Growth profile of preschool children in an Indian rural community

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SUMMARY An investigation into the nutritional anthropometry of preschool children of poor socioeconomic status was carried out in a rural community of India by door-to-door visits. All measurements—height, weight, left mid-arm girth, and chest and head circumferences—were far below local as well as international standards. By comparison with the Harvard standard, about 53% of the children were below it in respect of height for age and about 82% in respect of weight for height. The proportion of undernourished girls was relatively higher than that of boys. The need to develop regional standards is emphasised.

Studies on the growth performance of children are of the utmost importance as an index of nutritional status for the community. It is recognised that genetic factors play an important role in determining children's growth but the impact on their growth potential of socioeconomic and ecological conditions, health care, and nutrition cannot be ignored. The fact that better socioeconomic and living conditions, optimal health care, and adequate nutrition bring better health has been observed by many workers.¹⁻⁴

Protein energy malnutrition in growing children has always been a major public health problem in the developing countries. Severe clinical forms of diseases like kwashiorkor and marasmus are easy to recognise, but milder forms of the disease manifest themselves in varying degrees of growth retardation which could well be detected by the use of anthropometry. Infants from rural areas are generally well protected against malnutrition, because the majority are breast-fed up to the age of 9 to 12 months. The school child, being more or less independent, can fend for himself, but the preschool child is neither breast-fed nor independent and is therefore likely to suffer more from various nutritional disorders.

With these considerations in mind, our investigation of the anthropometric measurements of preschool children was carried out in a rural community of Jhansi district in Uttar Pradesh. Such data will also provide valuable information to help us to decide whether genetic differences in growth and development between Indian children and those in the technologically advanced countries of the West do, in fact, exist.

Material and methods

A cross-sectional survey of the growth performance of preschool children was undertaken in the three villages of Baragaon, Digara, and Baratha, all located within the limits of the Rural Field Practice Area of the Department of Social and Preventive Medicine, MLB Medical College, Jhansi, Uttar Pradesh, from August 1977 to March 1978. The investigation was carried out under the supervision and guidance of the authors by a team of interns and women social workers, who were given the requisite training in the department beforehand. Various anthropometric measurements, namely, weight, height, left mid-arm girth, and head and chest circumferences, were recorded by standard procedures.⁵ Ages were assessed in completed years using the 'age abbreviation' method,⁶ and a calendar based on local events. The utility and validity of the latter have been demonstrated.⁷

Agriculture was the main occupation in the community and most people belonged to Social Classes IV and V,⁸ so the children studied represented a low socioeconomic group. The data were compared with local⁹ as well as with international standards¹⁰ wherever possible, by drawing smoothed curves. Correlation and regression coefficients¹¹ were used to estimate the relationship between the measurements and per unit change in them respectively.

The study sample should have included 981 children in the age group 1–5 years in 1157 families of the three villages; however, bodily measurements were recorded on only 774 (78.9%) children. The remaining 207 (21.1%) children could not be

examined despite repeated visits. The reasons for this relatively high non-coverage were either that the children were away from their homes because their parents generally went to distant places to work taking the children with them or that parents refused permission, probably as a result of the intensive family welfare campaigns in the area before the time of our study, which had resulted in forcible sterilisation. Another reason may have been illiteracy.

Results

The values of the mean, the 50th percentile (median), and the standard deviation for different anthropometric measurements (height, weight, and chest, head, and left mid-arm circumferences) for boys and girls by age are given in Tables 1 and 2. Their growth pattern compared with local and international standards in respect of these measurements is also shown graphically in Figs. 1 to 5.

Figs. 1 and 2 clearly indicate that boys as well as girls in the present series were much shorter and lighter than those of Hyderabad and America. For measurements of both height and weight in the two sexes, 50th percentile values in the present series were far below the 25th percentile values of Hyderabad and even the 3rd percentile values of

Fig. 1 Percentile chart of height and weight (boys).

Fig. 2 Percentile chart of height and weight (girls).

