

# Revised Indian Academy of Pediatrics 2015 growth charts for height, weight and body mass index for 5–18-year-old Indian children

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### ABSTRACT

Growth chart committee of Indian Academy of Pediatrics (IAP) has revised growth charts for 5–18-year-old Indian children in Jan 2015. The last IAP growth charts (2007) were based on data collected in 1989–92 which is now >2 decades old. India is in an economic and nutrition transition and hence growth pattern of Indian children has changed over last few years. Thus, it was necessary to produce contemporary, updated growth references for Indian children. The new IAP charts were prepared by collating data from nine groups who had published studies in indexed journals on growth from India in the last decade. Growth charts were constructed from a total of 87022 middle and upper socioeconomic class children (m 54086, f 32936) from all five zones of India. Data from middle and upper socioeconomic class children are likely to have higher prevalence of overweight and obesity and hence growth charts produced on such populations are likely to “normalize” obesity. To remove such unhealthy weights from the data, method suggested by World Health Organization was used to produce weight charts. Thus, the new IAP weight charts are much lower than the recently published studies on affluent Indian children. Since Indian’s are at a higher risk of obesity-related cardiometabolic complications at lower body mass index (BMI), BMI charts adjusted for 23, and 27 adult equivalent cut-offs as per International obesity task force guidelines were constructed. IAP now recommends use of these new charts to replace the 2007 IAP charts.

**Key words:** Child, growth charts, Indian Academy of Pediatrics, India, revise

## INTRODUCTION

In January 2015, Indian Academy of Pediatrics (IAP) published revised growth charts for 5–18-year-old Indian children to replace earlier IAP charts.<sup>[1]</sup> In 2007, IAP had published growth monitoring guidelines for children from birth to 18 years.<sup>[2]</sup> The growth references used in these guidelines were based on the then available data<sup>[3,4]</sup> from 1989 which is now >2½ decades old. The pattern of growth of a population changes with time hence it is recommended that references should be updated regularly

so that they reflect current growth patterns of children and are representative of secular trends.<sup>[5]</sup> The old IAP growth charts may not be suitable for use any more especially in a country like India where major changes in nutrition status of children have been witnessed and hence there was an urgent need to update Indian growth references.<sup>[6]</sup>

In 2006, the World Health Organization (WHO) published the first global growth standards for children under the age of 5 years<sup>[7]</sup> and Government of India and IAP have adopted these standards for use in under five Indian children.

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In older children, however, growth patterns differ among different populations of the world as nutritional, environmental, genetic factors and timing of puberty seem to play a major role not only in the attainment of final height but also in the characteristics of the growth curve. Data from Asian countries such as China, Japan, and Saudi Arabia have shown that the growth of older non-European children is different especially after puberty with a relatively attenuated pubertal growth spurt.<sup>[8,9]</sup> Hence, it is necessary to have country specific growth charts to monitor the growth of children between 5 and 18 years.

Several studies on children's growth have been published from many parts of India in the last decade, but no unified growth charts for Indian children were produced. Many studies have also reported increasing incidence of overweight and obesity across India and there is concern about "normalizing" obesity when charts are produced from data taken from these studies. Since a lot of children around the world are showing a rising trend of increasing weight and body mass index (BMI), no population seems perfect on whom ideal weight/BMI charts can be constructed. Hence, a statistical approach has been suggested by experts including the WHO.<sup>[6,9]</sup> WHO has described a method to eliminate unhealthy weights from populations by removing children who have weight for height z scores above +2 standard deviation (SD) This method eliminates children with unhealthy weights at the upper percentiles thus effectively dealing with the problem of "normalizing" obesity.

