

THE STANDARD PHYSICAL GROWTH CHART FOR SAUDI ARABIAN PRESCHOOL CHILDREN

Abdulrahman S. Al-Frayh, MD, Fachartz: Elijah A. Bamgboye, PhD(Lond);
Mohammed A. A. Moussa, PhD(Edin)

تعرض هذه الدراسة رسوماً بيانية لنمو الأطفال في مرحلة ما قبل المدرسة استناداً إلى بيانات شرائحية عن السكان في مدينة الرياض في المملكة العربية السعودية. تم تصميم الرسوم البيانية للوزن والطول حسب العمر بصورة منفصلة لكل من الصبيان والبنات. كان وزن الصبيان يفوق وزن البنات في كل الأعمار ضمن هذه الفئة. كان الصبيان أيضاً أطول من البنات بعد السنة الأولى من العمر. ونظراً لأن القصور في نمو الأطفال في المملكة العربية السعودية بالمقارنة مع المقاييس المعتمدة دولياً للسكان قد يعزى إلى عوامل وراثية وبيئية، فإن الرسوم البيانية المقدمة تكفي لتكون مقياساً لمراقبة نمو الأطفال السعوديين بشكل خاص ونمو الأطفال في منطقة الخليج بشكل عام.

This study presents growth charts of preschool children based on cross-sectional data of the population in Riyadh, Saudi Arabia. Charts on weights and heights per age were designed separately for boys and girls. Boys consistently weighed more than girls for this age group at every age. Also, the boys were taller than the girls after the age of one year. Since the growth deficits in children from Saudi Arabia compared with internationally recommended reference populations may be attributed to genetic and environmental factors, the charts presented will suffice as a standard in monitoring the growth of Saudi children in particular and those in the Gulf Region in general.

There is a dearth of information on the growth patterns of Saudi preschool children [1,2]. Previous reports have been based on sample sizes too small to minimize sampling errors in the estimates [2-5]. In a comparison of the physical growth of Saudi children from birth to age five years according to the internationally recognized reference populations, statistically significant growth deficits have been observed [3,6]. The consensus has been to attribute these growth deficits to genetic and environmental factors rather than infection and malnutrition [3,6].

Thus, it is essential to develop a standard growth chart for use in the Kingdom of Saudi Arabia and in the Arabian Gulf region [6,7]. The present analysis shows the growth chart which was calculated using

the cross-sectional data from the Riyadh population for preschool children selected randomly from the different socioeconomic classes.

Material and Methods

Population and Sample

The methodology of the cross-sectional survey of preschool children carried out in the city of Riyadh and on which the present analysis was based has been previously described in the literature [6,8]. However, the most important elements are highlighted. The final sample of children was obtained from a three-stage stratified cluster sampling procedure. The 93 administrative areas in Riyadh were initially divided into six socioeconomic homogenous strata based on the socioeconomic interpretation of the Central Department of Statistics, Ministry of Finance and National Economy, Saudi Arabia. A total of 17 areas was selected by simple random method during the first stage of sampling. During the second stage, a simple random sample of

From the Department of Pediatrics (Dr. Al-Frayh), and the Department of Family and Community Medicine (Drs. Bamgboye and Moussa), King Saud University, College of Medicine, Riyadh.

Address reprint requests and correspondence to Dr. Al-Frayh: King Saud University, Department of Pediatrics (39), College of Medicine, P.O. Box 2925, Riyadh 11461, Saudi Arabia.

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224 roads was selected from a total of 1,376 roads in the selected 17 areas. Finally, during the third stage, a random sample of blocks in which houses on selected roads had been subdivided was selected and all preschool children in one of every two houses were included in the study [8].

Data Collection

The data were collected by personal interviews and anthropometric measurements. There were five interviewing teams and each team included a field supervisor, anthropometrist, and a pediatrician who was responsible for the clinical examination of all preschool children. Any child diagnosed as clinically unsuitable by the pediatrician on the evidence of any illness such as chronic disease or malnutrition was excluded from the study. The mothers of the selected children were interviewed by trained interviewers while the nurse anthropometrists recorded the measurements of infants and children. All anthropometric measurements which were recorded utilized procedures recommended by Jelliffe [9]. Standing height was measured using a stadiometer (Harpender) and weight was measured using a balance beam (Seca). For children younger than two years of age, the Harpenden measuring board was used to measure supine length and weight was measured using a baby scale.

