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The pattern of growth and obesity in Saudi Arabian male school children

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OBJECTIVE: To determine the prevalence of overweight and obesity among male school children in Saudi Arabia and provide a growth chart for males 6–18 y old.
DESIGN: Three stage stratified cluster sampling procedure.
SUBJECTS: The study population was 9061 male school children, attending public schools in Saudi Arabia. Their ages ranged from 6–18 y and covered all the 12 grade levels of school. Children with evidence of chronic or acute diseases were excluded from the study.
MEASUREMENT: Structured questionnaire, including: location of school, socio-demographic characteristics and age of the student. Anthropometric measurements of weight and height was done for all the study sample. Growth charts were designed through fitting the polynomial regression model of degree three. The percentage of body mass index (BMI) of expected BMI at the 50th percentile for each age group was computed. The 50th percentile of The National Center for Health Statistics/Center for Disease Control reference population was used as the expected standard population values for defining childhood overweight and obesity.
RESULTS: The overall prevalence of overweight was 11.7% and obesity 15.8%. There was a statistically significant variation in the regional distribution of overweight and obesity ($P < 0.01$). The highest prevalence (18.0%) was recorded in Riyadh, capital of Saudi Arabia, and the lowest was in Sabea (11.1%) located in the Southern region.
CONCLUSION: These findings of a high prevalence of childhood obesity when compared with the NCHS/CDC calls for an early health education program on the appropriate choice of diets for growth, health and longevity. However, because of the possible ethnic differences between the Saudi and American populations, the growth charts presented could serve as a better reference for future comparisons.

Keywords: pattern; growth; obesity; Saudi; male; children

Introduction

Being overweight or obese is known to be a risk factor of a number of cardiovascular diseases, diabetes mellitus and gall bladder diseases.[1–3] Several determinants and correlates of excess body weight or fat were associated with higher prevalence, among them, middle age, female gender, positive energy balance, increased amount of energy intake, decreased physical activity and high ratio of fat to lean tissue.[4] A review of the epidemiology of obesity suggested a high prevalence in societies with an abundant supply of appetizing foods, a characteristic feature of prosperous countries.[3] The discovery of oil in the last two decades has changed the economic fortunes of the Kingdom of Saudi Arabia and this has resulted in a tremendous change in the current life style that favors the development of overweight and obesity both in childhood or adulthood.[4–7]

As adult obesity in the majority of patients starts during childhood, obesity related complications can be prevented if effective measures are implemented to control childhood obesity.[3,8] Therefore, effective primary preventive measures against overweight or obesity in children is imperative. The knowledge of the extent of the problem is, however, essential for such a preventive program to succeed. We have reported, through a population based epidemiological study, on the prevalence of overweight and obesity among Saudi subjects over the age of 15 y old, of 29% and 27% among male and female subjects respectively for overweight and 15% and 25% among male and female subjects respectively for obesity.[9] Such prevalence of obesity in Saudi Arabia is among the highest reported in the world.[10,11] The present national study reports on the prevalence of overweight and obesity among male school children, aged 6–18 y in Saudi Arabia.

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Materials and methods

Study population and sample size

A national survey of the anthropometry of male school children in the Kingdom of Saudi Arabia was conducted between September, 1994, and March, 1995. The study population was all male school

children attending public schools in the Kingdom. The determination of the sample size was influenced by WHO recommendations of a minimum of 200 healthy children, at each age of the children.[12] This translated to a minimum total sample size of 2600 children between the age of 6–18 y. However, in this study, the sample size was increased more than three fold at each specific age in order to increase the precision of our estimates.

Sample selection

The children in this study were selected in a two-stage stratified cluster sampling procedure. Saudi Arabia is divided into five administrative areas (West, East, Central, North and South) and each administrative area was further sub-divided into a number of educational regions. An educational region caters for between 50–80 schools. Therefore, the initial sampling frame was the list of educational regions in each administrative area and an educational region was defined as the primary sampling unit (PSU) at this stage, one educational region. The largest 5 educational regions with respect to number of students from each administrative area were listed. An educational region was randomly selected from each of the five administrative areas with probability proportionate to size (PPS) of population of each administrative area. The selected educational regions were Riyadh (Central), Hail (North), Al-Hassa (East), Madina (West) and Sabea (South). In the second stage, the list of schools in the selected educational regions, was defined as the sampling frame. A random sample of five schools were subsequently selected from each educational region. All children in all the grade levels of the selected schools constituted the final sample. Each child was examined physically by the physician on the data collection team and children with evidence of a chronic or acute disease was excluded from the study.

