The Growth Pattern of Schoolchildren in Saudi Arabia

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Saudi Medical Journal 1992; 13(2): 141-146

A cross-sectional study of schoolchildren in Saudi Arabia was carried out to determine their health status. The sample was selected using a multistage stratified sampling technique and anthropometric measurements were taken. The growth charts of height for age, and weight by age were constructed and smoothed by the spline regression polynomial technique. The study showed that Saudi boys and girls have similar growth patterns to their American counterparts. However, they were retarded by less than one standard deviation compared with the National Council of Health Statistics standards. Schoolboys and girls with normal weight and height for age constitute about 58% and 53% respectively of the total sample. Overweight and obesity were more frequent in girls than in boys.

Saudi Arabia has witnessed spectacular development of health services in the last 20 years that correspond to the economic boom of the country.\(^1,2\) However, the statistics on the state of health of schoolchildren in Saudi Arabia is scanty. The evaluation processes have not been satisfactory despite the fact that school health programmes and other nutritional programmes have been in operation for several decades.\(^3,4\)

An early and convenient method of assessing nutritional and socioeconomic status of growing children is anthropometry.\(^5\) Physical growth in terms of weight and height is considered an important parameter reflecting the pattern of growth and development of a country.\(^6\) In Saudi Arabia, the available anthropometric reports have concentrated on pre-school children and such studies have been carried out in limited geographical areas of the country.\(^4,5\)

There has not been any national survey to gather relevant data from which standard growth charts for the population of Saudi children can be constructed. The present study represents a preliminary attempt to provide standard growth charts for Saudi children aged 6–18 years.

Materials and Methods

Sampling procedure

A sample size of 48,000 children aged 6–18 years was determined as adequate for achieving a reasonably precise estimate of growth. The choice of the sampling plan was motivated to take advantage of the structure, distribution and factors underlying the heterogeneity among the schoolchildren in Saudi Arabia namely age, sex, residence, and socioeconomic level. Accordingly, a three-stage stratified cluster sampling technique was used. The process of sampling had a schematic organization as follows: for administrative purposes, there are five regions in Saudi Arabia, namely East, West, North, South and Central. Therefore, the estimated sample size of 48,000 was allocated to each region in proportion to its
population. In the first stage of sampling, the cities, towns and villages in each region were stratified into urban and rural and a random sample was selected from each stratum. The selection of villages in rural areas was done proportionate to population size (PPS).

In the second stage, a list of schools as sampling units was defined and stratified according to age as indicated by educational level (primary intermediate and secondary), sex (male and female), and socioeconomic level (low, medium and high). A simple random sample of schools were chosen from each stratum, the schools defining the clusters.

In the third stage of sampling, the full directory of children's names by class were obtained in each school selected in stage two. A simple random sample of schoolchildren in each class was drawn as the final sample.

Data was collected on anthropometric measurements like age (through birth certificate), weight, height and sex of the children. All anthropometric measurements were guided by the WHO monograph produced by Jelliffe. The children were weighed wearing light clothes on a lever balance (single beam clinic scales) to the nearest 0.1 kg. The scales were checked regularly with a known weight after every ten measurements. Height was measured on a portable measuring board, the metre rule being screwed on perpendicular to the foot of the board. A triangular right-angled block was placed on the head touching the metre rule to make it parallel to the floor. The subject stood upright without shoes with the examiner exerting firm upward pressure under the jaw to encourage maximum stretching. The data was analysed on the mainframe of the King Saud University computer centre. A statistical software package 'SAS' (Statistical Analysis System) was used to produce seven percentile curves each of weight by age and height by age for boys and girls separately. The four charts covered the period from 6 years to 18 years of age. The observed percentiles were smooth by the spline polynomial regression method.

The 50th percentile of each chart was also plotted on the

Figure 1. Boys' height by age percentiles: ages 6–18 years.

Figure 2. Boys' weight by age percentiles: ages 6–18 years.

Figure 3. Girls' height by age percentiles: ages 6–18 years.

National Council of Health Statistics (NCHS) standards for comparative purposes, which have been favourably recommended by Waterlow et al.

