Original Article

Growth and obesity status of children from the middle socioeconomic group in Lucknow, northern India: A comparison with studies on children from the upper socioeconomic group

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ABSTRACT

Background. Children from the upper socioeconomic group in India currently show a modest positive secular trend in height, accompanied by a high prevalence of obesity. We examined the anthropometric pattern among children from the middle socioeconomic group.

Methods. A cross-sectional study of anthropometry in 3794 schoolchildren from the middle socioeconomic group in the city of Lucknow, Uttar Pradesh, India.

Results. A comparison with the data of a 20-year-old study of children from the upper socioeconomic group showed that the height of boys in our study was at par with or higher than that of boys of the same (Lucknow–Allahabad–Varanasi) region or national data, at all centiles. In contrast, girls in our study were shorter than national data at all centiles and shorter than girls of the same region at the 3rd centile. Children from the middle socioeconomic group did not show the large increase in weight centiles seen in the recent data of the upper socioeconomic group. The values of body mass index at the 85th and 95th percentile at 17 or 18 years of age in girls and boys were 23 and 25 kg/m^2, respectively. Obesity was prevalent in 1% of children of the middle socioeconomic group and an additional 5.7% were overweight.

Conclusions. Children from the middle socioeconomic group in Lucknow have grown taller than their 20-year-old counterparts from the upper socioeconomic group. Boys have fared better than girls. Children from the middle socioeconomic group in Lucknow are at present spared from the epidemic of obesity.

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INTRODUCTION

Linear growth is a measure of general well-being of a child, and is also a measure of the economic well-being and health systems in a country. With positive changes in the economic and nutritional status of any country, a secular improvement in height is expected until a plateau is reached which represents the genetic potential for that population. The first nationally representative reference growth charts for Indian children were published in 1992,[1,2] which contained data obtained in the late 1980s of Indian children from the affluent class. Two multicentric studies[3,4] assessed the secular trend in height of Indian children belonging to the upper socioeconomic group (USEG), which was brought about by intergenerational improvements in nutrition. Both studies[3,4] showed a positive secular trend in height percentiles in comparison to the previous studies.[1,2] However, the weight percentiles showed a remarkable upward shift, highlighting the huge burden of overweight and obesity in the USEG.

No data are available for healthy Indian children in the middle socioeconomic group (MSEG). It is likely that children from the MSEG are less influenced by modern lifestyle that poses a risk for obesity, while at the same time do not face any nutritional constraints to growth compared with children in the lower socioeconomic group. We examined the status of children from the MSEG of Lucknow (northern India) with regard to height, weight and body mass index (BMI), in comparison to children from the USEG.

METHODS

We did this cross-sectional study during 2010 and 2011 in three Kendriya Vidyalayas (Central Schools) of Lucknow, Uttar Pradesh. The schools with the maximum number of children from the MSEG were chosen. Written informed parental consent was obtained from each participant, and permission from school authorities was taken as well as approval from the institutional ethics committee was obtained. The examination of children was planned so as to least disturb the school academics and, wherever possible, it was coordinated with routine medical check-ups.

All children from classes I to XII were given a predesigned standard questionnaire in Hindi to be filled and signed by the parents and returned confidentially in sealed envelopes to the investigators. The questionnaire asked for verification of the correct date of birth, and any concurrent or past chronic illness or surgery. Children with any chronic illness potentially affecting growth were excluded. This questionnaire documented the education and profession of both parents, the total family income per month and the total number of family members. The income categories were defined by the Kuppuswamy socioeconomic status scale updated for current income by the all-India average consumer price index.[5] MSEG was defined by a total Kuppuswamy score of 11–25.