Statistical Analysis

The data were processed on the IBM mainframe of the King Saud University Computer Center using the BMDP software computer package. Growth charts were effected through fitting the least squares polynomial regression model of degree three, using age as an independent variable and the percentiles as the dependent variable [10]. This cubic polynomial

regression provided a better fit to our data than the spline polynomial regression method [11]. The graphics facility in the statistical analysis system (SAS/GRAPH) software package was used to plot the growth curves [12]. A comparison of the nutritional indicators with the reference population recommended by the World Health Organization (WHO) has been previously reported [5,6]. However, the standard scores distribution of weight/height/age for males and females separately expressed multiples of the standard deviation (SD) of the reference population were analyzed using the WHO "Anthro" software program [13].

Results

Complete data from a total of 3,795 children, 55.2% males and 44.8% females, aged 0-5 years on basic anthropometric measurements of age, weight, and height were collected. The minimum number of children in each age category was 279, a number far in excess of the recommended minimum number of 250 children by Waterlow et al [14]. The distribution of weight for height of the children at each age expressed in multiples of the standard deviation of the NCHS median are presented in Tables 1 and 2 for both sexes. The distribution is positively skewed with nearly 20% of the male and female children below 2.0 SD of the reference population median. On the average, the proportion of children below this critical cut off Z score, usually interpreted as an indicator of wasting, significantly decreases with increase in age. This decrease is, however, more pronounced in females than in males. When high weight for height was considered at each age, the proportion was significantly higher in females than in males, and a higher proportion of males (65%) than

TABLE 1. Percentage of weight for height of Saudi Arabian male children aged 0-5 years in multiples of SD scores of the NCHS/CDC reference population in each age group.

| Age in months | No. of children (1992*) | SD scores of weight for height (% of Age-group) | | | | |
|---------------|-------------------------|---|--------------------|------------------|-------------------|----------|
| | | ≤ - 2 SD | -1.99 SD to - 1 SD | -0.99 SD to 1 SD | 1.1 SD to 1.99 SD | ≥ 2 SD |
| < 6 | 224 | 33 (14.7) | 44 (19.6) | 112 (50.0) | 23 (10.3) | 12 (5.4) |
| 6-11.99 | 229 | 54 (23.6) | 59 (25.8) | 91 (39.7) | 11 (4.8) | 14 (6.1) |
| <12 | 453 | 87 (19.2) | 103 (22.7) | 203 (44.8) | 34 (7.5) | 26 (5.7) |
| 12 | 341 | 103 (30.2) | 105 (30.8) | 113 (33.1) | 13 (3.8) | 6 (1.8) |
| 24 | 300 | 52 (17.3) | 116 (38.7) | 122 (40.7) | 9 (3.0) | 1 (0.3) |
| 36 | 297 | 68 (22.9) | 88 (29.6) | 116 (39.0) | 18 (6.1) | 4 (1.3) |
| 48 | 263 | 49 (19.6) | 72 (27.4) | 118 (44.9) | 17 (6.5) | 5 (1.9) |
| 60 | 268 | 41 (15.3) | 86 (32.1) | 123 (45.9) | 13 (4.9) | 5 (1.9) |
| All ages | 1922 | 400 (21.1) | 570 (29.7) | 795 (41.3) | 104 (5.4) | 47 (2.4) |

* Children with Z-score values outside the range - 4 and + 6 were excluded from the analysis; SD=standard deviation.

TABLE 2. Percentage of weight for height of Saudi Arabian female children aged 0-5 years in multiples of SD scores of the NCHS/CDC reference population in each age group.

| Age in months | No. of children (1525*) | SD scores of weight for height (% of Age-group) | | | | |
|---------------|-------------------------|---|-------------------|------------------|-------------------|-------------|
| | | ≤ -2 SD | -1.99 SD to -1 SD | -0.99 SD to 1 SD | 1.1 SD to 1.99 SD | ≥ 2 SD |
| < 6 | 157 | 25 (15.9) | 36 (22.9) | 76 (48.4) | 15 (9.6) | 5 (3.2) |
| 6-11.99 | 194 | 50 (25.8) | 50 (25.8) | 73 (37.6) | 14 (7.2) | 7 (3.6) |
| <12 | 351 | 75 (21.4) | 86 (24.5) | 149 (42.4) | 29 (8.3) | 12 (3.4) |
| 12 | 300 | 61 (20.3) | 76 (25.3) | 130 (43.3) | 19 (6.3) | 14 (4.7) |
| 24 | 234 | 40 (17.1) | 66 (28.2) | 116 (49.6) | 6 (2.6) | 6 (2.6) |
| 36 | 226 | 45 (19.9) | 71 (31.4) | 90 (39.8) | 15 (6.6) | 5 (2.2) |
| 48 | 218 | 25 (11.5) | 58 (26.6) | 113 (51.8) | 14 (6.4) | 8 (3.7) |
| 60 | 246 | 45 (18.3) | 69 (28.0) | 105 (42.7) | 17 (6.9) | 10 (4.1) |
| All ages | 1575 | 291 (18.5) | 426 (27.0) | 703 (44.6) | 100 (6.3) | 55 (3.5) |

* Children with Z-score values outside the range - 4 and + 6 were excluded from the analysis; SD=standard deviation.