### Process of constructing growth charts

A committee was formed by the IAP in January 2014 to design new growth charts for Indian children older than 5 years so that they represent the growth of modern day Indian children. Studies performed on children's growth, nutritional assessment and anthropometry published in Indexed journals in the last decade were identified through internet based search engines viz. Google, Pubmed, Embase. Studies presenting anthropometric data on apparently healthy Indian children between the age of 5 and 18 from upper and middle socioeconomic classes were included where height, weight, and age were available for every child. Studies performed on children of lower socioeconomic class (data on them may not represent the optimal growth potential due to under-nutrition) and where authors refused/could not share data were excluded. Three studies were performed to construct growth percentiles.<sup>[10-12]</sup> Other studies were performed to assess the incidence of underweight, overweight, and obesity in school going children.<sup>[13-18]</sup> Authors of nine studies were able to provide required raw data on their study subjects.

Total number of children was 87022 (m 54086, f 32936) (south 61173, center 3253, east 4507, north 7405, and west 10684). Data from fourteen cities that is, Agartala, Ahmadabad, Chandigarh, Chennai, Delhi, Hyderabad, Kochi, Kolkata, Madurai, Mumbai, Mysore, Pune, Raipur, and Surat were collated. To make the regional distribution more uniform, 8142 children out of 61173 from the south were randomly selected by generating random numbers in age wise groups. Data from a total of 33991 children (18630 males, 15361 females) were used in the final analysis. Using centers for disease control (CDC) standards, children above and below 5 SD scores for height, weight, and BMI were removed (a total of 197 children) as obvious outliers.<sup>[19]</sup>

### Method used to remove children with unhealthy weights

In case of cross-sectional data, World Health Organization recommends removing observations that are above +2 SD of the study population for weight for height as unhealthy overweight.<sup>[6]</sup> Children who were above +2 SD scores (a total of 646 children, 329 males) were removed from the analysis.

Cole's lambda, mu, and sigma (LMS) method was used to compute growth curves for height, weight, and BMI.<sup>[20]</sup> For height and weight 3<sup>rd</sup>, 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup>, and 97<sup>th</sup> percentiles were generated. For BMI, however, using International obesity task force (IOTF) approach 3<sup>rd</sup>, 5<sup>th</sup>,

