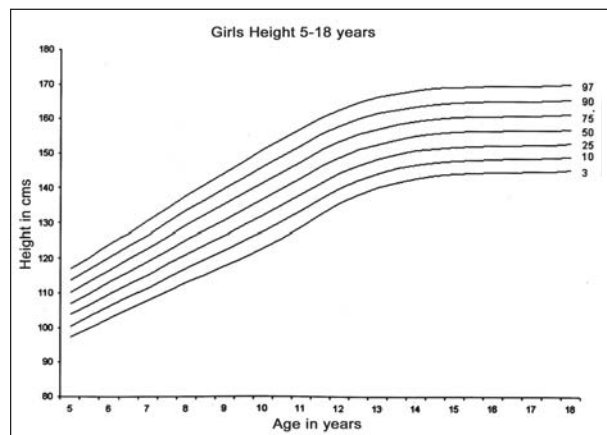
**Height, Weight and BMI**

*Figure 1* and *Fig. 2* show the smoothened height curves for Indian boys and girls in the study, using 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles, respectively. Equivalent height percentile values are shown in *Table I* and *Table II*, respectively. *Figure 3* and *Fig. 4* show the smoothened weight curves for Indian boys and girls using 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles, respectively. Equivalent weight percentile values are shown in *Table III* and *Table IV*, respectively. The secular trend of increasing height and weight are observed from these figures and tables.

*Figures 5, 6* and *Table V, VI* show the BMI



**FIG. 1** Reference curves for height percentiles for Indian boys using the conventional 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles.



**FIG. 2** Reference curves for height percentiles for Indian girls using the conventional 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles.

TABLE I HEIGHT PERCENTILES FOR INDIAN BOYS

Age (y)	3	10	25	50	75	90	97
5	98.3	101.4	104.7	108.1	111.6	115.2	118.9
5.5	101.5	104.8	108.1	111.6	115.1	118.7	122.5
6	104.7	108.0	111.4	114.9	118.5	122.2	125.9
6.5	107.5	110.9	114.4	118.0	121.6	125.4	129.2
7	110.1	113.7	117.2	120.9	124.6	128.4	132.3
7.5	112.7	116.4	120.1	123.9	127.7	131.6	135.6
8	115.4	119.1	123.0	126.9	130.8	134.8	138.9
8.5	117.9	121.8	125.7	129.8	133.8	137.9	142.1
9	120.1	124.2	128.3	132.4	136.6	140.8	145.0
9.5	122.2	126.4	130.6	134.9	139.1	143.4	147.7
10	124.3	128.6	132.9	137.2	141.6	146.0	150.4
10.5	126.3	130.7	135.2	139.7	144.2	148.7	153.2
11	128.4	133.1	137.7	142.4	147.0	151.7	156.3
11.5	130.8	135.6	140.5	145.3	150.2	155.0	159.8
12	133.1	138.2	143.3	148.3	153.4	158.4	163.4
12.5	135.6	140.9	146.2	151.5	156.7	161.8	167.0
13	138.5	144.0	149.4	154.8	160.1	165.4	170.6
13.5	141.7	147.3	152.8	158.2	163.6	168.9	174.1
14	145.1	150.6	156.0	161.4	166.7	171.9	177.0
14.5	148.2	153.6	158.9	164.1	169.2	174.2	179.1
15	150.8	156.0	161.1	166.1	171.0	175.8	180.6
15.5	152.8	157.8	162.7	167.5	172.3	176.9	181.5
16	154.1	159.0	163.8	168.5	173.1	177.7	182.1
16.5	155.1	159.9	164.6	169.2	173.7	178.2	182.6
17	155.8	160.5	165.1	169.7	174.2	178.5	182.9
17.5	156.3	160.9	165.5	170.0	174.5	178.8	183.1
18	156.7	161.3	165.9	170.4	174.7	179.0	183.3

percentiles for Indian boys and girls including the 75th, 85th and 95th percentiles. The gap between the 3rd and 97th percentiles was wider indicating much greater variability.

