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Comparison of the Anthropometry of Saudi Arabian Male Children Aged 6–11 Years with the NCHS/CDC Reference Population

Key Words

Nutritional status

Male children

Anthropometric indicators

Abstract

Objective: To assess the nutritional status of children based on anthropometric indicators and to develop a standard growth chart for schoolchildren in Saudi Arabia. **Methods:** A total of 4,154 male Saudi primary schoolchildren aged 6–11 years were randomly selected, using a three-stage stratified cluster sampling procedure that covered all regions of Saudi Arabia. Weight and height were measured and used to calculate the anthropometric indicators: weight for height, height for age and weight for age. These indicators were compared with the American National Center for Health Statistics Center for Disease Control (NCHS/CDC) reference population. **Results:** There was an indicator of past malnutrition of children whose height for age fell in the lower centile range of the NCHS/CDC reference population. Weight for height, an indicator of current nutritional status, was comparable with the reference population with only 5% below –2 standard deviations of the reference population. There was a statistically significant trend in the prevalence of indicators of past and current malnutrition with age. While the indicator of past malnutrition increased with age, the prevalence of the indicator of current malnutrition decreased with age. The level of obesity increased from 3.8% at age 6 years to 8.3% at 11 years, with the overall level of obesity of 6.6%. **Conclusion:** These findings showed high reliability of the interpretation of the anthropometric indicators, and that the Saudi male primary schoolchildren appear to enjoy a comparable nutritional status with their American counterparts. The generated growth charts are more applicable to the Saudis and probably to the Gulf communities as they are derived from local rather than European or American measurements.

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Introduction

Nutritional assessment is considered to be an integral part of the evaluation of the general health status of any community [1]. The statistics of weight for height, height for age and weight for age have been recommended as useful monitoring indicators of wasting, stunting and undernourishment, respectively [2, 3]. In particular, physical growth in terms of height and weight is considered as a reliable indicator of the patterns of growth and development in a nation [4, 5]. There is at present limited information on the anthropometry of Saudi schoolchildren. The available reports on the growth pattern of Saudi Arabian children have concentrated on preschool children aged 5 years and below [6–8]. The only available study on schoolchildren was based on data collected more than 10 years ago [9].

Earlier reports have tended to suggest a deficit in the growth pattern of Saudi preschool children when compared with the American reference population [6–8]. The reverse was observed in the only reported study on schoolchildren [9]. The explanations put forward for the observed discrepancies have appeared neither convincing nor conclusive [6–9]. Therefore, the present anthropometric measurements of a crosssection of Saudi male primary schoolchildren are another attempt to compare the growth pattern of Saudi male children with the internationally recognized United States National Center for Health Statistics/Center for Disease Control (NCHS/CDC) reference population [10]. The main objectives of this study are to assess the nutritional status of the schoolchildren based on the anthropometric indicators and to develop a standard growth chart for this population.

Materials and Methods

Study Population and Sample Size

A national cross-sectional survey of the life-style of male schoolchildren in Saudi Arabia was carried out between September 1994 and March 1995. Education at primary school level is compulsory in Saudi Arabia for all Saudi children. Male primary schoolchildren aged 6–11 years were the target population and all children attending public schools constituted the study population. Saudi Arabia is divided into five administrative areas (East, West, Central, North and South) and each administrative area is further subdivided into a number of educational regions. An educational region caters for 50–80 schools approximately. The sample size determination was based on the recommendations of Waterlow et al. [4] and others that a minimum of 200 healthy children is required in each age-group, for any reliable estimate of the growth pattern of children, thus suggesting a sample size of 1,200. But in order to increase the precision of our study, the sample size was increased to more than 3-fold to a final sample size of 4,158 [1].

Sample Selection

The sampling strategy used was the three-stage stratified cluster sampling method. Saudi Arabia has been divided into five administrative regions namely. East, West, North, South and Central. Each of these regions consists of cities, towns and villages of various population sizes. The Ministry of Education further subdivided each region into a number of catchment areas called educational regions. The list of educational regions in each administrative region constituted the sampling frame in the first stage of sampling. One educational region was selected in each administrative region with probability proportionate to size. The selected educational regions were Riyadh (Central), Hail (North), Al-Hassa (East), Madina (West) and Sabea (South). In the second stage, the list of all schools in the selected educational regions was the sampling frame. Five schools were then selected from the list of schools in each educational region using the simple random sampling method. All children in grade levels 1–6 in the selected schools were examined as the final sample.

