Clinical growth charts for pre-school children

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ABSTRACT

Objective: Growth standards are indicators for normal growth of the children and growth charts are important tools for their growth monitoring. Children from different populations are different in their growth pattern, it is important to create national standards for the growth of children in each population to develop local growth charts, and since these were not available in the Kingdom of Saudi Arabia (KSA), the aim of this study was to construct national growth standards and to develop growth charts for 0-5-years Saudi children.

Methods: A cross-sectional study following World Health Organization (WHO) criteria in determining sample size was adopted, where by 24000 children from 5 regions in the KSA were selected during the period 1992 to 1995 to be the desired sample. One hundred and two Primary Health Care centers (PHCCs) were selected randomly from the 5 regions, from where the sample was drawn, and a special questionnaire was designed. Weight, height and head circumference were measured by standard procedures.

Results: The total number of children examined was 23821 (11913 boys and 11908 girls). Saudi (0-5-years) boys weight and height for age measurements were significantly different from girls. The same difference was found between urban and rural boys and girls and between boys and girls from the different regions of the country ($p<0.05$).

Conclusion: These national standards derived from this study were used to develop national growth charts that are currently utilized to monitor growth in all Saudi health institutes.

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The growth and mental developments are indicators of good health and nutrition.[1] The accurate assessment of the physical growth and development of children is a subject that gains the interest of pediatricians and public health officers.[2] There is a worldwide variation in size and shape between children belonging to different populations of mankind. These differences are multi-factorial, including genetic interaction, environment and nutrition throughout the growth of the children.[3] Knowledge of what adequate growth is? How it can be properly observed? How deviations from normal can be recognized in good time is extremely useful in childcare. Anthropometry is the single most universally applicable, inexpensive, and non-invasive method available to assess the size, proportions and composition of human body. Anthropometry has been widely and successfully applied for the assessment of health and nutritional risk, especially in children.[3]

In spite of the great achievements of the significant expansion in health services over the last 20 years,[4] the studies on the growth of Saudi children are still very limited.[5,6] We still have little knowledge regarding the growth status of Saudi children, and national standards for growth are not yet available. However, we are aware that their patterns of growth deviate from the reference standards established in Europe and the United States of America. Many researchers highlighted the need for national growth standards to assess the growth status of Saudi children.[7] This can not be

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achieved by a single study at a single region in KSA. The main objective of the current study was to develop national growth standards of weight, height and head circumference, for age and weight for height for 0-5-years Saudi children then develop clinical growth charts to be tools to monitor the children growth at health establishments. Percentile indices were chosen to achieve these objectives.

Methods. A cross-sectional method was adopted to conduct the current study. A questionnaire was constructed to record child's birth date, exact age and anthropometric measurements that included his weight (WT), height (HT) and head circumference (HC). Weight was measured to the nearest 0.1 kg. and HT and HC to the nearest 0.1 cm. The sample size was estimated following World Health Organization (WHO) criteria;[8] in addition, Waterelow et al[9] and Healy[10] recommendations were taken into consideration.[8-11] The measurements were carried out on well nourished healthy (0-5) years children (inclusion criteria were stated to guide the doctor to what is meant by healthy child), 200 child in each of the 60 age and sex groups in order to estimate the extreme centiles accurately. The measurements were carefully performed and recorded by trained doctors and nurses together, one of them to fix the child head and the other to fix the legs, new, well tested beam scales as recommended by the WHO were used and calibrated at the start of each measuring session. The investigators supervised the measurements and re-checked a sample of the children. Color coded data collection (sheets were used, blue for boys and pink for girls) using bilanguaged printouts (Arabic and English). Beam scales were utilized for weight measurements. All clothes including shoes and napkins of infants were removed before measuring the weight. The child was allowed to wear only one layer of undergarments. Length was measured for children below 2 years of age and height was measured for the others as recommended by Tanner and WHO.[11,12] The field of the study was the well baby clinics (WBC) of the primary health care (PHC) centres that were chosen by the random stratified sampling method and the following steps were taken: 1. Five main regions of KSA were selected randomly. The urban and rural localities at each region were selected randomly. 2. The health centres participated in this survey were chosen randomly in the urban and rural localities. 3. The sample size was divided on the 5 main regions according to the population density of their urban and rural localities. 4. Inclusion and exclusion criteria for the healthy child were defined.

The desired sample size was 24000 (0-59) months children healthy Saudi healthy (12000 boys and 12000 girls). The sample size of Northern KSA estimated to be 2280 children (9.5% of population), South region 5616 children (23.4% of population), Central region, 448 children (22.7% of population), East region 3,792 children (15.8% of population) and West region 6,864 children (28.6% of population). Several steps and precautions were followed to ensure that the sample would be random and to control the bias. As it was realized that the correct measurements were the milestone of this survey, the quality of the collected data were also ensured. A pilot study was conducted in 5 randomly chosen primary health care centers in Jeddah, KSA.