A standard physical examination of the children was done. Weight and height were measured in minimum acceptable standard clothing without shoes and socks. Weight was recorded to the nearest 100 g in the standing position by a digital weighing scale (Salter, India). Standing height was measured with a portable stadiometer to the nearest 1 mm by a single observer (a trained paediatrician). The equipments were calibrated daily before starting the field work and the same equipments were used throughout the study. Variation in repeated measurements of height by the same observer was <3 mm. International age- and gender-specific BMI cut-offs were used to define overweight, obesity and thinness.[6,7] The overweight and obesity cut-offs defined by Cole *et al.*[6] for each age were the centiles coinciding with the 25 and 30 kg/m^2 adult BMI centiles extrapolated backward into childhood. Thinness was defined by Cole *et al*.[7] as mean (–2 SD) kg/m^2 of the reference data, i.e. below the 17 kg/m^2 adult BMI percentile extrapolated backwards into childhood.

Smoothed percentiles for each of the three indicators, i.e. weight, height and BMI, were computed as a function of age, disaggregated by gender. This was done using the LMS (lambda, mu, sigma) with penalized log likelihood' method proposed by Cole and Green, which takes exact ages into consideration while calculating the results.[8] The data were first cleaned for outliers using box-plots. The LMS technique assumes that the measure has a skewed distribution which can be transformed into a normal distribution using a suitable Box–Cox power transformation. The centile curves at each age group, *t*, are summarized by three curves, the power transform function (*L*), the median curve (*M*) and the coefficient of variation (*S*). The software LMS chart-maker was used to generate centile curves, the web link to which was provided by Pan and Cole.[9] Since there is a trade-off between smoothing and goodness of fit, the method imposes a penalty which translates into the *L, M* and *S* curves being natural cubic splines, centred at each age-group. To determine the smoothing parameters, goodness of fit measures including the Schwartz–Bayes criteria (SBC), Q-Q plots and the Kolmogorov–Smirnov test were used. After obtaining the *L*, *M* and *S* curves, centile curves were derived as follows:

$$C_{100\alpha}(t) = M(t)\,[1 + L(t)S(t)z_{\alpha}]^{1/L(t)}$$

where 100_{α} is the required centile and z_{α} is the normal equivalent deviate corresponding to the tail area α. As the measures were monotonic in age, the age axis was rescaled such that more weight is given to the periods of faster growth compared to the periods of slower growth. After estimating the smoothing parameters using the rescaled data, the indicators were transformed back in terms of the original units.

The MSEG growth percentiles obtained in the present study were then compared with those from the USEG 1992 (Agarwal, both national and the central zone, representative of the Lucknow/ Uttar Pradesh region),[1] 2009 (Khadilkar)[3] and 2011 (Marwaha)[4] datasets.

RESULTS

All students (*n*=3794) from the three schools, who belonged to the MSEG, provided parental consent and did not suffer from any medical or surgical disease potentially affecting growth were studied. This included 2027 boys aged 6.5–18 years and 1767 girls aged 7–17.5 years. Boys <6.5 years or >18 years and girls <7 years or >17.5 years were excluded because of the very small number of children in these age groups. Table I highlights the final/near-final height, weight and BMI attained by the MSEG children of the present study and Indian USEG children data for 1992, 2009 and 2011.

TABLE I. Final/near-final height, weight and body mass index (BMI) attained in different datasets of children