All children with clinical evidence of chronic diseases were excluded. Children with acute diseases like diarrhea which resulted in weight loss were excluded from the study. The children who were either affected by chronic or acute diseases were 1.4 and 0.8%, respectively. Children of guest workers or expatriates are giv-

en access to public school in Saudi Arabia only if there are vacant slots which are not needed by Saudi children. The percentage of such slots varies from 0 to 15% depending on the region, the city and village with overall slots in public schools of 9% which are filled by children of expatriates. We have, therefore, excluded children of guest workers and expatriates from the study.

Data Collection and Analysis

The data collection form contained items for information on location of school, sociodemographic characteristics and the anthropometric measurements of weight and height. Age was ascertained by examining the birth certificates and was recorded to the nearest year. The birth certificate is the single most important identification document at the National Registration Office. It is the most important document in the schoolchildren's files. The birth certificate is filled up at the time of birth. This system has covered completely all births over the last 20 years. Children are denied school registration if birth certificates are not available at the time of submitting the entry application. All children, with light clothes on, were weighed on a lever balance, simple beam clinical scales to the nearest 0.1 kg. The scales were checked after every ten measurements with a known weight to ensure accuracy. Height was measured on a portable measuring board and the meter rule was screwed on perpendicular to the foot of the board. A triangular right-angled block was placed on the head touching the meter rule to make it parallel to the floor. The child stood upright without shoes on while the examiner exerted firm upward pressure under the jaw to encourage maximum stretching. The data entry processing was done on a microcomputer using the DBase 4 software package. Statistical analysis was carried out using the BMDP software package [12]. Growth charts were effected through fitting (by least squares method) the polynomial regression model of degree 3, using the percentiles as dependent variables and age as an independent variable. This third-degree polynomial regression model provided a better fit than the spline polynomial regression [13]. The growth curves were plotted using the facilities in the Harvard Graphics for plotting curves.

A comparison of the nutritional indicators with the reference population recommended by WHO was carried out using the WHO-Anthro software package [14]. The standard scores distribution of weight/height/age were expressed as multiples of the standard deviation (SD) of the reference population. The proportion of children whose weight for height were below -2 SD of the American reference population was calculated at

each age, to determine the trend in the prevalence of current malnutrition with age. In a similar analysis, proportion of height for age and weight for age below -2 SD of this reference population provided evidence of stunting and wasting, respectively [11]. The statistical significance of the trends in the proportion with malnutrition, i.e. proportions of children having values below -2 SD for each of the nutritional indicators with age, was determined using the chi-square test.

Result

There was a total of 4,154 male primary schoolchildren with accurate measurements of height and weight. The mean and SD of weight and height classified by age is shown in table 1. The sample size for each age is reasonably large to guarantee a small sampling error in the estimate of mean weight and height. The values of mean weight range from 20.5 kg for 6-year-old children to 32.2 kg for children 11 years of age, at the end of their primary or elementary education. The corresponding values for height are 118–135 cm. There is a gradual and a steady increase in both weight and height with increasing age, becoming steeper after 7 years of age.

Centile Distribution

Weight and Height. The centile distribution of weight for height, compared with the NCHS/CDC reference population, for the entire male primary schoolchildren aged 6–11 years is presented in table 2. It is noteworthy that a greater proportion (23%) of the children are below the 10th centile with nearly 50% below the 30th centile. The expected frequency in each centile range is 10%. The deviation is largest at the lower centile ranges and becomes smaller in the higher centile ranges. Nearly 10% are below the 3rd centile, an indicator of the proportion of male children with severe acute or current malnutrition.