American children. Similarly, 50th percentile values of chest circumference of the children in the present study were much lower than those of Americans and the mean values of Bombay children (Figs. 3 and 4). The same was true for the head circumference of boys (Fig. 3); however, girls in the study community showed some improvements over those of Hyderabad after the age of 4 (Fig. 4). In the absence of international standards on arm circumference for the type of children studied, the present children could be compared only with the local standard (Hyderabad). It was, however, observed that 50th percentile values for boys and girls were considerably lower than even the 25th percentile values of Hyderabad subjects (Fig. 5).

In nutrition surveys, considerable significance is attached to the head/chest ratios. Normally, in well-nourished children, chest circumference becomes larger than head circumference after the first six months of life.⁶ In children suffering from protein energy malnutrition, the chest does not develop properly, probably because of poor growth or wasting of the pectoral muscles, and the head remains the larger of the two circumferences.¹² In the present study, equalisation of head and chest in boys occurred at two years of age and in girls somewhere between the ages of two and three years. Because the study children's age-grouping was in whole years, the

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Fig. 3 Percentile chart of chest and head circumferences (boys).

Fig. 4 Percentile chart of chest and head circumferences (girls).

Fig. 5 Percentile chart of arm circumference (boys and girls).

ages at equalisation of their head and chest circumferences are only crudely accurate, yet these values portray interesting results for the interpretation and comparison of growth performance. The results (Tables 1 and 2) clearly indicate that these children were largely undernourished and that the proportion of such girls was relatively higher than that of boys.

The statistical significance of the correlation of age as well as weight with other measurements was also investigated (Table 3). The increase in the values of different parameters—height, and head, chest, and arm circumferences, etc—per unit increase in age and weight separately was estimated by linear regression analysis. It may be seen that all correlation coefficients for both boys and girls are highly significant. Regression coefficients, in each case, clearly indicate that there was a definite increase in the quantum of various parameters with increase in age or weight of the children.

Because the height and weight of children are the most sensitive measures of their nutritional state,¹³ such measurements of boys and girls in our study were expressed as percentages of the Harvard standard and they were later graded into different levels of undernutrition as suggested by Jelliffe.⁶ When weight was considered to be a criterion for the assessment of their nutritional state, the results

Table 1 Mean (M), standard deviation (SD), and median (Me) of various anthropometric measurements in preschool boys

Age (completed years)	No. of boys	Height (cm)		Weight (kg)		Chest circumference (cm)		Head circumference (cm)		Arm circumference (cm)		Head/chest ratio	
		M ± SD	Me	M ± SD	Me	M ± SD	Me	M ± SD	Me	M ± SD	Me	M ± SD	Me
1	76	72.9 ± 8.8	72.8	7.0 ± 1.6	7.2	44.8 ± 3.2	45.2	45.8 ± 2.4	45.8	13.1 ± 1.4	13.1	1.02 ± 0.05	1.02
2	67	78.0 ± 7.2	79.0	8.7 ± 2.0	8.7	47.3 ± 3.1	47.2	47.3 ± 1.9	47.0	13.3 ± 1.5	13.5	1.00 ± 0.05	1.00
3	85	85.1 ± 7.0	84.9	9.9 ± 2.0	9.8	48.6 ± 2.9	48.9	47.9 ± 2.4	48.1	13.9 ± 1.3	13.9	0.99 ± 0.07	0.99
4	112	93.8 ± 7.9	93.8	12.3 ± 1.9	12.1	51.2 ± 3.5	51.3	49.0 ± 2.3	49.4	14.5 ± 1.3	14.4	0.96 ± 0.05	0.96
5	66	97.1 ± 7.1	97.3	13.1 ± 1.9	12.9	52.4 ± 2.7	52.4	49.5 ± 2.3	49.7	14.3 ± 1.2	14.3	0.94 ± 0.04	0.94

Table 2 Mean (M), standard deviation (SD), and median (Me) values of various anthropometric measurements in preschool girls

