Growth pattern among primary school entrants in King Abdul-Aziz Housing City for National Guard in Riyadh, Saudi Arabia

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ABSTRACT

Objectives: To provide information on nutritional status of primary school entrants at King Abdul-Aziz Housing City for National Guard in Riyadh, Saudi Arabia and compare it with national and international studies of anthropometric data on weight and height.

Methods: A cross-sectional study carried out at the School Health Clinic in King Abdul-Aziz Housing City for National Guard in Riyadh, Saudi Arabia. The study population comprised 6207 children aged 4-8 years from both sexes attending the obligatory pre-school health examination for years 2003-2005. Weight, height, and demographic data were collected according to international standards and the body mass index (BMI) calculated. The data were computer analyzed using Statistical Package for Social Sciences and Anthro 2005 and compared to international references.

Results: Obesity, defined as BMI <95th centile in our population was found to be 4%, which is less than the national and international references. This also applies to underweight, defined as Weight-for-Height Z score less than -2 SD, which was found to be 5.8%. While stunting, defined as height Z score less than -2 SD was higher than international references (5.9%).

Conclusion: Compared to national and international references, our population is more similar to the American reference population than the national population, with a healthier growth pattern that could be related to the nature of the less urbanized community, the policies limiting the fast food chains inside the housing city and the presumed higher physical activity of children in our population. Thus, we encourage the promotion of more health programs to preserve this healthy pattern, and the performance of more studies to help understand the nature of growth related factors in our community.

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Lifestyles and health status in Saudi Arabia have changed following the rapid economic development in the last 3 decades.[1] It is important to find out how these changes have affected the nutritional status and health behaviors of the population, especially school children. The Saudi Arabia National Guard housing population, estimated to be 55,000 residents, formed by soldiers and their families from different regions and tribes, from both rural and urban decent, presents a homogenous community that would reflect most of these changes seen by the rest of the Saudi community. The housing city, which is located in the east of Riyadh, is government built and has an excellent sanitary and safe water supply with many primary health care centers providing free medical services. There are 48 government built schools providing free education from kindergarten to grade 12 (secondary level) for approximately 18,000 school children. Every academic year, approximately 1700 children ages 48-84 months are subjected to a comprehensive obligatory medical examination at the school health clinic. The measurement of growth of an individual child or of a group of children is one of the most sensitive and commonly used indicators of child health.[2] Obesity is considered now a global epidemic. It is increasing at an alarming rate worldwide and affecting all age group, especially children.[3] Obesity itself affects child's self-esteem and increases psychopathology risks in adolescents, as suggested by a study conducted in Turkey.[4] Furthermore, the epidemic of obesity has highlighted the extent of the risks associated with this disease. The risks arise from the increased mass of fat tissue, as well as the products produced by the increased number and size of fat cells in obese individuals. Obstructive sleep apnea,[5] and osteoarthritis[6] can be a direct result of increased fat mass. Other diseases associated with obesity result from the metabolic consequences of enlarged fat cells. Diabetes,[7] high blood pressure,[7,8] liver disease,[9] coronary artery disease,[10-12] cerebrovascular disease,[13] certain types of cancers,[14] and infertility[15] can all be traced in part to the increased secretion of inflammatory and coagulation molecules from fat cells. Finally, obesity also increases the overall mortality.[16] With regards to underweight, an overall improvement in the global situation is anticipated.[17] However, underweight is still widespread among children in developing countries. In 2000, it was estimated that 26.7% of preschool children in developing countries are underweight.[18] An underweight child would show poor cognition during school, and promoting early childhood nutrition could enhance long-term cognitive development and school performance, especially in children with multiple nutritional deficits.[19] There has been much controversy regarding the use of growth standards based on well-nourished children, mostly of Caucasian origin, growing in a good environment in developed countries, as references for the assessment of nutritional status in developing countries.[20] In 1999, a workshop convened by the international obesity task force (World Health Organization [WHO]) concluded that body mass index (BMI) is a reasonable measure assessing overweight in children and adolescents.[21] The WHO expert committee has recommended using reference body mass index (BMI) values derived from data from the United States' First National Health and Nutrition Examination Survey (NHANESI) for international use.[22] In 2000, the Centers for Disease Control (CDC) developed new improved BMI charts,[23] based on the same data set from the NHANESI.[24] In 1986, the WHO developed a global database on child growth and malnutrition (henceforth referred to as the 'database') to compile, standardize, and disseminate results of nutritional surveys performed worldwide.[25,26] The internationally recommended way to assess malnutrition at the population level is to take body or anthropometric measurements (namely, weight and height).[27] Based on combinations of these body measurements anthropometric indices are constructed.[28] This includes underweight and stunting. Recent research conducted by the WHO shows that the growth pattern of healthy breastfed infants differs significantly from the current international reference.[29] The WHO has generated new growth curves for assessing the growth and development of infants and young children around the world.[30] The limitation of the use of these curves is due to the fact that it is only developed for infants and children up to the age of 60 months. School entry time is particularly suitable as a point to start evaluation of nutritional status in children as it is possible to screen them in the obligatory pre-school health examination.[31,32] In other regions of Saudi Arabia several research has reported the high prevalence of obesity and overweight ranging from 10.5% in a study carried by Al-Nuaim[33] in 1996 and up to 19% in a study carried by El-Hazmi in 2002.[35] A prior study in 1992 also showed that the prevalence of obesity among Saudi school children was 9.5%. Those studies adapted different definitions of obesity with different parameters to evaluate it.