TABLE 3. The mean height and standard deviation of Saudi Arabian children aged 0-5 years by age/sex.

| Age in mos. | No. of children | Male | | No. of children | Female |
|-------------|-----------------|------------------|--|-----------------|-----------------|
| | | Mean \pm SD | | | Mean \pm SD |
| 0 | 279 | 62.1 \pm 13.6 | | 189 | 62.5 \pm 13.4 |
| 6 | 266 | 70.6 \pm 10.1 | | 222 | 72.7 \pm 15.5 |
| 12 | 365 | 77.5 \pm 7.7 | | 328 | 77.7 \pm 10.3 |
| 24 | 320 | 87.8 \pm 9.2 | | 242 | 85.9 \pm 7.8 |
| 36 | 308 | 95.4 \pm 8.4 | | 236 | 93.7 \pm 10.2 |
| 48 | 275 | 100.5 \pm 10.2 | | 227 | 99.0 \pm 10.8 |
| 60 | 282 | 107.1 \pm 9.1 | | 256 | 106.3 \pm 8.5 |

SD = standard deviation.

TABLE 4. The mean height and standard deviation of Saudi Arabian children aged 0-5 years by age/sex.

| Age in mos. | No. of children | Male | | No. of children | Female |
|-------------|-----------------|----------------|--|-----------------|----------------|
| | | Mean \pm SD | | | Mean \pm SD |
| 0 | 279 | 5.3 \pm 1.5 | | 189 | 5.1 \pm 1.4 |
| 6 | 266 | 7.7 \pm 1.4 | | 222 | 7.5 \pm 4.4 |
| 12 | 365 | 9.5 \pm 1.5 | | 328 | 9.3 \pm 1.9 |
| 24 | 320 | 11.6 \pm 2.0 | | 242 | 11.4 \pm 2.0 |
| 36 | 308 | 13.3 \pm 2.9 | | 236 | 13.2 \pm 2.5 |
| 48 | 225 | 15.0 \pm 2.9 | | 227 | 14.8 \pm 3.1 |
| 60 | 282 | 16.7 \pm 2.8 | | 256 | 16.4 \pm 3.2 |

SD = standard deviation.

females (60%) were within the (-1.0 SD and 1.0 SD) normal range of the reference population. The mean and standard deviation of the heights and weights of the children are presented in Tables 3 and 4. The girls appear slightly taller than the boys during the first year of life, but soon after, the situation reversed. The weight patterns of boys and girls appeared similar at each age, even though the boys seemed to have higher weights. The five percentile points (5th, 25th, 50th, 75th, and 95th) of weight and height for age that were plotted separately for boys and girls are shown in Figures 1(A and B), and 2 (A and B).