Data collection and analysis

The information on the structured questionnaire were location of school, socio-demographic characteristics and the anthropometric measurements of weight and height. Age recorded to the nearest year was ascertained by examining the birth certificates. It was converted from the Hegira calendar to the Gregorian for international comparison. 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 with meter rule screwed 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 and the examiner exerted firm upward pressure under the jaw to encourage maximum stretching.

The DBase-IV software package was used for data entry and processing while the BMDP Package was used for statistical analysis.[13] Growth charts were effected through fitting (by least squares method) the polynomial regression model of degree three, using the percentiles as dependent variables and age as independent variable. The growth curves were plotted using the facilities in the Harvard Graphics for plotting curves.[14]

The percentage of body mass index (BMI) of expected BMI at the 50th percentile for each age group was computed using the equation

$$\frac{\text{Weight}}{\text{Height}^2} \Big/ \frac{(\text{50th centile weight for age})}{(\text{50th centile height for age})^2} \times 100$$

The 50th percentile of the National Center for Health Statistics/Center for Disease Control NCHS/CDC reference population was used as the expected standard population values.[15] Childhood obesity was defined as children more than 120% of the expected median percentile of the reference population, overweight as 110–120% and underweight as less than 90%. The chi-square test was used to assess the statistical significance of the differences in the proportion obese in the five regions.

Results

The means and standard deviations of weight and height by age of the 9061 male school children is presented in Table 1. There were no statistically significant differences ($P < 0.05$) in either the mean weight or height between the 6 y and the 7 y old children. There was a progressive significant increase in weight and height with increase in age from age 7 y up to age 17 y. At 18 y of age, the weight and height were not statistically significantly different from those recorded for 17 y olds. On the other hand, weight with lowest coefficient of variation of 15.6% at age 6 and

Table 1 Mean (SD) of weight (kg) and height (cm) among male school children with respect to age in Saudi Arabia

Age (yrs)	Sample size	Weight (kg) (means.d.)	Height (cm) (means.d.)
6	421	20.53 (3.2)	118.2 (4.6)
7	658	21.31 (3.8)	118.3 (5.4)
8	771	23.56 (6.0)	122.4 (5.6)
9	825	26.03 (5.5)	126.5 (6.2)
10	754	29.39 (6.6)	130.9 (6.8)
11	724	32.23 (8.2)	135.2 (7.0)
12	802	36.39 (10.1)	140.5 (8.3)
13	883	41.17 (10.6)	147.0 (9.7)
14	689	47.11 (13.0)	152.00 (8.4)
15	671	53.89 (13.8)	158.00 (8.8)
16	643	58.72 (13.9)	163.1 (7.9)
17	669	61.36 (15.4)	164.9 (7.3)
18	551	61.96 (13.5)	167.1 (6.5)
Total	9061		

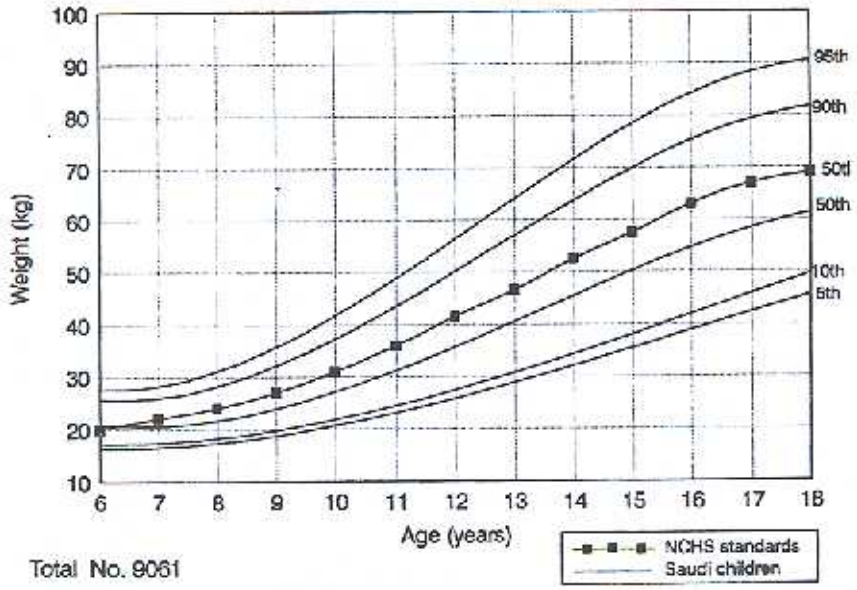

Figure 1 Percentile distribution of weight (kg) among male school children in Saudi Arabia