The main objective of this study is to provide information on the nutritional status of the primary school entrants aged 4 to 8 years registering in 32 primary schools and kindergartens available at King Abdul-Aziz Housing City for the National Guard. In addition, anthropometric data on weight and height will be compared with the national studies and with the US National Center for Health Statistics (NCHS) reference in order to study the growth pattern of Saudi children in our community.

Methods. ***Sampling procedure.*** The study population comprised 6027 Saudi children. It included all children from both genders aged 4 to 8 years, who attended the obligatory health examination for primary school entry during the period from March 2003 until October 2005. Children below 4 years or above 8 years and disabled children were excluded. This medical examination itself is obligatory for all children in accordance with government laws and authorized by the higher educational and health authorities at the National Guard. Data used in this study were collected from relevant clinical data taken routinely during this medical examination. The study does not involve experimental investigations. The setting of the study was the school health clinic for the National Guard sited in King Abdul-Aziz Housing city for National Guard in Riyadh, Saudi Arabia.

Techniques. A comprehensive medical form was designed to cover all aspects of screening needed for school health entry examination. This form includes the necessary demographic data; weight, and height that were taken by experienced pediatrics nurse in accordance with international standards.[32] Birth date in Gregorian dates was obtained from the hospital medical record. Each child weight was measured early in the morning by one trained nurse, while the child was wearing light clothes, using a digital weighing scale (Seca, made in France) to the closest 100 g. An estimation of 0.1 kg was subtracted to account for clothes. Children were weighed standing and calibration was checked with a standard weight at each 25 measurements.

Height was measured with the child standing bare footed with the heels and back in contact with an upright stadiometer. The head was held erect so that the subject looks straight forward, with the lower border of the orbit in the same horizontal plane as the external auditory meati. The right angle board, which is perpendicular to the backboard, is slid down until its lower surface touches the head. The subject told to stretch the neck to be as tall as possible. Height was recorded to the closest 0.1 cm.

Statistical analysis. The Statistical Package for Social Sciences and Anthro 2005 were used for statistical analysis. Individual data for the growth indications, weight, height, and BMI were compared with those of the NCHS reference population[25] according to age and gender. Four centile bands were used for height and weight: below 10th, 10-49th, 50-89th and above 90th. Percentiles were tested by chi-square analysis. The z scores percentages, based on the NCHS reference population, were calculated for height, weight, and weight-for-height. The BMI was calculated and plotted on the CDC growth curves. Cut off points for growth indicators for our study population were calculated in constructed tables for comparison with international cut points.