Table 1. Mean (SD) of male schoolchildren aged 6–11 in Saudi Arabia

Age	Records	Weight, kg		Height, cm	
		mean	SD	mean	SD
6	421	20.5	3.21	118	4.60
7	658	21.3	3.77	118	5.35
8	771	23.6	6.01	122	5.62
9	825	26.0	5.52	126	6.15
10	754	29.4	6.55	131	6.80
11	724	32.2	8.16	135	7.01

Table 2. Centile distribution of height for age, weight for height and weight for age of male primary schoolchildren, aged 6–11 years, compared to NCHS/CDC reference population

Centile	Height for age (%)	Weight for height (%)	Weight for age (%)
0.0– 2.9	735 (17.7)	288 (7.1)	479 (11.5)
0.0– 4.9	994 (23.9)	425 (10.4)	802 (19.3)
0.0– 9.9	1,469 (35.4)	683 (16.8)	1,364 (32.8)
10.0– 19.9	681 (16.4)	411 (10.1)	547 (13.2)
20.0– 29.9	459 (11.1)	461 (11.3)	547 (13.2)
30.0– 39.9	343 (8.3)	264 (6.5)	356 (8.6)
40.0– 49.9	298 (7.2)	352 (8.6)	179 (4.3)
50.0– 59.9	225 (5.4)	378 (9.3)	274 (6.6)
60.0– 69.9	174 (4.2)	304 (7.5)	207 (5.0)
70.0– 79.9	176 (4.2)	342 (8.4)	235 (5.7)
80.0– 89.9	171 (4.1)	328 (8.1)	161 (3.9)
90.0– 99.9	159 (3.8)	549 (13.5)	284 (6.8)
95.0–100.0	85 (2.1)	387 (9.5)	191 (4.6)
97.0–100.0	43 (1.0)	313 (7.7)	133 (3.2)
Total	4,155	4,072	4,154

Weight for Age. Table 2 also shows the centile distribution of weight for age on the NCHS/CDC reference population. The pattern is similar to weight for height with nearly 12% below the 3rd centile and 30% below the 10th centile.

Table 3. Percentage of male children below –2 SD of the NCHS/CDC reference population

Age years	Sample size	Height for age	Weight for age	Weight for height
6	421	1.0	5.5	15.5
7	658	9.2	11.7	7.6
8	771	13.1	15.6	5.2
9	825	18.1	12.4	3.8
10	754	20.2	10.6	1.5
11	724	21.0	9.7	2.1

Height for Age. Table 2, column 2, is the centile distribution of height for age. A comparison with the American reference population (NCHS/CDC) also indicated that more than 35% of the children was below the 10th centile with nearly half (17.7%) below the 3rd centile, indicating a high proportion of male children with severe malnutrition in the past.

SD Scores. The percentage of male children below –2 SD of the NCHS/CDC reference population for the nutritional indicators weight for height, weight for age and height for age are presented in table 3 for each age-group. There is a statistically significant direct linear trend in the proportion with stunted growth (height for age < –2 SD of the NCHS/CDC) and age. Apart from one or two fluctuations at ages 6 and 8, the distribution of the prevalence of low weight for age, compared to the reference standard, is almost uniform. The lowest prevalence was 5.5% at age 6 years and the highest 15.6% at 8 years of age. Table 4 also showed the distribution of the children’s weight for height expressed in multiples of the SD at each age-group of the median NCHS/CDC reference population. The discrepancy in distribution from the standard reference population is not too evident. About 5 per 1,000 could be interpreted as severely malnourished while only 5% of the children

Table 4. Percentage of Saudi Arabian male primary schoolchildren with weight for height in standard multiples (SD scores) of the NCHS/CDC reference population

Age years	Children	SD scores of weight for height (% of age-group)			
		≤ -3 SD	≤ -2 SD	1.1–1.99 SD	> 2 SD
6	420	6 (1.4)	65 (15.5)	30 (7.1)	16 (3.8)
7	656	4 (0.6)	51 (7.8)	62 (9.5)	29 (4.4)
8	765	4 (0.5)	42 (5.5)	73 (9.5)	40 (5.2)
9	822	5 (0.6)	31 (3.8)	82 (10.0)	68 (8.3)
10	736	0 (0.0)	11 (1.5)	143 (19.4)	59 (8.0)
11	673	0 (0.0)	14 (2.1)	93 (13.8)	56 (8.3)
All ages	4,072	19 (0.5)	214 (5.2)	483 (11.9)	268 (6.6)

are malnourished. The highest prevalence of malnutrition was recorded for children aged 6 years. The prevalence decreased steadily with increasing age with a minimum of 1.5% for children 10 years of age.