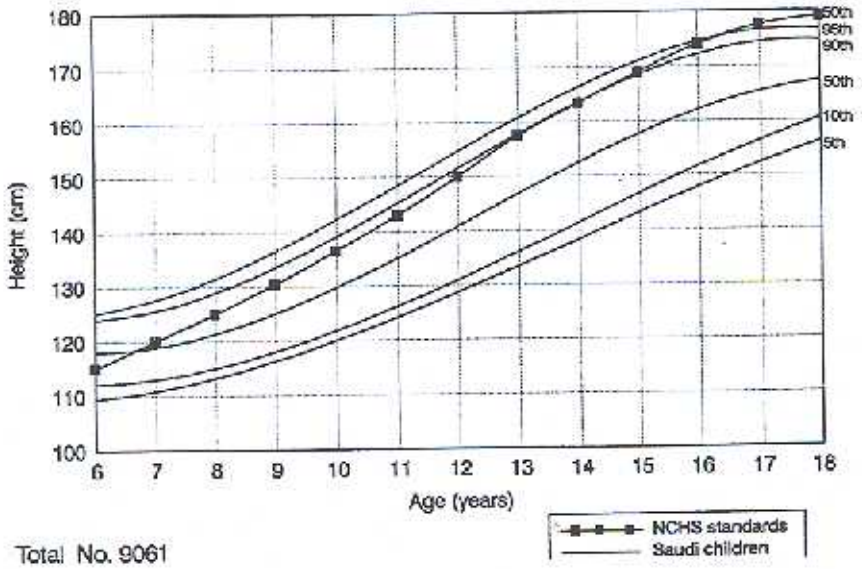

Figure 2 Percentile distribution of height (cm) among male school children in Saudi Arabia.

Table 2 Prevalence of overweight and obesity among male school children at different age groups in Saudi Arabia

Age (yrs)	*Sample size*	*Overweight (%)*	*Obesity (%)*
6	421	15.2	10.5
7	658	13.2	10.3
8	771	11.3	8.2
9	825	11.4	11.4
10	754	13.7	13.5
11	724	12.8	16.9
12	802	12.2	20.8
13	883	8.6	16.8
14	689	9.6	17.6
15	671	11.9	21.3
16	643	12.8	21.2
17	669	11.4	19.4
18	551	10.7	17.0
Total	9061	11.7	15.8

highest of 23.7% at age 16 was more varied at each age than height with lowest coefficient of variation of 3.9% at age 6 and the highest of 6.6% at age 13 y. Figures 1 and 2 show the percentile distribution of weight for age and height for age. The 50th percentile of the American population reference plotted on these graphs lies at a higher percentile range. This suggests that, the Saudi Arabian male children are on the average shorter than their American counterparts at every age.

The prevalence of overweight and obesity in the male school children was 11.7 and 15.8% respectively. The graphical illustration shown in Figure 3, indicated no specific definite pattern for overweight which appears to decline gradually with age up to 9 y

Figure 3 The prevalence of overweight and obesity by age among male Saudi school children.

Table 3 The regional distribution of obesity among male school children at different age groups in Saudi Arabi

Age (yrs)	*National no. (%)*	*Hail no. (%)*	*Hasse no (%)*	*Riyadh no (%)*	*Madina no (%)*	*Sabea no (%)*
6–8	175 (12.3)	15 (10.2)	17 (5.3)	103 (15.1)	37 (25.0)	3 (2.2)
9–10	196 (13.7)	36 (24.5)	33 (10.4)	82 (12.1)	28 (18.9)	17 (12.6)
11–12	289 (20.2)	41 (27.9)	58 (18.2)	143 (21.0)	23 (15.5)	24 (17.8)
13–14	269 (18.8)	32 (21.8)	73 (23.0)	119 (17.5)	11 (7.4)	34 (25.2)
15–16	279 (19.5)	7 (4.8)	74 (23.3)	142 (20.9)	28 (18.9)	28 (20.7)
17–18	220 (15.4)	16 (10.9)	63 (19.8)	91 (13.4)	21 (14.2)	29 (21.5)

before it suddenly peaks again and finally fluctuates uniformly in higher ages. Obesity on the other hand, gradually increases with age from 9 y with a prevalence of 11.4% to a peak of 20.8% at 12 y, followed by a gradual decline, peaked again at 15 y before it resumed a gradual decline. The combined prevalence showed biphasic pattern with increase in prevalence at age 12 and 15 y, Table 2.