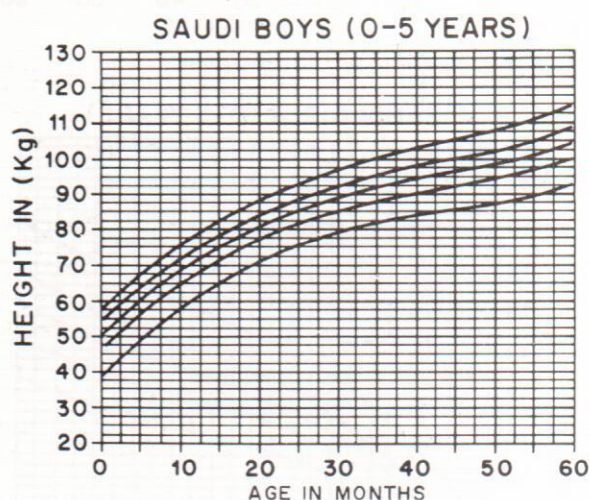


FIGURE 1a: Stature by age: Boys, 0-60 months

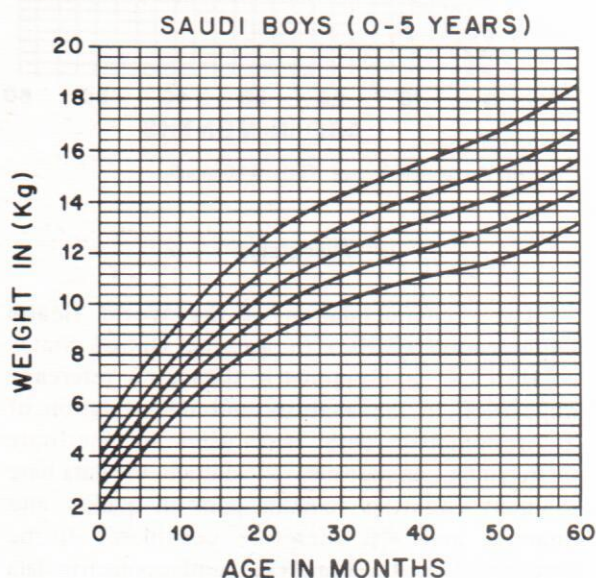


FIGURE 1b: Weight by age: Boys, 0-60 months

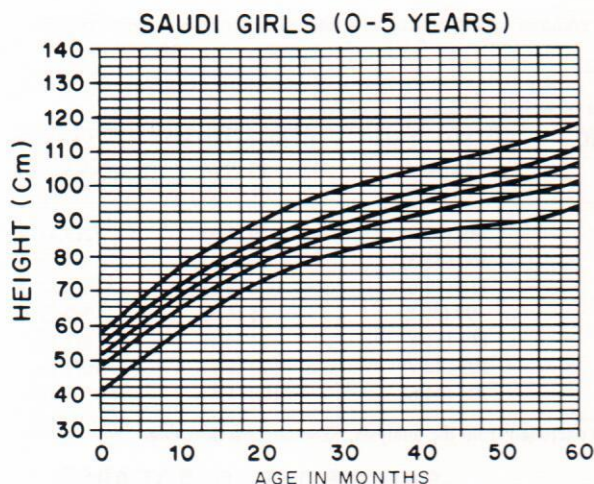


FIGURE 2a: Stature by age: Girls, 0-60 months

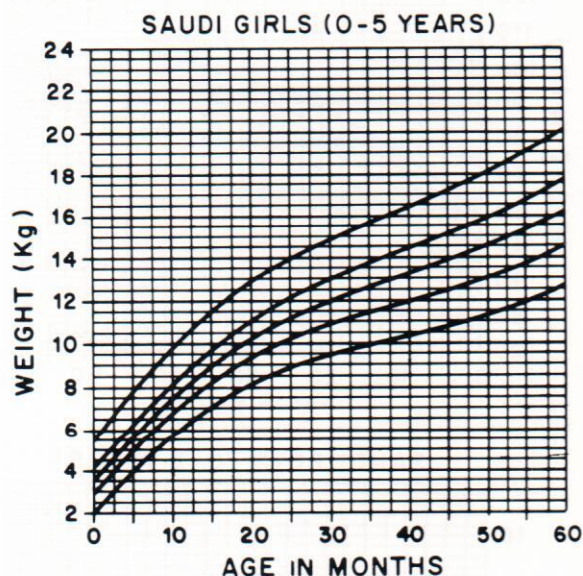


FIGURE 2b: Weight by age: Girls, 0-60 months

Discussion

The recommendation of the World Health Organization (WHO) to use the United States NCHS/CDC anthropometric data as a reference population in the analysis and interpretation of anthropometric data was used to facilitate intercountry comparisons. In addition, the data base in many countries remains poor in quality and quantity and was therefore considered to be unreliable [13,14]. The present anthropometric data on preschool children, although collected in a cross-

sectional study, a practical study design found widely acceptable to statisticians, is of high quality and quantity [13,15,16]. The design of the study is reproducible and the sample of children in each age and sex group is higher than the number recommended by WHO [13]. In addition, the anthropometric measurements were recorded carefully by well trained and experienced professionals using standard and reliable equipment [8].

The high proportion of preschool Saudi children below the 2.0 SD of the NCHS/CDC reference population median of weight for height observed in this study can be explained in terms of the different population characteristics of Saudi Arabia compared to the standard used in the American population. Previous studies have shown differences in growth patterns between populations [5,7,18]. The implications of the deficits in the growth patterns of preschool children compared to the reference population have been previously discussed. The studies highlight a genetic control versus nutritional deficiencies [2,5,6,19].

Conclusion

The general pattern of growth observed in this study, whereby boys consistently had higher weights than girls at every age, is similar to that which has been previously reported for other countries [17,18,20-22]. It is also well documented that the birth weight of boys is higher than that of girls and with good nutrition and environmental sanitation, is expected to continue until, perhaps, the age of puberty for girls [19,23]. However, the growth patterns observed are comparable to situations found in similar communities in the Middle East [20,21-26]. Although the present study is based on the population in Riyadh, Saudi Arabia, the selection of sample covered all socioeconomic classes of Saudi Arabia [8]. While a prospective anthropometric study of children from birth to required age is desirable [19], the present growth charts may serve as a more reliable standard growth chart to monitor the growth of preschool Saudi children in particular and Gulf states in general.

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