Main outcome measures. Obesity assessed as BMI >95th the age- and gender- specific using CDC growth charts, underweight defined as weight-for-height z score $\leq$2, and stunting defined as height z score $\leq$2 was based on NCHS reference population.

Results. A total of 6027 school entrants aged 4-8 years were screened over 3 years in this study, of whom 3087 were boys and 2940 were girls. **Table 1** shows anthropometric results of BMI, weight, and height between both genders. It shows that BMI over 95th in the present study was lower than those pertaining to the NCHS reference population. The height figures were lower than those of the reference population (p<0.001). For children at the 95th centile, the stature was similar to the reference population. However, for the 10th centiles, the difference in height was evident. Distribution of children is significantly skewed to the right for their height (X^2 = 1048.37, p<0.001), weight (X^2 = 2844.75, p<0.001), and BMI (X^2 = 4011.87, p<0.001) percentiles. There were no significant gender differences in either height (X^2 = 5.69, p=0.13) or weight (X^2=0.93, p=0.82). However, gender difference was highly significant for BMI. Children of less than the 5th percentile for BMI constituted significantly higher percentage of boys (20.9%) than that of girls (17.3%), with X^2 = 20.35, p<0.005.

Table 2 shows Z scores for height, weight, and weight-for-height, compared to the NCHS reference population. The distribution of children is significantly skewed to the right for their height (X^2 = 343.39, p<0.001), weight (X^2 = 508.98, p<0.001), and weight-for-height (X^2 = 100.70, p<0.001) Z scores.

Figure 1 shows that our population is shifted to the left if compared to the reference population in weight-for-height, although this shift is parallel to the reference

Table 1 - Height, weight and body mass index percentiles for gender for all subjects according to the growth charts.

Parameters	No. of patients (%)		Total
	Male	Female	
Height			
<10th	579 (18.8)	593 (20.2)	1172 (19.4)
10th - 49th	1479 (47.9)	1431 (48.7)	2910 (48.3)
50th - 89th	875 (28.3)	798 (27.1)	1673 (27.8)
≥90th	154 (5.0)	118 (4.0)	272 (4.5)
Weight			
<10th	886 (28.7)	834 (28.4)	1720 (28.5)
10th - 49th	1424 (46.1)	1343 (45.7)	2767 (45.9)
50th - 89th	623 (20.2)	622 (21.2)	1245 (20.7)
≥90th	154 (5.0)	141 (4.8)	295 (4.5)
Body mass index			
<5th	644 (20.9)	510 (17.3)	1154 (19.1)
5th - 85th	2171 (70.3)	2134 (72.6)	4305 (71.4)
85th - 95th	140 (4.5)	185 (6.3)	325 (5.4)
>95th	132 (4.3)	111 (3.8)	243 (4)
Total	**3087 (51.2)**	**2940 (49.8)**	**6027 (100)**

Table 2 - Weight-for-height, height, and weight Z scores based on National Center for Health Statistics (NCHS) reference.

Parameter	Frequency n	(%)
Weight-for-height Z scores		
≤2 (underweight)	232	(3.8)
Between -2 and +2	5556	(92.2)
≥2	239	(4.0)
Height Z scores		
≤2 (stunt)	358	(5.9)
Between -2 and +2	5610	(93.1)
≥2	59	(1.0)
Weight Z scores		
≤2	416	(6.9)
Between -2 and +2	5401	(89.6)
≥2	210	(3.5)
Total	**6027**	**(100)**