Age (completed years)	No. of girls	Height (cm)		Weight (kg)		Chest circumference (cm)		Head circumference (cm)		Arm circumference (cm)		Head/chest ratio	
		M ± SD	Me	M ± SD	Me	M ± SD	Me	M ± SD	Me	M ± SD	Me	M ± SD	Me
1	92	70.7 ± 6.7	71.2	6.9 ± 1.6	6.8	43.2 ± 3.3	42.7	43.9 ± 2.4	44.0	12.4 ± 1.7	12.4	1.02 ± 0.06	1.02
2	63	77.4 ± 8.6	76.3	8.0 ± 1.9	8.2	45.4 ± 3.7	45.2	46.1 ± 2.0	46.0	12.7 ± 1.7	12.6	1.01 ± 0.05	1.01
3	77	82.8 ± 8.4	82.8	9.8 ± 2.1	9.7	48.4 ± 3.1	48.7	47.2 ± 2.3	47.0	13.6 ± 1.5	13.8	0.98 ± 0.05	0.98
4	72	91.5 ± 8.3	90.3	11.3 ± 1.8	11.3	50.7 ± 2.5	50.6	48.2 ± 2.1	48.5	14.3 ± 1.3	14.3	0.96 ± 0.04	0.96
5	64	97.5 ± 8.7	97.3	12.7 ± 2.1	12.5	51.7 ± 2.8	51.5	49.2 ± 1.9	49.5	14.4 ± 1.6	14.4	0.95 ± 0.04	0.95

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Table 3 Correlation and linear regression coefficients in respect of various bodily measurements in preschool boys and girls

Correlation coefficient (rij†)	BOYS		GIRLS	
	Coefficient of correlation (rij)	Coefficient of regression (Xj on Xi)	Coefficient of correlation (rij)	Coefficient of regression (Xj on Xi)
r ₁₂	0.8259	1.6554	0.6610	1.5402
r ₁₃	0.8231	6.8630	0.8263	6.8180
r ₁₄	0.4979	0.5176	0.5289	0.5801
r ₁₅	0.6861	1.4804	0.3234	0.6831
r ₁₆	0.7469	2.1920	0.6683	2.0278
r ₂₃	0.8088	3.3643	0.8728	3.8594
r ₂₄	0.6060	0.3589	0.7173	0.4178
r ₂₅	0.7480	0.8053	0.7754	0.8698
r ₂₆	0.7842	1.1481	0.8420	1.3578

† X₁ = age X₂ = weight X₃ = height X₄ = left mid-arm girth
X₅ = head circumference X₆ = chest circumference

indicate (Table 4) that only 2.5% of the children (3.0% boys and 1.9% girls) were normal and 29% were below the 60% of the reference standard weight. However, when height was taken as a criterion, 46.6% of the children (49.3% boys and 43.7% girls) fell within normal limits (Table 5). Only four (0.5%) girls were below the 70% height of the reference standard.

The weight of our children was compared with the reference weight, adjusted for differences in height. The prevalence of undernutrition, based on weight for height, has been shown in Table 6. The results indicate that about 81.8% of the children (80.3% boys and 83.4% girls) were undernourished and 17.3% were even below the 70% weight for height of the Harvard standard.

Discussion

Like other growth studies carried out in India, ^{2,4,14} the present study showed that boys were relatively heavier and taller than girls. However, in respect of all measurements considered in the study, both boys and girls were far below the local as well as the international standards. This was a clear indication of their considerable growth retardation.

As was pointed out earlier, the head/chest ratio of children is sometimes taken to be indicative of their nutritional state. In healthy well-fed infants and children, the crossover of the chest circumference with that of the head circumference would occur earlier than in undernourished children. In the present study, such equalisation took place at two years of age in boys and somewhere between two and three years of age in girls. Studies from urban Delhi¹⁵ have shown this to occur at the age of 10 to 12 months. However, in Calcutta preschool children¹⁴ it occurred at one year of age. Thus, the nutritional

Table 4 Weight for age, expressed as a percentage of the international (Harvard) standard in preschool boys and girls