#### Comparison of 2007 and 1989 Data

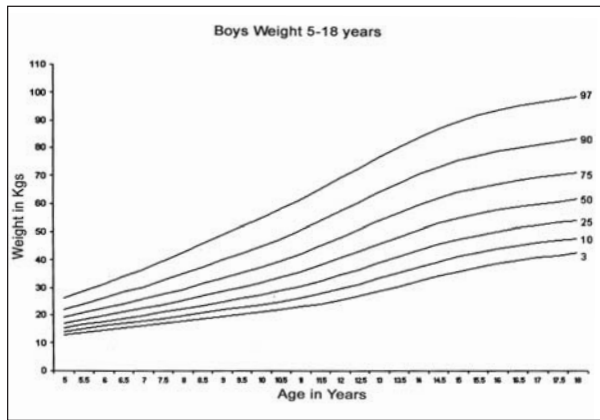
**Table VII** shows the comparison between 2007 and 1989 data for height, weight and BMI for boys and girls. The 50th percentile for boy's height was greater than that of the 1989 data at all ages. The 97th percentile at 18 years was 1.7 cm greater than in 1989. The 50th percentile for girls' height was greater than in 1989 at most ages, the greatest

difference being 3.1 cm at 12 years. The median final height was similar to 1989, but the 97th percentile was 2.4 cm greater, indicating increased variability.

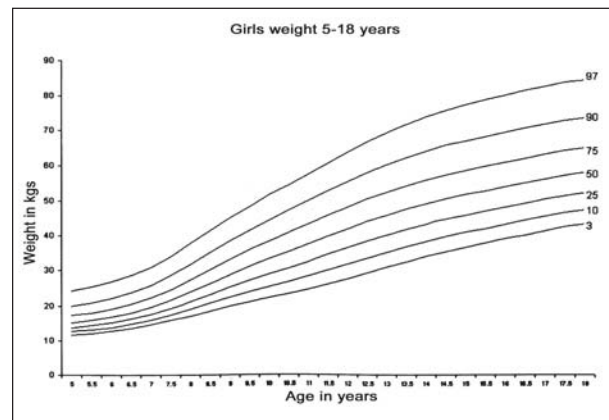
The 50th percentile for boys' weight was greater than in 1989 at all ages except 5 years, maximum 6.5 kg at 14 years reducing to 2.9 kg at 18 years. At 18 years the 97th percentile was 14.7 kg, higher than in 1989. The 50th percentile for girls weight was lower than the 1989 percentiles up to 6.5 years and higher afterwards, maximum 8.0 kg at 17 years. Unlike in boys, there was no reduction in difference in weight approaching adulthood. Compared with the 1989

**TABLE II** HEIGHT PERCENTILES FOR INDIAN GIRLS

Age (y)	3	10	25	50	75	90	97
5	97.2	100.4	103.7	107.0	110.3	113.7	117.1
5.5	100.0	103.3	106.7	110.1	113.5	117.0	120.5
6	102.7	106.1	109.6	113.1	116.7	120.2	123.9
6.5	105.3	108.9	112.5	116.1	119.7	123.5	127.2
7	107.8	111.5	115.2	119.0	122.8	126.7	130.6
7.5	110.5	114.3	118.3	122.2	126.2	130.2	134.3
8	113.1	117.1	121.2	125.4	129.5	133.7	138.0
8.5	115.5	119.7	124.0	128.3	132.6	137.0	141.3
9	117.9	122.3	126.7	131.2	135.6	140.1	144.6
9.5	120.4	125.0	129.5	134.1	138.7	143.3	148.0
10	123.1	127.7	132.4	137.1	141.8	146.5	151.2
10.5	125.9	130.6	135.4	140.1	144.9	149.6	154.4
11	129.1	133.8	138.5	143.2	148.0	152.7	157.5
11.5	132.6	137.2	141.8	146.4	151.1	155.8	160.5
12	135.7	140.1	144.6	149.1	153.7	158.3	163.0
12.5	138.3	142.6	146.9	151.3	155.8	160.3	165.0
13	140.3	144.4	148.7	153.0	157.4	161.9	166.5
13.5	141.8	145.9	150.0	154.3	158.6	163.0	167.6
14	143.0	147.0	151.0	155.2	159.5	164.0	168.5
14.5	143.8	147.7	151.8	155.9	160.2	164.6	169.1
15	144.3	148.2	152.2	156.3	160.6	165.0	169.5
15.5	144.6	148.5	152.5	156.6	160.9	165.2	169.8
16	144.8	148.6	152.6	156.8	161.0	165.4	169.9
16.5	144.9	148.7	152.7	156.8	161.1	165.5	170.0
17	144.9	148.8	152.8	156.9	161.1	165.5	170.0
17.5	145.1	149.0	153.0	157.1	161.3	165.7	170.2
18	145.4	149.2	153.2	157.3	161.5	165.9	170.4