The regional distribution of obesity among the male school is shown in Table 3. There was no consistent pattern with age, however, the proportion of obesity in each region was significantly different ($P < 0.0001$). The Riyadh and Sabea regions had the highest and lowest proportion of obese children, 18.0 and 11.1% respectively.

Discussion

The cross-sectional design adopted in this present study is similar to previous studies on the growth pattern of children and adolescents.[15–18] The sample size in each age group was large enough not only to absorb the design effect due to cluster sampling but was also to increase the precision of our estimate.

In general, the measurement of excess body fat is complex and researchers are generally using body mass index (BMI) or the Quetelet's index (weight/height^2, kg/m^2) which is known to be well correlated with other measures of body fat in adults.[19] But, variations in frame size and fatness with BMI is recognized during childhood.[8] The increase in BMI due to frame size was shown to be associated with variation in weight up to 20% around the expected weight for children of the same sex, height and fatness.[2] Therefore, the definitions of overweight and obesity in this study seemed appropriate and are in accordance with that used by the United States Office of Disease Prevention and Health Promotion.[15–17]

The finding of an increase in weight and height with increasing age in this study is in accordance with biological process when children are provided with adequate nutrition.[8,17] The height and weight increase observed is also similar to that obtained in similar studies carried out in other parts of the country, as well as, the Gulf States.[20–22]

However, the overall prevalence of obesity (15.8%) observed is higher than 9.5% reported in an earlier study. Although the prevalence of overweight (17.6%) reported in the earlier study is also higher than 11.7% reported in the present study, the prevalence of both overweight and obesity combined, are almost equivalent (27.5% in this study and 27.1% reported in the earlier study).[18] The differences in these rates could be attributed to different methodology in the determi-

nation of cut-off points for obesity and overweight. The earlier study used body mass index with values 2 standard deviations or more above the National Council for Health Statistics (NCHS) reference median as cut-off point for obesity,[16] whereas the 120% of the expected BMI value which was considered as the upper limit for obesity in our present study corresponds approximately to the 95th percentile, suggesting a lower cut-off point for obesity.[8,19–21,23] However, the observed prevalence of obesity in the present study is lower than 16.4% reported for the American Indian boys 7–17 y in Nebraska.[24]

In spite of this apparent comparability, the prevelance of overweight and obesity in male school children in the United Kingdom of Saudi Arabia is considered high.[22,25] The boys are supposed at these ages to engage in strenuous games and sporting activities that should prevent overweight and obesity. However, the high prevalence could possibly be attributed to either less of physical exercise, a high calorie intake, genetic, environmental factors or a combination of these factors.[1,3,6,17,23] To date, studies have failed to find a constant factor that will give children 100% tendency to develop excessive weight.[8,21] Certain genes, prenatal hyperinsulinemia and pattern of feeding in early childhood are contributing factors.[8,19–23] However, the ever improving health services and socio-economic standards of the Kingdom of Saudi Arabia, which has tremendously changed the life style of the people and their high consumption of high calorie foods could facilitate excessive weight gain, particularly, if the physical activity is low.[26] The high levels of overweight and obesity which are significant predictors of a number of cardiovascular, endocrine, and gastrointestinal diseases, could cause increased costs of hospital services and mortality.[24,26] Therefore, it is necessary to review the existing nutritional educational programs for school children in Saudi Arabia.[8,17,24,26] The school health curriculum can be restructured to accommodate some of the nutritional programs aimed at controlling overweight and obesity.

The finding of a regional variation in the extent of overweight and obesity emphasizes the influence of urbanization and possible uncontrolled nutrition. The city of Riyadh, capital of Saudi Arabia that recorded the highest prevalence of obesity in this study is characterized by an abundance of appetizing foods. An appreciable proportion of expatriates live in this region, and there is an uncontrolled influx of fatty foods. Sabea on the other hand, recorded the lowest prevalence of obesity, is in the Southern part of the country with less urbanization and Western influence.

Conclusion

The study showed a high prevalence of overweight and obesity in male school children. Tracking this prevalence into adulthood is a well established phenomenon of obesity.[7,21] Therefore, an early development of preventive strategies for the control of overweight and obesity by introducing nutritional education programs in this target group is mandatory. This may reduce the costs of treatment of associated disease. However, the NCHS/CDC statistics may not serve as the ideal reference population because of ethnic differences between the Saudi and American populations. Hence a standard or reference growth chart based on the Saudi population as presented in this study is more appropriate for future comparisons.

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