**Table 1: Girls height and weight comparison of revised IAP 2015 charts at 18 years with International data**

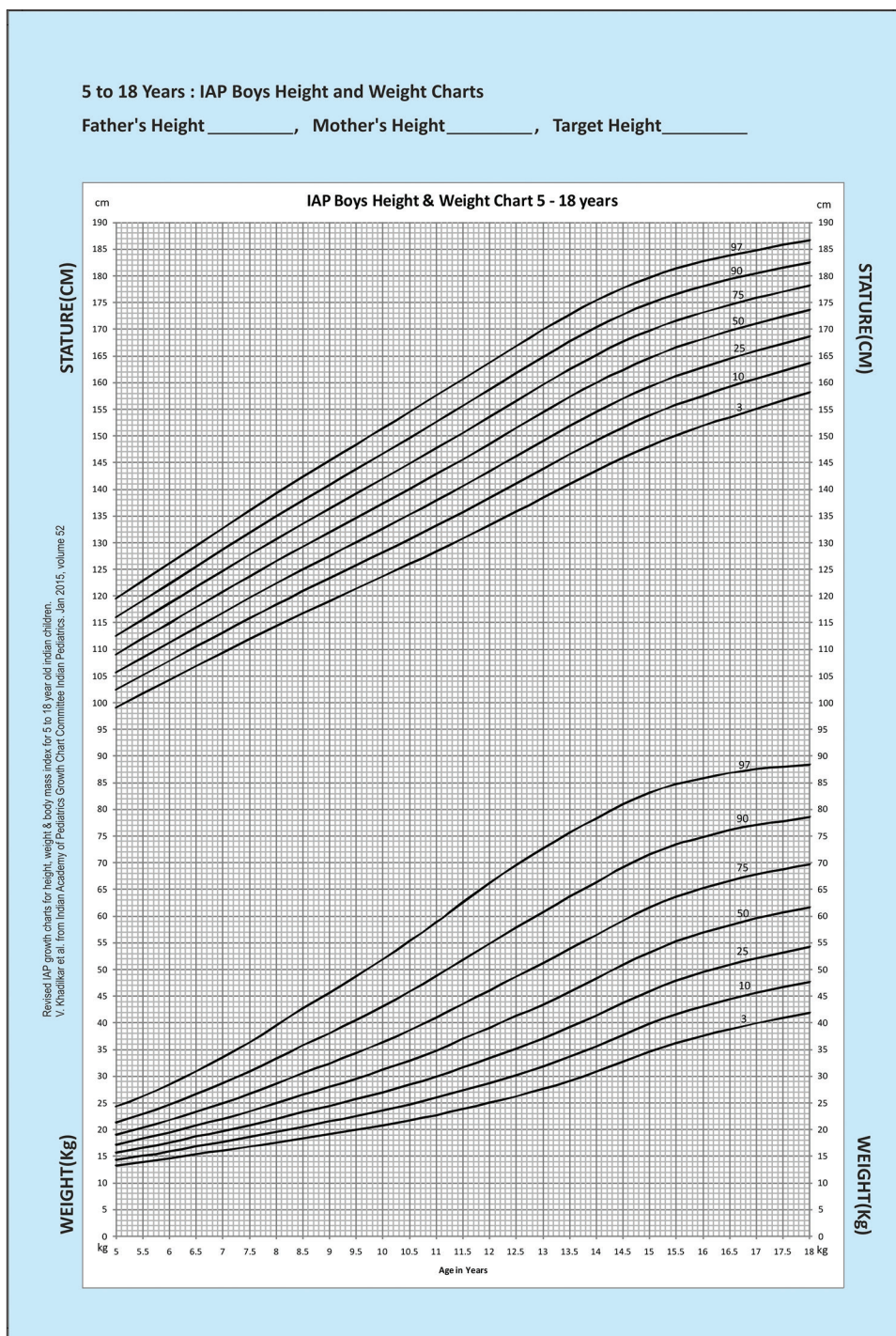
Parameter	Country				
	Saudi (2007)	China (2009)	IAP 2015	CDC (2000)	WHO 2007
Height					
3 <sup>rd</sup>	144	147	146.6	150.9	150.6
50 <sup>th</sup>	157	160	157.8	163.1	163.1
97 <sup>th</sup>	170	171	170.6	175.3	175.5
Weight					
3 <sup>rd</sup>	37	40	37.6	44.2	-
50 <sup>th</sup>	56	51	52	52.9	-
97 <sup>th</sup>	84	67	73.5	83.2	-

IAP: Indian Academy of Pediatrics, CDC: Centers for disease control, WHO: World Health Organization

**Table 2: Boys height and weight comparison of revised IAP charts at 18 years with International data**

Parameter	Country				
	Saudi (2007)	China (2009)	IAP 2015	CDC (2000)	WHO 2007
Height					
3 <sup>rd</sup>	156	158	158	162.5	162.1
50 <sup>th</sup>	169	170	173.6	176.2	176.1
97 <sup>th</sup>	181	183	186.7	189.5	193.5
Weight					
3 <sup>rd</sup>	41	47	41.8	51.7	-
50 <sup>th</sup>	65	61	61.6	67.3	-
97 <sup>th</sup>	103	85	88.4	97.2	-

IAP: Indian Academy of Pediatrics, CDC: Centers for disease control, WHO: World Health Organization



1: Boys height and weight charts

10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup>, 97<sup>th</sup> adult equivalent (as overweight cut-off) and 27 adult equivalent (as obesity cut-off) percentiles were generated as per recent recommendations for Asian Indian overweight and obesity cut-offs.<sup>[21,22]</sup>