**FIG. 3** Reference curves for weight percentiles for Indian boys using the conventional 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles.



**FIG. 4** Reference curves for weight percentiles for Indian girls using the conventional 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles.



**TABLE III** WEIGHT PERCENTILES FOR INDIAN BOYS

Age (y)	3	10	25	50	75	90	97
5	12.9	14.0	15.4	17.1	19.2	22.0	26.1
5.5	13.8	15.0	16.5	18.4	20.8	24.1	28.6
6	14.7	16.0	17.7	19.8	22.5	26.1	31.3
6.5	15.5	17.0	18.8	21.1	24.1	28.2	33.9
7	16.2	17.9	19.9	22.5	25.8	30.3	36.6
7.5	17.0	18.8	21.1	23.9	27.5	32.4	39.4
8	17.9	19.9	22.3	25.4	29.4	34.9	42.5
8.5	18.7	20.9	23.6	27.0	31.5	37.4	45.8
9	19.5	21.9	24.9	28.6	33.4	39.9	48.8
9.5	20.3	22.9	26.1	30.1	35.3	42.2	51.8
10	21.1	23.9	27.3	31.7	37.3	44.7	54.8
10.5	21.9	25.0	28.8	33.5	39.5	47.4	57.9
11	22.9	26.3	30.4	35.6	42.1	50.4	61.4
11.5	24.2	27.9	32.4	38.0	45.0	53.8	65.3
12	25.5	29.5	34.4	40.5	47.9	57.2	69.1
12.5	26.9	31.3	36.6	43.0	50.9	60.6	72.8
13	28.5	33.2	38.8	45.6	53.8	64.0	76.5
13.5	30.3	35.2	41.0	48.1	56.7	67.2	80.2
14	32.2	37.2	43.3	50.6	59.4	70.2	83.6
14.5	34.1	39.2	45.4	52.8	61.8	73.0	86.8
15	35.8	41.0	47.2	54.7	63.9	75.3	89.4
15.5	37.3	42.5	48.8	56.3	65.6	77.1	91.6
16	38.6	43.8	50.1	57.7	67.0	78.7	93.4
16.5	39.7	44.9	51.2	58.8	68.2	79.9	94.9
17	40.7	45.9	52.1	59.8	69.2	81.0	96.2
17.5	41.6	46.8	53.1	60.7	70.1	82.0	97.3
18	42.5	47.7	53.9	61.5	71.0	82.9	98.3

data, average difference in the 97th percentile was similar to the 50th percentile (6.8 kg and 4.7 kg, respectively) which was in stark contrast to the data on boys, where the difference was much greater (12.8 kg and 4.1 kg, respectively).

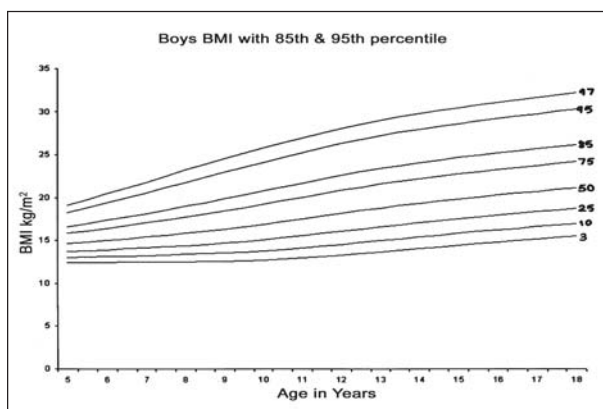
In boys, the median BMI values were higher at almost all ages compared with the 1989 data. The difference in the 95th percentile in the two datasets was 2.3 at 18 years. In girls the median BMI values were higher at almost all ages, the maximum difference being 1.1 kg/m<sup>2</sup> at 18 years.