The data was processed using statistical package for social sciences computer software, and t-test, One Way Anova, and Scheffe multiple range tests were used to test the significance.

Results. The nationwide anthropometry data from a total of 23,821 children 11,913 boys and 11,908 girls of healthy Saudi children 0-5-years of age were collected from 102 selected PHC centres throughout the 5 regions of the country. The sample size of each monthly age group (0-59 months) was 200 + 5%. There was a statistically significant difference ($p<0.05$) between Saudi boys and girls (0 –5)-years in respect of the weight and height for age measurements. Saudi boys were taller and heavier than Saudi girls. The means and standard deviation for the weight, height and the head circumference for age were calculated. In addition, 15 percentiles that included the third, fifth, tenth, twentieth, twenty-fifth, thirtieth, fortieth, fiftieth, sixtieth, seventh, seventy-fifth, eightieth, ninetieth, ninety-fifth, ninety-seventh percentiles of weight, height (length and stature) for age for each of the monthly age interval (0-59 months) were calculated and they showed a statistically significant variation in these measurements between urban and rural boys ($p<0.05$) . The weight and height for age measurements among boys from the 5 main regions showed a statistically significant variation ($p<0.05$) and a similar statistically significant variation ($p<0.05$) was found among the girls weight and height for age measurements. The national growth standards of the 15 smoothed percentiles were developed into 2 forms (tables and charts). Nineteen national growth standards tables were constructed. For the children below 2-years, 14 tables for age were developed including one table for the mean and standards deviation and 6 tables for the boys and 6 tables for the girls for the weight, length, and head circumference. For the older children, 5 tables were developed; one table for the mean and standard deviation and 4 tables for the boys and the girls (2 each) for the weight and stature. Furthermore, 4 tables for the weight for height were constructed. These tables were 2 tables for the boys and 2 tables for the girls (for the weight for 46-76

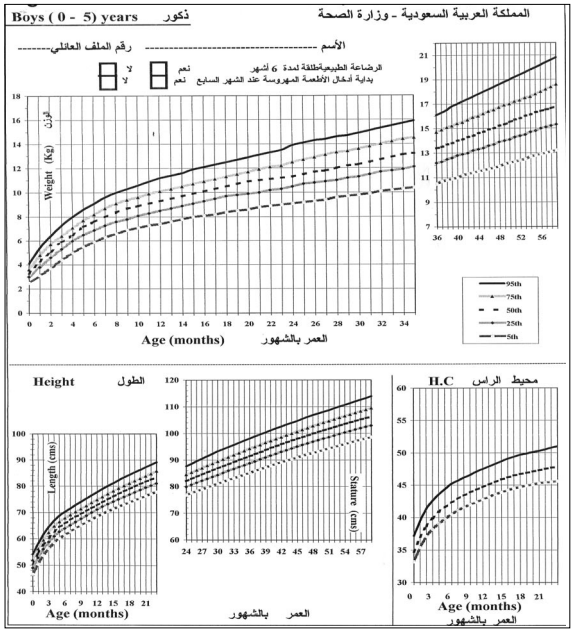

Figure 1 - Growth chart for Saudi (0-59-months) boys.