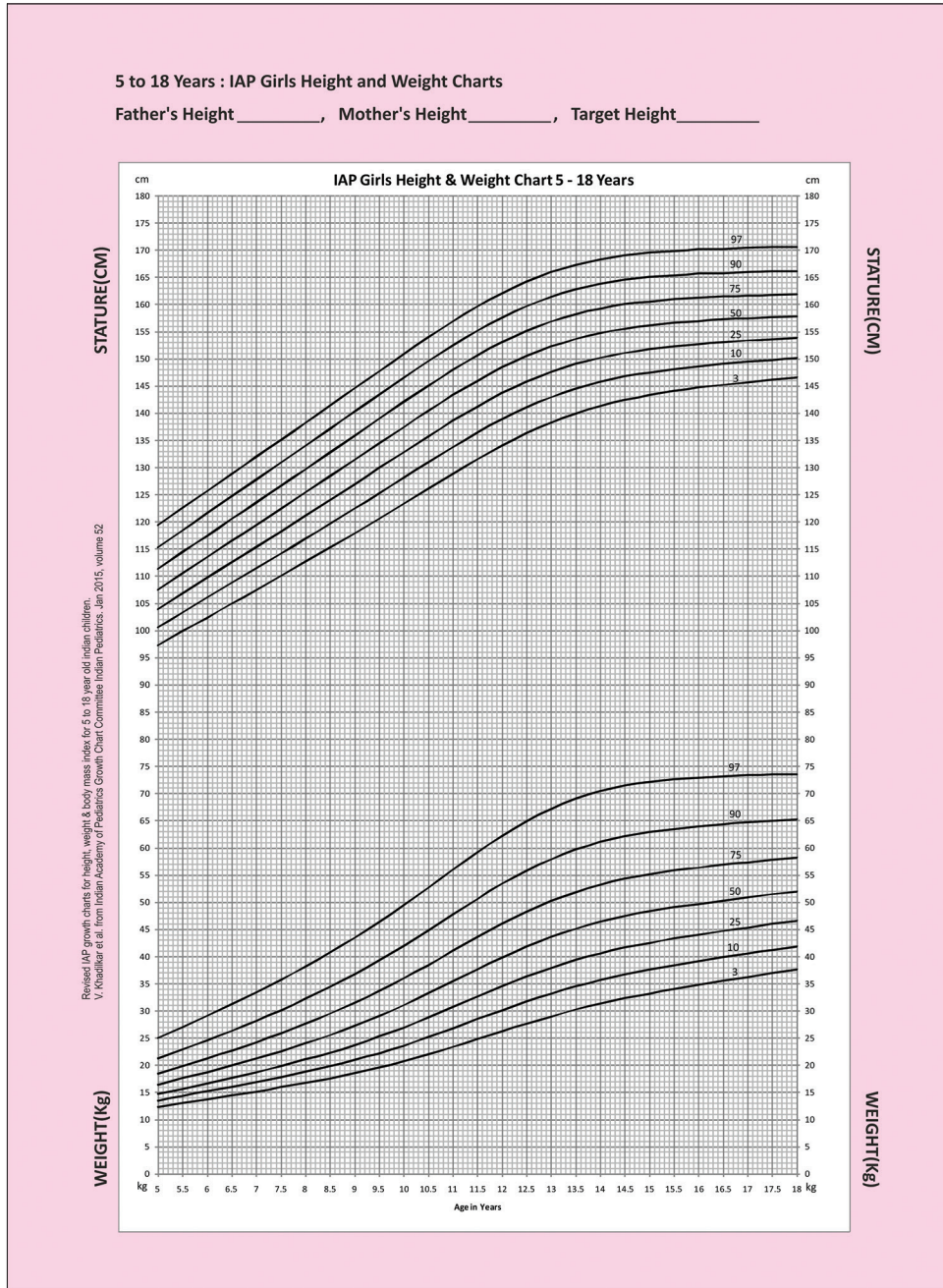
## RESULTS

Data on 33148 children (18170 boys and 14978 girls) from 14 Indian cities were used in the construction of growth

charts and all five zones of India as defined by IAP were represented.<sup>[1]</sup>

### Height, weight and body mass index

Figures 1 and 2 show IAP charts for height and weight for boys and girls from 5 to 18 years respectively. Figures 3 and 4 show the IAP BMI percentile curves including adult equivalent (overweight) and 27 adult equivalent (obesity) percentiles for boys and girls from 5 to 18 years respectively.