## DISCUSSION

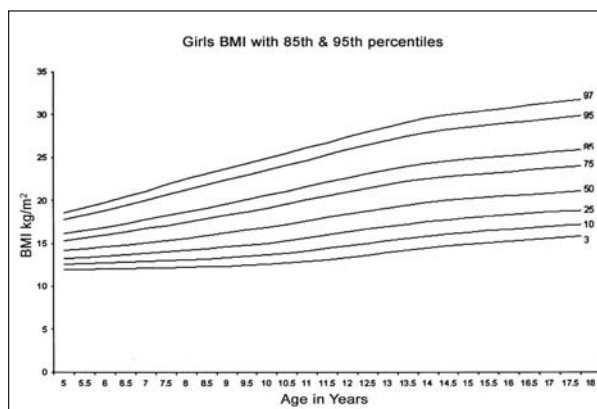
Cross sectional reference percentiles curves based on data collected in 2007-2008 for height, weight and body mass index for affluent urban Indian boys and girls age 5-18 years are presented. As compared to the 1989 data, boys and girls were taller at a younger age. The increment in the 97th height percentile since 1989 (1.7 cm in boys and 2 cm in girls) is similar to that observed in Britain from 1965 to 1990, a time gap of 25 years as against 18 years in the present study (5). Secular trend in height is

**TABLE IV** WEIGHT PERCENTILES FOR INDIAN GIRLS

Age (y)	3	10	25	50	75	90	97
5	12.4	13.4	14.7	16.3	18.3	20.9	24.7
5.5	13.1	14.2	15.6	17.3	19.5	22.5	26.7
6	13.8	15.0	16.6	18.5	21.0	24.3	29.0
6.5	14.6	16.0	17.7	19.9	22.7	26.4	31.7
7	15.3	16.9	18.9	21.3	24.4	28.6	34.4
7.5	16.1	17.9	20.1	22.8	26.3	31.0	37.5
8	16.9	18.9	21.4	24.4	28.3	33.5	40.7
8.5	17.7	19.9	22.7	26.1	30.4	36.1	43.8
9	18.6	21.0	24.1	27.8	32.6	38.8	47.0
9.5	19.4	22.2	25.6	29.7	34.9	41.5	50.1
10	20.4	23.5	27.2	31.7	37.3	44.4	53.3
10.5	21.5	24.9	28.9	33.9	39.9	47.3	56.5
11	22.9	26.6	31.0	36.3	42.7	50.5	59.9
11.5	24.6	28.5	33.2	38.8	45.5	53.7	63.6
12	26.3	30.4	35.3	41.1	48.1	56.6	67.0
12.5	28.1	32.2	37.2	43.1	50.3	59.2	70.1
13	29.8	33.9	38.9	44.9	52.3	61.4	72.7
13.5	31.3	35.5	40.4	46.4	53.9	63.2	75.0
14	32.7	36.8	41.7	47.7	55.2	64.7	76.9
14.5	33.8	37.8	42.7	48.7	56.2	65.8	78.4
15	34.6	38.6	43.4	49.4	56.9	66.6	79.4
15.5	35.1	39.1	43.9	49.9	57.4	67.1	80.1
16	35.6	39.5	44.4	50.3	57.8	67.6	80.7
16.5	36.0	40.0	44.8	50.7	58.2	68.1	81.3
17	36.4	40.3	45.1	51.1	58.6	68.5	81.8
17.5	36.8	40.7	45.5	51.4	58.9	68.8	82.3
18	37.0	41.0	45.7	51.7	59.2	69.1	82.6



**FIG. 5** Reference curves for BMI for Indian boys 2007 using the 3rd, 10th, 25th, 50th, 75th, 85th and 95th percentiles. 75th centile is suggested as cut-off.