Results
The estimated sample size for study was 48,000 students but the actual number of boys and girls studied was 47,810 giving a 99% coverage rate. Of these 24,383 (51% of the sample size) were male and 23,427 (49% of the sample size) were female. There were 30,120 (63% of the total sample size) living in urban areas and 17,690 (37% of the total sample size) in rural areas.
The summary descriptive statistics for weight and height, by age for boys and girls with seven percentile points (5th, 10th, 25th, 50th, 75th, 90th, 95th) plotted are presented in Figs 1-4. The emerging pattern was that on average, males had a higher weight than females between the age of 6 years and 9 years. But at 10 years of age, the reverse occurred with females weighing more than males. Also the males were taller than females between the age of 6 and 11 years but this was reversed at 12 and 13 years only for males to take over again at 14–18 years.

The weight for age and height for age in each sex group were compared with the NCHS standard. Apart from age six, the Saudi boys had lower weights than the American boys. But the pattern of growth was the same in both countries with the average Saudi boys lying within
growth of height with age was the same and the average Saudi boy was within one standard deviation of the NCHS standards (Fig. 7). There was no statistically significant difference between the pattern of growth of Saudi girls and the NCHS standards, (p > 0.05). However, the Saudi girls were on the average shorter than the NCHS standards; generally their 50th percentile points were between the 10th percentile and the 25th percentile of the NCHS standard except in the 6-year-olds (Fig. 8).

Tables 1 and 2 summarize the distribution of weight for height of the schoolchildren based on the values of standard deviations above and below the NCHS median for both sexes. The distribution shifted to the right of the normal distribution of the reference population with only 0.1% of the male and female schoolchildren being 'wasted' (≤ – 2 SD of the reference median). Conversely, when a high weight for height (> 1 SD of the reference median) was considered as overnutrition, a large number of children, 27.1% male and 31.8% of female fell in this category. These figures included 9.5% of males and 11.3% of females considered as obese (weight for height ≥ 2 SD), and the remaining 17% of males and 20% of females who appeared to be overfed but not necessarily obese (1–1.99 SD of reference median).

**Discussion**

Reliable growth charts are not available in most countries because of the lack of an adequate data base. Previous attempts in Saudi Arabia to produce growth charts have been based on cross-sectional studies. This is perhaps the most practical design which is widely acceptable to statisticians. The ideal situation would have been to follow up a group of children from birth to a required age, measuring the relevant anthropometric variables at standard intervals. However, the growth charts from the present study, though based on a cross-sectional data appear to be more national in outlook for Saudi schoolchildren and

**Table 1**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>No. examined</th>
<th>≤ -2SD Severe</th>
<th>-1.99–1.99 SD Mild to moderate</th>
<th>-0.99–0.99 SD Normal</th>
<th>1–1.99 SD Overweight</th>
<th>≥ 2SD Obese</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1890</td>
<td>0.2</td>
<td>15.1</td>
<td>65.6</td>
<td>13.5</td>
<td>5.6</td>
</tr>
<tr>
<td>7</td>
<td>1870</td>
<td>0.3</td>
<td>18.4</td>
<td>68.4</td>
<td>9.3</td>
<td>3.6</td>
</tr>
<tr>
<td>8</td>
<td>1906</td>
<td>0.3</td>
<td>16.7</td>
<td>64.1</td>
<td>12.5</td>
<td>6.4</td>
</tr>
<tr>
<td>9</td>
<td>1880</td>
<td>0.2</td>
<td>12.4</td>
<td>69.3</td>
<td>13.9</td>
<td>4.2</td>
</tr>
<tr>
<td>10</td>
<td>1886</td>
<td>0.1</td>
<td>12.1</td>
<td>68.7</td>
<td>12.0</td>
<td>6.0</td>
</tr>
<tr>
<td>11</td>
<td>1875</td>
<td>0.1</td>
<td>15.3</td>
<td>60.3</td>
<td>14.6</td>
<td>9.7</td>
</tr>
<tr>
<td>12</td>
<td>1891</td>
<td>0.1</td>
<td>16.4</td>
<td>56.3</td>
<td>16.4</td>
<td>10.1</td>
</tr>
<tr>
<td>13</td>
<td>1902</td>
<td>0.0</td>
<td>16.4</td>
<td>52.5</td>
<td>17.8</td>
<td>13.3</td>
</tr>
<tr>
<td>14</td>
<td>1887</td>
<td>0.0</td>
<td>18.3</td>
<td>50.6</td>
<td>10.0</td>
<td>11.1</td>
</tr>
<tr>
<td>15</td>
<td>1863</td>
<td>0.0</td>
<td>13.3</td>
<td>52.3</td>
<td>15.2</td>
<td>9.2</td>
</tr>
<tr>
<td>16</td>
<td>1876</td>
<td>0.0</td>
<td>14.2</td>
<td>50.9</td>
<td>20.8</td>
<td>8.1</td>
</tr>
<tr>
<td>17</td>
<td>1828</td>
<td>0.0</td>
<td>10.8</td>
<td>53.7</td>
<td>20.6</td>
<td>14.9</td>
</tr>
<tr>
<td>18</td>
<td>1829</td>
<td>0.0</td>
<td>9.9</td>
<td>47.3</td>
<td>26.8</td>
<td>16.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>24383</td>
<td>0.1</td>
<td>14.4</td>
<td>58.4</td>
<td>17.6</td>
<td>9.5</td>
</tr>
</tbody>
</table>
are a major improvement over previous growth charts which were based on data from selected areas of the population.\textsuperscript{4,7}