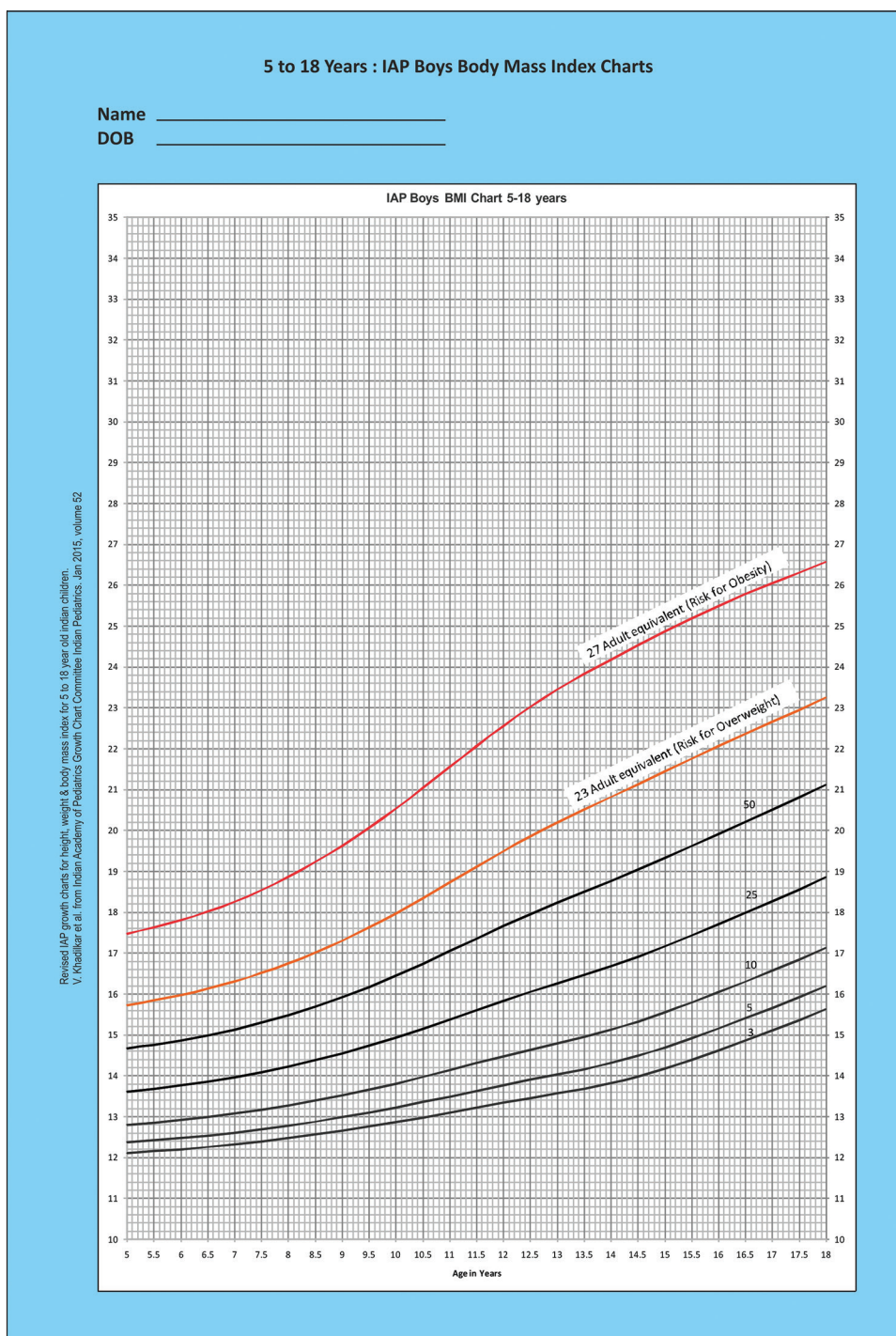
2: Girls height and weight charts

Tables 1 and 2 illustrate the comparison of height and weight of Indian children with data from Saudi Arabia,<sup>[9]</sup> China,<sup>[8]</sup> CDC,<sup>[23]</sup> and WHO.<sup>[6]</sup> The height percentiles of boys and girls on the new IAP charts were almost at par with China and Saudi Arabia but were still lower than the CDC and WHO percentiles. Boys' average height at 18 years was found to be 2.8 cm higher than that of previous IAP growth charts, and the 97<sup>th</sup> percentile was also higher (186.7 cm vs. 181.6 cm). In case of girls, the average height at 18 years showed an increase of 0.8 cm from 157.0 to 157.8 while the 97<sup>th</sup> percentile showed an increase of 2.6 cm from 168.0 to 170.6. The upper weight

percentiles of 2015 charts are higher than IAP 2007 growth data for boys but comparable in girls; but are lower than Saudi Arabia, China and CDC in case of boys and at par with Saudi Arabia and China but lower than CDC in case of girls.

## DISCUSSION

The revised 2015 IAP growth charts for 5–18-year-old Indian children thus represent the most modern, contemporary updated growth charts for use in Indian children. As compared to the previous IAP charts, boys