**FIG. 6** Reference curves for BMI for Indian girls using the 3rd, 10th, 25th, 50th, 75th, 85th and 95th percentiles. 75th centile is suggested as cut-off.

TABLE V BMI PERCENTILES FOR INDIAN BOYS

Age (y)	3	10	25	50	75	85	95
5	12.4	13.0	13.7	14.6	15.8	16.6	18.3
5.5	12.4	13.1	13.8	14.8	16.1	17.0	18.8
6	12.5	13.1	13.9	15.0	16.4	17.3	19.4
6.5	12.5	13.2	14.0	15.2	16.7	17.7	20.0
7	12.5	13.2	14.1	15.4	17.0	18.1	20.6
7.5	12.5	13.3	14.3	15.6	17.4	18.5	21.2
8	12.5	13.4	14.4	15.8	17.7	19.0	21.8
8.5	12.6	13.5	14.6	16.1	18.1	19.4	22.4
9	12.6	13.6	14.7	16.3	18.4	19.9	23.0
9.5	12.7	13.7	14.9	16.6	18.8	20.3	23.6
10	12.7	13.8	15.1	16.9	19.2	20.8	24.1
10.5	12.8	14.0	15.3	17.2	19.6	21.2	24.7
11	13.0	14.1	15.6	17.5	20.0	21.7	25.3
11.5	13.1	14.3	15.8	17.8	20.4	22.2	25.8
12	13.3	14.6	16.1	18.2	20.8	22.6	26.3
12.5	13.5	14.8	16.3	18.5	21.2	23.0	26.8
13	13.7	15.0	16.6	18.8	21.6	23.4	27.2
13.5	13.8	15.2	16.8	19.1	21.9	23.8	27.6
14	14.0	15.4	17.1	19.3	22.2	24.1	28.0
14.5	14.2	15.6	17.3	19.6	22.5	24.4	28.3
15	14.4	15.8	17.5	19.8	22.7	24.7	28.6
15.5	14.6	16.0	17.7	20.1	23.0	24.9	28.9
16	14.8	16.2	18.0	20.3	23.3	25.2	29.2
16.5	15.0	16.4	18.2	20.5	23.5	25.4	29.5
17	15.2	16.6	18.4	20.7	23.7	25.7	29.8
17.5	15.4	16.8	18.6	20.9	23.9	25.9	30.0
18	15.5	17.0	18.7	21.1	24.2	26.2	30.3

therefore observed in Indian children, although it is not very marked.

On comparison with the 1989 data, boys and girls were also heavier at all ages. The 97th percentile for boys' weight was much higher suggesting that boys are getting heavier, especially in the upper percentiles. Since the 3rd percentile in boys was comparable to the 1989 data, it suggests that the gap between the obese and thin boys is growing, and the whole population has not moved up. This effect was less marked in girls, with the 3rd percentile also

moving upwards with increasing age. Our study thus confirms the alarming trend of increased childhood obesity in urban upper socioeconomic class children shown by several studies in recent years(21-23).

Various authors have argued that the growth of children of higher socioeconomic status is similar throughout the world, irrespective of ethnic background(24,25). Environmental rather than genetic differences are believed to be the principal determinants of disparities in physical growth(26). Hence, in developing countries, it is important to use