Item	Centile	Boys (at 18 years)					Girls (at 17 years)*				
		Socioeconomic group					Socioeconomic group				
		Middle	Upper				Middle	Upper			
		Present study, Lucknow	Agarwal (1992),[1] Central zone	Agarwal (1992),[1] National	Khadilkar (2009),[3] National	Marwaha (2011),[4] National	Present study, Lucknow	Agarwal (1992),[1] Central zone	Agarwal (1992),[1] National	Khadilkar (2009),[3] National	Marwaha (2011),[4] National
Height	3rd	160.9	160.3	161.0	156.7	160.4	146.1	147.8	148.3	144.9	148.1
(cm)	50th	171.7	167.9	169.8	170.4	174.4	156.4	155.3	157.0	156.9	158.1
	97th	182.8	181.0	181.6	183.3	185.5	166.7	164.8	168.0	170	168.1
Weight	3rd	44.7	46.1	47.6	42.5	45.7	36.4	37.6	37.6	36.4	39.2
(kg)	50th	59.1	53.8	58.6	61.5	66.2	48.2	46.9	48.4	51.1	54.2
	97th	85.5	72.8	83.6	98.3	90.5	66.7	65.9	75.6	81.8	78.9
BMI	3rd	15.3	–	–	15.5	15.8	15.4	–	–	15.6	15.9
(kg/m^2)	5th	15.7	–	15.7	–	16.4	15.9	–	16.6	–	16.5
	50th	19.8	–	20.0	21.1	21.5	19.5	–	20.1	20.8	21.5
	75th	21.9	–	22.5	24.2	24.4	21.5	–	22.0	23.7	24.3
	85th	23.2	–	23.6	26.2	26.3 (90th centile)	22.7	–	23.0	25.5	26.0 (90th centile)
	95th	25.7	–	28.0	30.3	30.1	25.1	–	25.9	29.5	29.5

*Near-final height described at 17 years in the present study as in the Agarwal (1992) dataset for girls, the upper age range ended at 17 years

Height

Comparison of our data with the USEG national and central zone data for 1992. In comparison with the data for 1992 as well as their data for the central zone (which includes the cities of Lucknow, Allahabad and Varanasi), boys in the present study were as tall or taller at all ages and centiles. In contrast, the final height of girls in our study had not caught up with those of girls in the 1992 national reference data, though they certainly had gone beyond those of their central zone data at the 50th and 97th centiles.

Comparison of boys' height with the USEG national data for 2009 and 2011. The height of boys in our study did not lag behind that of the data for 2009 (taller at 3rd and 50th centile and a lag of 0.5 cm in the 97th centile at 18 years). However, there was a greater discrepancy in the heights between the children in our study and the (taller) boys of the 2011 USEG study.

Comparison of girls' height with the USEG national data for 2009 and 2011. Though the heights of the girls in our study compared favourably with the 2009 data in the 50th and lower centiles at all ages, the upper centiles matched them only till 11 years of age (data not shown), after which they lagged behind. In comparison with the 2011 data, our girls were shorter at 17 years at all percentiles, similar to the situation in boys.

Weight and BMI

Children (both boys and girls) in our study maintained similar weight percentiles as that of the national USEG data for 1992. This is distinct from the high weight and BMI results seen in the USEG data for 2009 and 2011. In our study children, the values of 85th and 95th BMI percentile at 17/18 years of age in both girls and boys were 23 and 25 kg/m^2, respectively. Using the International Obesity Task Force (Childhood Obesity Working Group) age- and gender-specific international BMI cut-offs to define overweight and obesity, 1% (40/3794) MSEG children were obese and an additional 5.7% (216/3794) were overweight. The prevalence of overweight/obesity was statistically not different between the boys (6.7%) and girls (6.8%; p=0.91). Using Cole's BMI reference charts for defining thinness, 9.7% of boys and 9.8% of girls were thin, higher than expected by the statistical definition of mean (–2 SD) for age. The prevalence of thinness was statistically not different between boys and girls (p=0.89).

DISCUSSION

Our results show that urban children belonging to the MSEG in Lucknow have become taller at final height (except for 3rd centile girls) than the USEG cohort of 1992 from the same region (Lucknow, Allahabad, Varanasi).[1] They compare favourably with their 2009 USEG nationally representative counterparts with respect to boys. However, with respect to girls, the MSEG still lags behind the national USEG data for 1992 and 2009 for the older age groups.[1,3] The gender difference is unlikely to be due to genetically shorter population in our region, otherwise it would have affected boys and girls equally. An explanation could be that the negative bias towards the girl child in our region has not allowed girls to achieve improvement in height to the extent to which the boys have. There is an improvement of height percentiles in the pre-pubertal years, which is not carried through during the pubertal growth spurt, suggesting that perhaps a few more years of improved nutrition for the girl child may also bring her at par with the national USEG data. This gender disparity, as well as the contrasting patterns of secular trend between different socio-economic level cities or regions, has been reported from several countries including China and Poland.[10–12] In a Chinese study[10] of secular trend in anthropometry between 1990 and 2005 in affluent versus second level cities, the authors documented that the increase in height per decade lagged behind in girls compared with boys. The mean stature was higher in 'group 1' cities than in 'group 2 or 3' cities. However, the secular increment was higher in the latter cities than in group 1 cities, suggesting that the children in group 1 cities had already achieved most of their genetic potential.