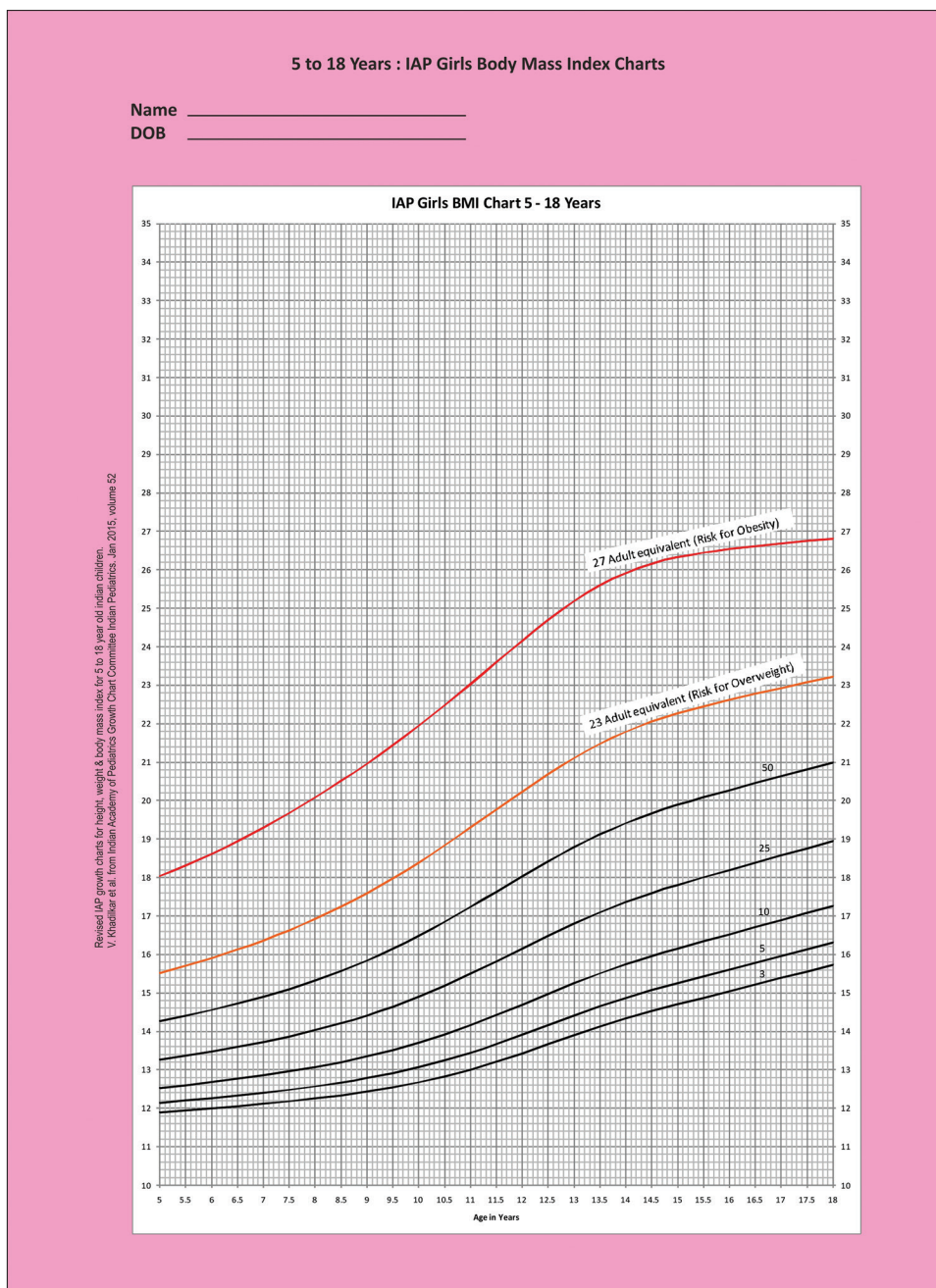
3: Boys' body mass index charts

and girls were taller at all ages. At 18 years, average boys' height was 2.8 cm higher and the 97<sup>th</sup> percentile was 5 cm higher; for girls these figures were 0.8 cm and 2.6 cm. Thus, there was a secular trend in height which underlines the importance of updating growth charts in a developing nation such as India.

By adopting the approach as suggested by the WHO, weight percentiles have been lowered in comparison

to the recently published weight charts on affluent Indian children, thus reducing the impact of unhealthy weights on weight charts.<sup>[6,9,11]</sup> Hence, the problem of “normalizing” obesity seems adequately addressed by these charts.

Body mass index charts presented are based on the same method as suggested by IOTF.<sup>[20]</sup> The 23 and 27 adult equivalent cut-offs lines (for overweight and obesity



**4: Girls' body mass index charts**

respectively) are more appropriate for use in Asian children as Asians are known to have more adiposity and increased cardio-metabolic risk at a lower BMI.<sup>[21]</sup> The new IAP 2015 study's 23 and 27 adult equivalent cut-offs are very close to IOTF's extended 23 and 27 cut-offs in both sexes.<sup>[20]</sup>

Comparing the final height and weight data with recent international studies from China, Saudi Arabia, WHO, and CDC, it is clear that Indian children are growing almost at par with Chinese and Saudi Arabian children, but are still shorter and lighter than their Caucasian counterparts,<sup>[1,7,8]</sup> Indian children's stature seems to be comparable to