TABLE VI BMI PERCENTILES FOR INDIAN GIRLS

Age (y)	3	10	25	50	75	85	95
5	11.9	12.5	13.2	14.2	15.4	16.1	17.8
5.5	12.0	12.6	13.4	14.4	15.7	16.5	18.3
6	12.0	12.7	13.5	14.6	16.0	16.9	18.8
6.5	12.1	12.8	13.7	14.8	16.3	17.3	19.4
7	12.1	12.9	13.8	15.1	16.7	17.8	20.0
7.5	12.2	13.0	14.0	15.3	17.1	18.2	20.6
8	12.2	13.1	14.2	15.6	17.5	18.7	21.2
8.5	12.3	13.2	14.4	15.9	17.9	19.1	21.8
9	12.3	13.3	14.6	16.2	18.3	19.6	22.4
9.5	12.4	13.5	14.8	16.5	18.7	20.1	23.0
10	12.5	13.7	15.0	16.9	19.1	20.6	23.5
10.5	12.7	13.9	15.3	17.2	19.6	21.1	24.1
11	12.9	14.1	15.6	17.6	20.1	21.6	24.7
11.5	13.1	14.4	15.9	18.0	20.5	22.1	25.3
12	13.4	14.7	16.3	18.4	21.0	22.6	25.9
12.5	13.6	15.0	16.6	18.8	21.4	23.1	26.5
13	13.9	15.3	16.9	19.1	21.8	23.6	27.0
13.5	14.2	15.6	17.2	19.5	22.2	24.0	27.5
14	14.4	15.8	17.5	19.7	22.5	24.3	27.9
14.5	14.7	16.1	17.7	20.0	22.8	24.6	28.3
15	14.9	16.3	17.9	20.2	23.0	24.8	28.5
15.5	15.1	16.4	18.1	20.3	23.2	25.0	28.8
16	15.2	16.6	18.2	20.5	23.3	25.2	29.0
16.5	15.4	16.8	18.4	20.6	23.5	25.3	29.2
17	15.6	16.9	18.6	20.8	23.7	25.5	29.5
17.5	15.7	17.1	18.7	21.0	23.8	25.7	29.7
18	15.9	17.2	18.9	21.1	24.0	25.9	29.9

unified curves based on subjects with minimum nutritional constraints and full access to health care(12,13), as applies to the affluent Indian children studied here. These data, thus, reflect true height potential and the new curves for height of boys and girls may, therefore, be considered as a standard(14).

It is now well recognized that there is a global epidemic of obesity affecting all ages(27). As per the recommendations of the IAP National Task Force for Childhood Prevention of Adult Diseases, all Indian children >10 years of age are to be considered to be

overweight if BMI >85th percentile for age or weight >120% of the 50th percentile weight for height by National standards(28). The other approach recommended is the one suggested by the ITFO definition for overweight and obesity worldwide(29). However, in the present study, 85th and 95th percentile values for BMI at 18 years are above 25 and 30, respectively, suggesting that if we use 85th and 95th percentiles as cut-offs for defining overweight and obese using current data, we are accepting higher BMI (overweight children) as "normal" at all ages. On comparison with the US

**TABLE VII** SECULAR TREND FOR HEIGHT IN BOYS AND GIRLS BETWEEN THE 1989 AND 2007 DATA

Age (y)	1989 Percentiles			2007 Percentiles			Difference		
	3rd	50th	97th	3rd	50th	97th	3rd	50th	97th
<b>Boys height</b>									
5	97.9	106.9	116.2	98.3	108.1	118.9	0.4	1.2	2.7
9	118	128.2	141.4	120.1	132.4	145.0	2.1	4.2	3.6
13	137.4	152	166.9	138.5	154.8	170.6	1.1	2.8	3.7
18	161	169.8	181.6	156.7	170.4	183.3	-4.3	0.6	1.7
<b>Girls height</b>									
5	96.9	106	113.7	97.2	107.0	117.1	0.3	1.0	3.4
9	117.8	129.2	143.1	117.9	131.2	144.6	0.1	2.0	1.5
13	138.5	150.4	162.1	140.3	153.0	166.5	1.8	2.6	4.4
18	-	-	-	145.4	157.3	170.4	-	-	-
<b>Boys weight</b>									
5	13.8	17.2	21.8	12.9	17.1	26.1	-0.9	-0.1	4.3
9	19.2	24.4	37.7	19.5	28.6	48.8	0.3	4.2	11.1
13	28.1	39.4	60.0	28.5	45.6	76.5	0.4	6.2	16.5
18	47.6	58.6	83.6	42.5	61.5	98.3	-5.1	2.9	14.7
<b>Girls weight</b>									
5	13.4	17.0	21.0	12.4	16.3	24.7	-1.0	-0.7	3.7
9	17.1	23.5	37.5	18.6	27.8	47.0	1.5	4.3	9.5
13	27.9	39.1	60.7	29.8	44.9	72.7	1.9	5.8	12.0
18	-	-	-	37.0	51.7	82.6	-	-	-
<b>Boys BMI</b>									
	50th	85th	95th	50th	85th	95th	50th	85th	95th
5	14.4	15.6	17.0	14.6	16.6	18.3	0.2	1.0	1.3
9	15.1	17.3	21.0	16.3	19.9	23.0	1.2	2.6	2.0
13	17.1	20.4	25.3	18.8	23.4	27.2	1.7	3.0	1.9
18	20.0	23.6	28.0	21.1	26.2	30.3	1.1	2.6	2.3
<b>Girls BMI</b>									
5	14.3	15.7	18.3	14.2	16.1	17.8	-0.1	0.4	-0.5
9	15.1	18.0	21.7	16.2	19.6	22.4	1.1	1.6	0.7
13	18.6	22.6	27.1	19.1	23.6	27.0	0.5	1.0	-0.1
18	20.0	23.2	25.9	21.1	25.9	29.9	1.1	2.7	4.0