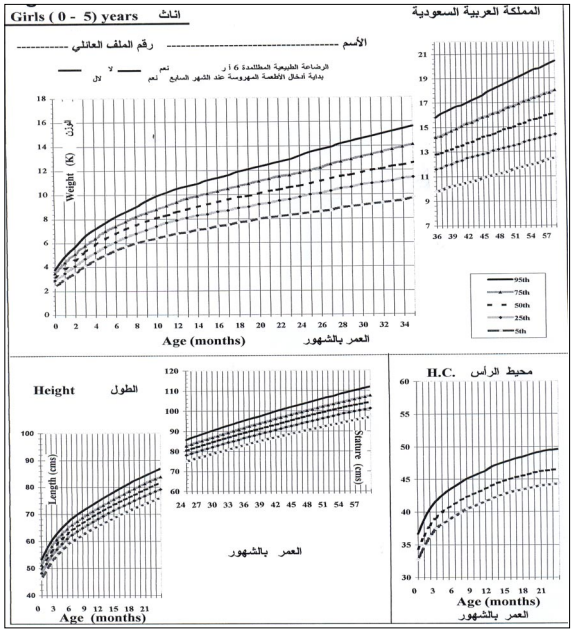

Figure 2 - Growth chart for Saudi (0-59-months) girls. HC - head circumference

cm and for 77-112 cm and for the weight for 46-74 cm and for 75-109 cm). Therefore, the weight for height tables first point was 46 cm for up to 112 cm for the boys and 109 cm for the girls. Six clinical tables (3 for the boys and 3 for the girls were constructed based on selected percentiles. For routine clinical follow up for the below 5-years 2 tables were developed that included 5 percentiles (the 5th, 25th, 50th, 75th and 95th percentiles) for girls and boys (**Figures 1 & 2**). For special clinical needs for children that need special care 2 charts were constructed that included 7 percentiles (the 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles). In addition, 2 growth charts were developed for weight for height (one for boys and one for girls) that included 7 percentiles (the 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles).

Discussion. Anthropometric indices are combinations of measurements. They are essential for the interpretation of measurements; a value of a body weight alone has no meaning unless it is related to an individual's age or height. Anthropometric indices can be expressed in terms of Z-scores (or standard deviation score), percentiles or percent of median. These indices can then be used to compare a child or group of children with a reference population. Percentiles are commonly used in clinical settings as their interpretation is straightforward.[1] Therefore, percentiles were the anthropometric indices for this survey. Commonly, there are 3 main types of anthropometric measures used as indicators of size: length or height, weight and various body circumflexes (head, thorax and arm). They have all advantages and disadvantages depending on the use to be made of measurements and the facilities available for making them.[8] The principal measurement is usually weight, and plotting the values on a growth curve constitute the main screening activity in the primary health care setting.[13] Measurements of length or stature and weight provide by far the most useful information. To be of greatest usefulness, these measurements must be accurately made and recorded, and compared with appropriate reference data.[13] The growth patterns of children have always been a focus of attention, as indicators of their nutritional status, and utilized as one of the major criteria for potential intervention programs and projects.[14] It was recommended that for the assessment of the nutritional status in cross-sectional studies, primary reliance should be placed on weight for height as an indicator of the present state of nutrition. The weight for age should be reliable indicator of the past nutrition. Although weight for age has been for many years utilized in the evaluation of nutritional status, it has the disadvantage that it does not distinguish between acute and chronic malnutrition. On the other hand, weight for age as well as height for age are useful indices when serial measurements are made, as in clinics for children under 5-years of age. Weight for age is particularly useful in children under one year old and, if length measurements are

not performed accurately, weight for age may be the most valid index.[9] The weight and height at all the monthly-age groups were shifted to the right (positive skewness). The Saudi (0-5)-years boys are significantly taller and heavier than the Saudi (0-5)-years girls. The current study showed that the boys were significantly taller and heavier than the girls, a finding similar to earlier studies in Riyadh and Asir regions.[7,15] The urban males and females children were significantly taller and heavier than the rural children. In addition, the Southern KSA (both urban and rural) male and female children were significantly lower in weight and height than the other regions. The second region in being significantly lower in weight was Northern KSA except for urban females' weight. For urban male and female children the Eastern region children were significantly heavier and taller than other region's children. The rural centre region children male and female were significantly heavier and taller than the others. These differences reflect the environmental and genetic difference between Saudis in general. However, the national weight and height percentiles get over these differences and resulted in one uniform set of tables and curves that represent the Saudi 0-5-years males and females at every region in KSA.

In addition, this study showed that after birth, the growth rate of the Saudi children is not symmetrical. Initially, after birth the growth rate is fast till the first 5-months after which their growth will be slower. Similar rapid initial growth rate of the Saudi children was expressed by the study executed at Asir region.[7] The national growth standards were compared with the commonly used reference population in KSA, the NCHS standards. The Saudi boys and girls percentiles were significantly different from the NCHS percentiles after the second half of the first year.[16] The developed growth chart were approved to be utilized at all PHC centers and hospitals (governmental and non-governmental) to follow up the growth of the Saudi children. The charts were printed on blue papers for the boys' and on pink papers for the girls'. Each charts compromised weight for age, height for age and head circumference curves. In addition, general information and exclusive breast-feeding for 6 months and weaning date were included.

In conclusion, since the current smoothed national growth standards overcame the regional and the urban and rural variations, therefore, the survey on Saudi 0-5-years-old children had achieved it's objective in the construction of national standards for Saudi boys and girls weight for age, height for age and weight for height. This data was used to develop growth charts of the weight for age and height for age and are currently used at the health institutes to monitor children growth and as an indicator to monitor the Saudi children growth at the well baby clinics. In addition, these charts can also be reliable tools for the assessment of the children past nutrition status whether at the clinics or during a cross-sectional study of nutritional status assessment.

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