Caucasian children until the onset of pubertal years; however, the growth spurt after puberty is attenuated in Indian children in both sexes, the effect being more pronounced in girls. Thus, the average difference in height between Caucasian girls and Indian girls from 5 to 11 years of age is only about 1 cm. However this gap widens to 6 cm at 18 years. Similar figures in boys are 1 cm from the age of 5 to 12.5 years and 3.5 cm at 18 years. Interestingly, Chinese children also show a very similar growth pattern suggesting that this is possibly a characteristic of Asian children.<sup>[24]</sup> These findings are of particular relevance in interpreting target height and predicting final adult height

based on prediction equations, thus stressing the need for ethnic specific growth charts.

Lambda, mu, and sigma values and LMS Macro for Microsoft excel, Microsoft office 2007 to calculate the height, weight, and BMI z scores has been prepared by authors and can be obtained by writing to the authors for research purpose. These growth charts can be downloaded from the IAP website: <http://www.iapinidia.org>.

In conclusion, the revised IAP 2015 growth charts are contemporary growth charts for Indian children between the age of 5 and 18 years that truly represent all zones of India and are recommended by Indian Academy of Pediatrics for use in children from 5 to 18 years to replace the old IAP growth charts. For younger children, IAP recommends the use of WHO 2006 growth standards.

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### Conflict of interest

There are no conflicts of interest.

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