The improvement in height in our MSEG children has not come at the cost of increased obesity. This is in contrast to the two large nationwide Indian USEG growth studies which were published in 2009 and 2011.[3,4] A striking finding in both these studies was an upward shift in the weight and BMI percentiles for both genders. In contrast to the remarkable increment in weight and BMI, height showed only a nominal increment. The reason for a more obvious positive secular trend in boys of the 2011 study could be that almost 50% of children in the study resided in the northern parts of India (including the states of Punjab, Haryana, Delhi, Jammu and Kashmir and Himachal Pradesh) in contrast to the 27% contribution of northern India in the 2009 study.[3] Though the recent USEG data had not provided regional comparisons, the 1992[1] data had shown that children from the northern regions were taller than those from the southern, western and eastern regions of India.

Numerous authors have shown that in developing economies there is initially a positive correlation between socioeconomic class and overweight, i.e. there is more obesity in the higher socioeconomic classes. As the transition to a more developed economy occurs, the correlation becomes negative, especially for women, with the lower socioeconomic group showing greater obesity than the USEG.[13,14] The prevalence of obesity is increasing alarmingly worldwide and the children in the USEG of urban India are no exception. The prevalence of overweight/obesity, by similar definitions, is 15% to 24% in almost all affluent class/USEG paediatric cohorts from India.[15–19] A lower 6.7% prevalence of overweight/obesity in our study points to children from the MSEG being still relatively spared from the epidemic of obesity. A similar 7.1% prevalence of overweight/obesity was noted in MSEG children of Delhi by Kaur *et al.*[16] However, their study did not provide data on height.

The strengths of our study lie in the single-observer height readings and application of an objective and valid socioeconomic scoring system. One key limitation of our study is its relatively small sample size drawn from children in one city, which is inadequate to make inferences about children belonging to the MSEG of other regions. Further, the statistical methods used for smoothing various databases are not completely identical. This may have allowed some errors in interpretation to creep in. The definition of socioeconomic class also was not the same in all the studies compared. Marwaha *et al.*[4] defined 'fee-paying school' as a surrogate for upper socioeconomic status, Agarwal *et al.*[1] as 'children of well-to-do educated families attending English medium schools' and Khadilkar *et al.*[3] giving the most detailed description of the schools catering to affluent families. Lastly, while comparing children in Lucknow with the data collected by Agarwal *et al.* from the central zone,[1] we presumed that children of Varanasi and Allahabad are ethnically and geographically close to those of Lucknow.

Conclusions

Our results show that MSEG children (both boys and girls) in Lucknow have shown a definite positive trend in their heights when compared with the 20-year-old USEG data from the same region. We find that MSEG girls still lag behind in comparison with the national 1992 and 2009 data. However, both genders are at present unaffected by the obesity epidemic. These results have implications for contextualizing the obesity epidemic seen among children within its socioeconomic context and pointing to a gender bias for improvement in heights.

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Conflict of interest: None

Contributions. VB gave the initial concept, designed and supervised the study, approved the final manuscript and is the guarantor. PG prepared the study protocol, acquired data, searched the literature, wrote the first draft of the manuscript and helped in final drafting. AK helped in the data collection, literature review and drafting of the paper. Besides reviewing the literature and drafting the paper, NM and JVM analysed and helped in interpretation of the data.

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