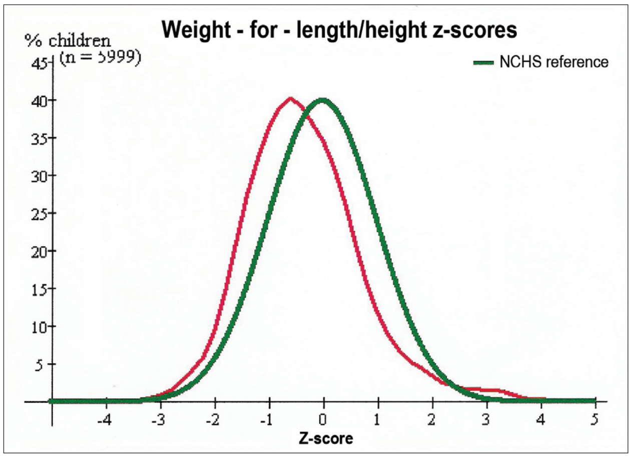

Figure 1 - Weight-for-height Z scores of our population compared to NCHS: weight-for-height Z scores at our population weight-for-height Z scores according to NCHS.

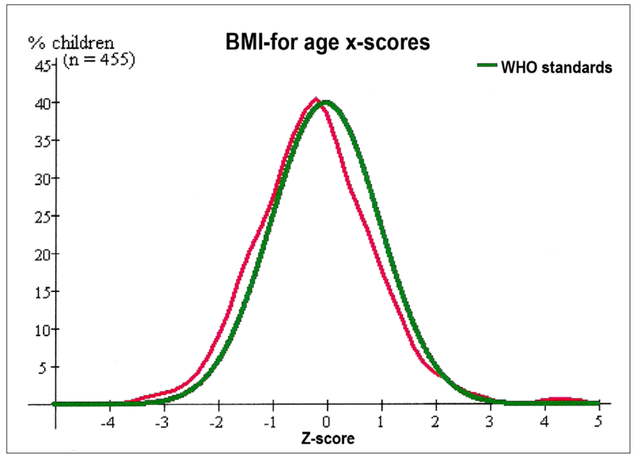

Figure 2 - BMI comparison between 455 of our children aged 48 to 60 months and the new WHO international reference: BMI-for-age Z scores at our population BMI-for-age Z scores according to WHO standards.

Table 3 - Constructed height (cm) and weight (kg) percentiles for the study by age and gender.

Age	Gender	Count	Parameter	Percentiles						
				5	10	25	50	75	90	95
48-59 months	Males	197	cm	98.9500	100.4000	103.5000	107.0000	110.0000	113.0400	115.0400
			kg	13.9900	14.3000	15.6500	17.2000	18.6000	20.2200	22.1300
	Female	150	cm	97.0000	100.0000	103.0000	105.6000	108.5500	112.4700	114.0000
			kg	13.3100	14.0100	15.2000	16.4000	18.5000	20.1800	22.0450
60-71 months	Males	1643	cm	103.0000	105.0000	108.0000	111.3000	114.5000	118.0000	119.6800
			kg	15.0000	15.7000	16.9000	18.3000	20.0000	22.0000	24.2800
	Female	1498	cm	103.0000	105.0000	107.3750	110.5000	113.6000	117.0000	119.0000
			kg	14.8000	15.4000	16.4000	17.9000	19.7000	22.0000	24.0000
72-83 months	Males	1216	cm	106.5000	108.0000	111.0000	114.5000	118.0000	121.5000	123.0000
			kg	15.5000	16.2000	17.5000	19.2000	21.0000	23.1300	25.5150
	Females	1257	cm	105.5000	107.2000	110.2000	114.0000	117.0000	120.5000	122.0000
			kg	15.1000	15.9000	17.0500	18.8000	20.7000	23.5000	26.0000
84-95 months	Males	31	cm	105.2000	107.6000	113.5000	116.0000	120.8000	124.4000	125.2000
			kg	14.1800	15.5800	17.8000	19.8000	22.5000	24.1400	25.0600
	Females	35	cm	107.4000	107.8000	111.6000	115.0000	120.0000	123.9200	125.7000
			kg	15.2800	15.8000	17.5000	20.0000	21.3000	24.9600	35.3800

Table 4 - Constructed body mass index percentiles for the study by age and gender.