The general tendency for boys to weigh more than girls below the age of 10 years after which the reverse occurs which was observed in this study is similar to the growth pattern recorded elsewhere.\textsuperscript{9,10,13,14} A possible explanation has been that puberty occurs at an early age for girls. Also, there could be a tendency for girls to be overweight.\textsuperscript{10} Except at the ages 12 and 13 years, the boys were found to be generally taller than the girls which is similar to the pattern from other countries.\textsuperscript{9,10,14} Even in India where the children are shorter on the average than the Saudi children, the same observation was found.\textsuperscript{14}

One major observation is the close agreement of the 50th percentile points of weight at age 6–18 years for boys and girls with the NCHS standards. In each sex group the weights for age were above the 25th percentile of the NCHS standards. Height for age, which is considered an indicator of past nutritional status,\textsuperscript{16} was found to be largely below the reference standard in the study population. The results show that the Saudi children are shorter on the average than the NCHS standards as boys' and girls' 50th percentiles are slightly below the 25th percentiles of the NCHS standards at each age. However, the differences are not statistically significant (p > 0.05). Moreover, when shortness of height upon weight is estimated and only the degree of underweight or overweight is measured, there are more children with high weight for height than expected of the reference population standards. In the absence of any recent nutritional intervention programme in Saudi Arabia, these findings highlight a genetic control of height and thus question the validity of comparisons with an international standard. The improvement in health services and socioeconomic standards of the Saudi community relegates nutritional factors to the background.\textsuperscript{6,12}

In similar communities in the Middle East, the growth patterns of boys and girls are comparable and similar to those of Saudis.\textsuperscript{10,15} There are no appreciable differences in the height and weight of Egyptian boys and girls at ages 9, 12, 15 and 18 and their Saudi counterparts,\textsuperscript{10} although it appears that the Egyptian girls are slightly heavier than Saudi girls. The significantly heavier weights and taller heights of Saudi boys and girls than their Indian counterparts may be attributed in part to nutritional status and partly to genetic factors. It is well known that the Indian community has a lower socioeconomic standard than the Saudis.

Height for age, and weight for height which were considered as indicators of malnutrition have been useful in interpreting the nutrition status of schoolchildren in the present study. Whereas 0.1% in both sexes were ‘wasted’, overweight and obesity were found in almost equal proportions but appear more prevalent in girls (31.8%) than boys (27.1%). This finding may possibly be attributed to one or more of the following factors: a high calorie intake, less physical exercise, genetic variation and environmental factors.

Though our study had its limitations, the present charts may serve as a base for the development of growth charts and give a reflection of the state of health in schoolchildren in a rapidly developing country. Our study showed a trend toward over-nutrition when weight for height standards were considered. There is a need for further studies to
compile statistics on weight and height for monitoring purposes. Also, there is a need for more exploratory studies on the genetic and environmental factors determining the nutrition status in the Kingdom.

Acknowledgements
The authors are grateful to all field workers.

References