Overweight and Obesity. If overweight is interpreted as weight for height for children in each age-group to be between 1 and 2 SD of the median reference population, the overall prevalence of overweight among the children would be 11.9%. The highest prevalence (19.4%) was recorded for children 10 years of age, while those who are 6 years of age have the lowest prevalence of 7.1%. The overall prevalence of obesity (weight for height $> +2$ SD) is 6.6%. The prevalence uniformly increased with age from 3.8% at 6 years to 8.3% at 11 years.

Growth Curves. The standard growth curves of weight for age and height for age for male primary schoolchildren from 6 to 11 years are presented in figures 1 and 2. The 50th centile of the NCHS/CDC reference population, plotted on these graphs, indicated that the American population are generally located on the high percentile point above the 75th percentile at each age of the Saudi Arabian growth curves.

Discussion

The samples size in each age-group of the children in this study is remarkably large enough to produce reliable estimates of the anthropometric measurements, larger than the minimum of 200 considered adequate [1–3].

The observed increase in height and weight with age is in line with usual biological growth. But the finding of a centile distribution that showed more male Saudi primary schoolchildren than expected in the lower centile ranges of the reference population (NCHS/CDC) of height for age, an indicator of past malnutrition, is in consonance with previous reports from the Middle East [15, 16]. This seems to suggest that Saudi Arabian male primary schoolchildren are generally shorter than their American counterparts, a phenomenon which has also been observed for the preschool children [6–8]. However, the low frequency of male children less than the 3rd centile, a cutoff point for chronic malnutrition, demonstrates that this apparent stunted growth observed in this study may not have been due to malnutrition, but rather to ethnic and genetic differences [17, 18]. The

Fig. 1. Percentile distribution of weight among male schoolchildren in Saudi Arabia.

Fig. 2. Percentile distribution of height among male schoolchildren in Saudi Arabia.

children of Saudi Arabia and Kuwait, countries with similar high socioeconomic standards, have growth patterns which are similar to those of their American counterparts. They are, however, shorter than their American counterparts. This suggests genetic difference rather than environmental factors. While the growth pattern of Saudi male children is similar to that observed in Egypt, Bahrain and Kuwait, the Indian boys are on the average shorter [15, 16, 19, 20]. The lower weights and heights of Indian boys could be attributed to their lower socioeconomic standards.

The reference population is used to assess the malnutrition status of any nation using adjusted values of the nutritional indicators [2]. Any differential growth pattern between a developing nation and the NCHS/CDC standard is often attributed to cumulative effects of chronic malnutrition [21, 22]. This is strongly indicated in this study by the trend in height for age where the proportion below -2 SD of the NCHS/CDC increases significantly with age. This again confirms the reliability of height for age as a good indicator of past malnutrition. However, the quality of life of the people of Saudi Arabia, caused by improved socioeconomic levels and availability of food and good health services, would suggest that any observed deficit could better be attributed to genetic differences [6, 9, 21]. This, however, would become evident if future studies report a decreasing prevalence of low weight for age with continuing good socioeconomic conditions.

This observation is also indicated by the low number of children below -2 SD of weight for height of the NCHS/CDC which also significantly linearly decreased with age. Weight for height could therefore also be said to be a good indicator of current malnutrition. The high prevalence of 15.5% recorded in male children who are 6 years old could possibly be attributed to poor adaptation of the

children to new dietary habits imposed by their entry into new school curricula with different time schedules when compared to the relaxed pace of the nursery schools they previously attended. However, the overall low prevalence of current malnutrition (5.2%) observed is a reflection of the improved socioeconomic levels of Saudi Arabia [24].

This overall percentage of wasting observed is also similar to values from other Middle East countries but lower than was recorded in an earlier study in Saudi Arabia [9, 15, 16]. Although the earlier study had a larger sample than the present study, this study has a sample size that appears more manageable and more likely to provide reliable and accurate measurements of height and weight [9, 11]. The median weight for height of Saudi male children is located at approximately the 4th centile, just below the expected 50th centile of the NCHS/CDC reference population. Regardless of the classification of the other two indicators (height for age and weight for age), all children with normal weight for height have been interpreted as not being malnourished. Therefore, Saudi Arabian children could generally be described as having a similar growth pattern as their American counterparts. Further studies are however needed to clarify the issue of female growth patterns.

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