Age	Gender	Count	Percentiles						
			5	10	25	50	75	90	95
48-59 months	Males	197	13.1000	13.5000	14.3000	15.1000	15.9000	16.5300	17.9100
	Females	150	12.9000	13.3000	13.9000	14.9550	15.9000	16.8000	18.3800
60-71 months	Males	1643	12.9000	13.4000	14.0000	14.8000	15.7000	16.3000	18.0000
	Females	1498	12.8000	13.2000	13.9000	14.7500	15.8000	16.4000	18.2000
72-83 months	Males	1216	12.6850	13.2000	13.8000	14.6000	15.6000	16.2000	18.1000
	Females	1257	12.6000	13.0000	13.7000	14.6000	15.7000	16.4000	18.4000
84-95 months	Males	31	10.9800	12.3600	13.5000	14.9000	15.9000	16.8000	17.9000
	Females	35	12.0800	13.1600	13.8000	14.6000	15.6000	17.1800	24.0000

population. **Figure 2** compares children less than 60 months of age from both genders to the recently published WHO international reference data, which is limited to this age and it shows closer proximity than the weight-for-height comparison of our population to the NCHS seen in **Figure 1**.

Tables 3 and 4 show constructed cut off points for height (cm), weight (kg) and BMI for our study population. At the age of 4, the cut point for the BMI 95th percentile among boys in our population (17.91) was close to the NCHS median cut point for boys at that age (17.83). However, at the age of 6, the cut off point is 18.10, while it becomes 18.69 in the reference population.

Discussion. This study illustrates the diversity in the prevalence of overweight and obesity in our population from other regions in Saudi Arabia. It is clearly below the national prevalence reported in other studies.[33-35] The differences may be attributed to the use of different definitions of obesity or to the different nature of our population. The prevalence of underweight from **Table 1** will be high if BMI <5th was used for assessment, though there is no scientific evidence to support the use of BMI <5th percentile as a tool to measure the underweight. On the other hand, when we used the WHO global database and compared our study sample using z-scores based on the NCHS in **Table 2**, the prevalence of underweight was found to be lower.

From the results, it is obvious that children in our population are generally less in weight and height than American children and seem to be close to the newly adapted international standards by the WHO. The difference in the weight for height z scores is proportional, but the gap between our population, and the NCHS reference population increases with age in all the 3 parameters (BMI, weight and height) to the favor of the NCHS population. Those results could be related to the possibility that homemade cooking is the main source of food in the housing city. The community, because of its insulation from the outside (this is a military residency compound), does not have what is commonly known as the "fast food" outlets in its immediate vicinity. Residents here are expected to have limited income and for the most part a large family to provide for. This could mean budgetary constraints in spending, and so it might encourage less spending on fast foods and more bulk buying of staple diet items. The cooking carried out in the home is usually pretty basic consisting of basic food groups.

Another possible factor supporting these results could be the higher physical activity among our population due to the presence of multiple playgrounds in the housing city and the presumed higher school non-educational activities. Breast-feeding pattern could also be linked to our findings, as the WHO new infants and young children reference data from around the world only includes breast-fed children.[29]

The major limitations to this study were the difficulty in the compliance of the parents with the policies and appointments of the newly established school health clinic. Another limitation was the lack of previously published researches conducted in this community that could be related to our study as references for comparison.

In conclusion, this study showed that, children in this particular community enjoy a healthy nutritional status. It also showed that a large segment of Saudi children in our population are more similar to Americans than to other Saudi children in different areas of Saudi Arabia in respect to the prevalence of obesity, overweight, and underweight. It might be due to factors such as the nature of the city, with less urbanization, policies not allowing opening of branches for fast food series, breast-feeding pattern, and possible higher physical activity. Thus, we think it is a great opportunity to start programs of anti-obesity behaviors at this community before the obesity epidemic finds its way to it. We also think that there is a need for further studies to evaluate the factors that could be linked to the growth pattern among our children such as breast-feeding pattern, socio-economic backgrounds, and physical activity. This study also provides valuable information on the cut off points for height, weight, and BMI for children in this community that can be utilized in the development of a local reference database that can be used for further evaluation of children nutritional status at the National Guard.

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