

Growth charts, the secular trend and the growing concern of childhood obesity

The growth of a child is a mirror of his or her health. It is also a mirror of the health of the nation. With the advent of industrialization and food security, industrialized countries witnessed a marked 'secular trend' in the physical development of children, with increases in height, weight and advancement in the age of puberty. Whereas this secular trend in height plateaued after the mid-twentieth century in the developed nations of that time, other countries such as Japan were still witnessing the secular trend till more recently. In contrast to the plateau in heights, the weight and body mass index (BMI) trajectories relentlessly rose upwards as the epidemic of obesity hit childhood and adolescent populations all over the world.

In India, the last major multicentre growth data of children from the upper socioeconomic strata were published in 1992 and 1994 by Agarwal *et al.*¹⁻³ Two recent studies have examined the status of the secular trend in India. One was published in 2009 by Khadilkar *et al.*⁴ and the other is reported in this issue of the *Journal* by Marwaha *et al.*⁵ They also set out to prescribe more relevant reference growth charts for the children of India than those hitherto used, as their database would reflect heights and weights of children from upper socioeconomic strata, who had no constraints to nutrition and who had experienced the secular trend, if any, of the past 2 decades. Marwaha *et al.* studied 60 000 schoolchildren 3–18 years of age from 19 cities in all regions of India, for height, weight and BMI. Compared with these children from 'fee paying schools' (their surrogate for upper socioeconomic status), were another 40 000 from 'non-fee paying' schools. It is the largest database for these parameters from any nationwide study during the past 20 years, and provides useful and interesting information.

Have Indians grown taller in 20 years?

What did Marwaha *et al.* and Khadilkar *et al.* find in terms of secular trend for height, 20 years after the Agarwal *et al.* study? At final height, the 3rd centile girl and boy and the 50th centile girl were not taller in the Khadilkar data. The 97th centile girl, however, was 2.4 cm taller in the Khadilkar data as compared to the Agarwal data. For boys, the increase in final height was 0.6 cm at the 50th centile and 1.7 cm at the 97th centile. Unexpectedly, the Marwaha *et al.* database threw up taller figures (by about 1 to 4 cm) than the Khadilkar results at final height (Tables I and II). The reason for this difference could lie in the fact that 44% of children resided in the northern-most parts of India (Delhi, Haryana, Punjab, Himachal and Jammu and Kashmir) in the present study, in contrast to 27% in the Khadilkar study. While Khadilkar *et al.* and Marwaha *et al.* did not present region-wise data and comparisons, Agarwal *et al.* had found children in the northern region to be significantly taller compared to all other regions of India.¹ Marwaha *et al.*⁵ have also drawn attention to the greater height at all ages in boys and girls, with early flattening, i.e. early achievement of final height, in their own study as compared to the Khadilkar study. As explained by them, this is most

TABLE I. Comparison of height, weight and body mass index data of girls at age 18 years between 3 Indian databases

Item	Centile	Agarwal <i>et al.</i> 1992 ^{1,2*}	Khadilkar <i>et al.</i> 2009 ⁴	Marwaha <i>et al.</i> 2011 ⁵
Height (cm)	3rd	148.3	145.4	149.0
	50th	157.0	157.3	158.5
	97th	168.0	170.4	168.0
Weight (kg)	3rd	37.6	37.0	40.8
	50th	48.4	51.7	55.6
	97th	75.6	82.6	80.1
BMI (kg/m ²)	75th	23.0	24.0	24.7
	85th	23.2	25.9	26.4 (90th)
	95th	25.9	29.9	29.9

* 17 years for Agarwal *et al.* data that in the 97th centile is 175.5 cm

For comparison, the 50th centile height in WHO 2007 charts is 162.9 cm and

TABLE II. Comparison of height, weight and body mass index data of boys at age 18 years between 3 Indian databases

Item	Centile	Agarwal <i>et al.</i> 1992 ^{1,2*}	Khadilkar <i>et al.</i> 2009 ⁴	Marwaha <i>et al.</i> 2011 ⁵
Height (cm)	3rd	161.0	156.7	160.4
	50th	169.8	170.4	174.3
	97th	181.6	183.3	185.5
Weight (kg)	3rd	47.6	42.5	45.7
	50th	58.6	61.5	66.2
	97th	83.6	98.3	98.5
BMI (kg/m ²)	75th	22.5	24.2	24.4
	85th	23.6	26.2	26.3 (90th)
	95th	28.0	30.3	30.1

* 17 years for Agarwal *et al.* data and that of the 97th centile is 190.2 cm.

For comparison, the 50th centile height in WHO 2007 charts is 176.1 cm and

likely due to the greater BMI in the present study, leading to early maturation. Another possible reason could be the grouping of children in 1-year age groups instead of 3 or 6 months. Thus, the height of a child of 10 years 11 months would be plotted on 10 years rather than at 10.6 or 11 years.