(NCHS 2000) and UK (1990) data, the 75th percentile for the current data was very close to the US and UK 85th percentile on BMI charts, especially after 7 years in boys and 9 years in girls. Boys on the 75th percentile in our study had a mean BMI of 24.2 and girls had a mean BMI of 24 at 18 years, this value is just under the adult cut-off for overweight(29). Thus the weight and BMI curves published in this paper may be considered as a

reference and are not proposed as standards. The authors, thus, suggest that the 75th percentile value on the current BMI curves may be used as a cutoff for screening for overweight boys and girls. However, it is important to keep in mind that BMI is a screening test (whatever statistical cut-off points are chosen) and must be followed by a more detailed evaluation to assess risk and plan intervention(30).

**WHAT IS ALREADY KNOWN?**

- Previous Nationally representative growth curves were created from data collected between 1989-1991.

**WHAT THIS STUDY ADDS?**

- Growth curves are provided for Indian children from data collected in 2007-2008 using LMS method which provides smoothened percentile reference curves.

Given the fact that India is a large country with a diverse genetic pool, there is the question whether regional charts should be constructed(31). Thus, to assess inter-regional differences, we used the method suggested by the WHO MGRS (standardized site effects) and found that there were no significant differences in height and weight(14). Also, regional charts would be very difficult to use in case of intermarriages and at a time when inter-regional migrations are very prevalent in India. The LMS method was used for analysis as this is the most widely accepted method for percentile construction(3,5,32,33). It also allows the calculation of Z-scores, which are useful in population-based research and surveillance to provide summary statistics (The LMS values needed to calculate Z-scores are available on request).

This study has some drawbacks. It was a cross sectional study and so provides no information on longitudinal growth. Tanner staging was not performed as the authors considered it ethically incorrect, and reference may be made to other publications(34). The measurement scales used in this study were different to those used by Agarwal, *et al.* Though an attempt was made to study equal numbers of children in all the IAP zones, the numbers in the five zones still differ, however the differences in heights and weights have been shown to be statistically insignificant as per weighted analysis. The sample does not include affluent children from small towns and rural areas as it was logistically not possible to do so.

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**Participating Investigators:** Sanwar Agrawal,

Director, Ekta Institute of Child Health, Raipur; Archana Dayal Arya, Consultant Pediatric Endocrinologist, Sir Ganga Ram Hospital, New Delhi; Anil Bhansali, Prof. and Head, Department of Endocrinology, PGIMER, Chandigarh; Shaila Bhattacharya, Consultant Pediatric Endocrinologist, Manipal Hospital, Bangalore; Rajesh Chokhani, Consultant Pediatrician, Health care for children, Mumbai; Subhankar Chowdhury, Head of Dept of Endocrinology and Metabolism, IPGIMER and SSKM Hospital, Kolkata; Vaishali Ghelani Consultant Pediatrician, Girgaon, Mumbai; Jayashree Gopal, Senior Consultant Endocrinologist and Diabetologist, Apollo Hospitals, Chennai; Jayanthi Ramesh, Consultant Pediatric Endocrinologist, Hyderabad; Mona Shah, Consultant Endocrinologist, Baroda.

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