LEVELS OF UNDERWEIGHT FOR AGE, EXPRESSED AS PERCENTAGE OF HARVARD STANDARD											
Sex	No. of children	Normal (over 90% standard)		1st level (90 — 81% standard)		2nd level (80 — 71% standard)		3rd level (70 — 61% standard)		4th level (60% and below standard)	
		No.	%	No.	%	No.	%	No.	%	No.	%
Boys	406	12	3.0	46	11.3	118	29.1	127	31.3	103	25.4
Girls	368	7	1.9	36	9.8	89	24.2	112	30.4	124	33.7
Total	774	19	2.5	82	10.6	207	26.7	239	30.9	227	29.3

Table 5 Height for age, expressed as a percentage of the international (Harvard) standard in preschool boys and girls

LEVELS OF UNDERHEIGHT FOR AGE, EXPRESSED AS PERCENTAGE OF HARVARD STANDARD											
Sex	No. of children	Normal (over 90% standard)		1st level (90 — 81% standard)		2nd level (80 — 71% standard)		3rd level (70 — 61% standard)		4th level (60% and below standard)	
		No.	%	No.	%	No.	%	No.	%	No.	%
Boys	406	200	49.3	173	42.6	33	8.1	Nil	Nil	Nil	Nil
Girls	368	161	43.7	160	43.5	43	11.7	4	1.1	Nil	Nil
Total	774	361	46.6	333	43.0	76	9.8	4	0.5	Nil	Nil

Table 6 Weight for height, expressed as a percentage of the international (Harvard) standard in preschool boys and girls

LEVELS OF UNDERWEIGHT FOR HEIGHT, EXPRESSED AS PERCENTAGE OF HARVARD STANDARD											
Sex	No. of children	Normal (over 90% standard)		1st level (90 — 81% standard)		2nd level (80 — 71% standard)		3rd level (70 — 61% standard)		4th level (60% and below standard)	
		No.	%	No.	%	No.	%	No.	%	No.	%
Boys	406	80	19.7	143	35.2	125	30.8	50	12.3	8	2.0
Girls	368	61	16.6	107	29.1	124	33.6	57	15.5	19	5.2
Total	774	141	18.2	250	32.3	249	32.2	107	13.8	27	3.5

state of our children was relatively worse than that of urban Delhi subjects¹⁵ and of Calcutta preschool children.¹⁴

Further analysis indicates that when weight and height for age of the boys and girls in our study were expressed as percentages of the Harvard standard, 97.5% and 53.4% respectively were below standard. Because the classification of undernutrition, based on height for age, gives the past nutritional history of children,¹⁶ these underheight children had suffered growth failure either for a short period at an early age or for a longer period at a later age.¹⁷

Our results also show that 81.8% of children in the present series were below standard on the basis of weight for height. Visweswara Rao,¹⁸ in a similar investigation carried out in a large population around Hyderabad of poor socioeconomic status, also studied the prevalence of undernutrition using the Harvard standard. He observed about 70.2% of children to be below standard on the basis of height

for age and 50% on the basis of weight for height, so the current nutritional state of our children was even worse than that of the Hyderabad subjects.¹⁸

The prevalence of undernutrition was observed to be relatively higher in girls than in boys, irrespective of the criteria used for its assessment. Such observations have also been made by Visweswara Rao.¹⁸ The reasons need to be investigated through more longitudinal studies.

The children of richer parents have been found to be larger than those of the poor both in India¹ and elsewhere^{19, 20} and those belonging to well-to-do families have generally been shown to have significantly improved bodily measurements,^{2, 4} so the very low values of measurements in the study children compared with local and international standards could have been due to their parents' poor socioeconomic status. There is a large variation in height between regions within a country and between social classes within a region and the results of our

investigation relate to the lower social classes of one of the poor regions of India.

The present study tends to suggest that the size of a growing child is influenced by environment. The fact that good environmental conditions affect health positively has been shown in Californian-born Japanese children who showed much improved height and weight compared with native born Japanese.²¹

In view of the large international variation in height, the limited use of a single international standard in the present study is obvious. For the proper interpretation and comparison of children's growth performances in different population groups, the development of relevant standards, regional as well as international, is essential. Although the values of various body measurements in the present study may not be considered to be the standards for that region because the children were from low socioeconomic groups, nevertheless these values can be used to compare communities similar to the present one.

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