Weight centiles climb skyward

Both the Khadilkar and Marwaha studies throw up an alarming statistic: that of markedly increased weights of both boys and girls compared to those in 1992. The definition of childhood overweight and obesity is BMI above the 85th and 95th centiles for age, respectively, as BMI changes with age. The adult cut-offs for overweight and obesity are 25 kg/m² and 30 kg/m² internationally. For Indians, many authors, including WHO, have suggested the overweight cut-off to be 23 kg/m², in recognition of our different body build and propensity for central obesity even with a lower BMI.^{6,7} In the Marwaha database, the 13- and 15-year-old girl (and the 14- and 16-year-old boy) have already reached the overweight and obese categories by the adult Indian definition. If the nation adopts these data as 'references' or 'prescriptive' growth charts, overweight and obesity would be misclassified as normal, posing a serious challenge to the fight against the epidemic of obesity. The authors of both studies suggest changing the definition of overweight to the 75th centile from the traditionally used 85th centile. The 75th centile of the present study coincides with 25 kg/m² at 18 years and that of the Khadilkar database coincides with 23 kg/m², the definition of adult overweight used for Indians. A difficulty one could visualize with this strategy is that every few years, as a new database is constructed, and as the obesity problem worsens, the overweight cut-off percentile could be shifted even lower, leading to confusion in definitions.

WHO 2007 charts

WHO had conducted the Multicentre Growth Reference Study (MGRS) in 6 countries (Brazil, USA, Oman, Ghana, Norway, India) for birth to 6-year-old children.⁸ India was represented by south Delhi alone. The aim was to make prescriptive growth references from infants whose nutrition was ideal *in utero* as well as postnatally. Pregnant women were selected for their upper socioeconomic and non-smoker status, with their babies being exclusively breastfed for 6 months. They were given frequent telephonic and personal advice on lactation and nutrition. It is well known that the growth of infants is more dependent on foetal nutrition than genetic and ethnic potential for height, and thus infants and toddlers are fairly comparable in their growth pattern all over the world. It is also known that formula-fed babies are heavier than exclusively breastfed babies. The WHO's prescription of these as ideal charts for <5-year-old children is therefore not unreasonable. However, their growth charts beyond the age of 5 years are drawn from the National Centre for Health Statistics (NCHS) 1977 references.⁹ Sophisticated statistical procedures were used to amalgamate the NCHS >5-year data with the MGRS <6-year data.¹⁰ In prescribing these as international growth charts, the WHO presupposes that ethnic differences in height do not exist! One has only to compare the tall Dutch and Scandinavians, to the relatively short French, all these European countries having

finished their secular trend many decades ago, to realize the inaccuracy of this presupposition. The consequences (labelling normal children as short or 'stunted' because of using an artificially high normative database) go beyond the individual child, and into the realm of economics and national policy-making.¹¹

How have other countries dealt with these issues?

Recognizing certain lacunae in the 1977 NCHS charts (unsatisfactory infant database and adolescent weight-for-height database, among others) the Centers for Disease Control (CDC, USA) published new charts in 2000.¹² They included data from 5 nationally representative surveys conducted in the previous 30 years (including National Health and Nutrition Examination Survey [NHANES] I, II and III) as well as from several other smaller longitudinal and cross-sectional surveys, and used statistical procedures to amalgamate and smooth out these data to provide prescriptive growth charts for their country. It is noteworthy that they chose to delete the weight, weight-for-height and BMI data of >6-year olds from the recent NHANES III survey, though they retained their height data. This was done to avoid pushing up the weight centiles and risk categorizing overweight children as normal. Experts in the UK when revising their 1990 charts in the year 2009, decided to use the WHO charts till 4 years of age, but retain the UK 1990 charts for older children.¹³ It would interest the reader to know that contrary to WHO's prescription of 'one size fits all', experts in The Netherlands have published separate reference databases for children of Turkish origin living in The Netherlands as well as those of Moroccan origin, in recognition of the ethnic diversity within their country!

In conclusion, Marwaha *et al.* and Khadilkar *et al.* provide valuable databases and insight into the issue of secular trends in height, weight and BMI. Marwaha *et al.* show that the increases in final height at the 3rd, 50th and 97th centiles, in girls and boys, over a 20-year period, ranged from 0 cm to 4.5 cm. In the Khadilkar database, the range of increase was from 0 cm to 2.4 cm. Both groups of investigators faced the same confounding issue of overweight, which becomes an impediment to either of their databases being used in entirety as prescriptive growth charts. Other countries that faced similar problems set up a committee of experts to perform statistical manipulations on existing databases to produce modern prescriptive growth charts for their countries. It may be necessary to pursue some similar procedure in order to produce prescriptive growth charts suitable for Indian children.

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