

Growth Pattern of Qatari Preschool Children

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Aim. To compare the growth patterns of Qatari preschool children aged 0-5 years with the growth reference charts developed by the American National Center for Health Statistics and Centers for Disease Control and Prevention (NCHS/CDC).

Methods. The demographic data of weight, height, and age were collected in a cross-sectional study among 8,231 Qatari children aged 0-5 years. There were 4,136 (50.2%) boys and 4,095 (49.8%) girls. The children were selected by a cross-sectional stratified random sampling procedure based on the stratification on the location and a socio-economic status. The measured data were compared with NCHS/CD growth charts.

Results. The boys were significantly taller than girls in age groups 0-6 months (58.3 ± 4.1 vs 57.4 ± 4.0 cm, respectively; $p < 0.001$), 6-12 months (66.7 ± 4.0 vs 66.2 ± 5.1 cm, respectively; $p = 0.018$), 48-54 months (102.1 ± 3.6 vs 100.9 ± 3.9 cm, respectively; $p < 0.001$), and 54-60 months (106 ± 4.8 vs 103.1 ± 3.5 cm, respectively; $p < 0.001$). The boys had significantly heavier weight pattern than the girls in all age groups ($p < 0.001$). The height for boys ranged from 58.3 cm to 106 cm, and for girls from 57.4 cm to 103.1 cm. The weight range for boys was 5.4-17.6 kg and 5.1-16.8 kg for girls. More than 11% of the children had stunted growth, 5.4% of the children were taller than normal for their age, 4.4% of the children were undernourished, and 0.6% were severely undernourished.

Conclusion. A combination of height for age (as an indicator of stunting) and weight for height (as an indicator of wasting) showed – that a sizeable proportion of Qatari children had normal or slightly above normal nutritional status. The growth pattern we presented may suffice as a standard for monitoring the growth of Qatari children in particular, and those in the Gulf region in general.

Key words: anthropometry; body height; body weight; child, preschool; growth; infant; Qatar

Growth patterns as determined from height, weight, and other anthropometric measurements reflect the nutritional status of a population's health when compared with other references (1). The use of growth charts is an essential tool in the assessment of the health status of children (2-10). Growth standards for children, their interpretation, and guidelines for their use have been developed by experts in the field of auxology (11,12). Information on health and growth status of the population is essential for administering any health intervention program. Growth charts for children constitute a basic tool for medical practitioners in a variety of disciplines, especially pediatrics, epidemiology, and genetics.

Waterloo et al (12) suggested the methods of classification that would allow comparison of nutritional status of children in different regions. Later, the World Health Organization (WHO) Committee suggested the growth charts developed by the National Center for Health Statistics/Center for Disease Control (NCHS/CDC) to be used as reference values in nutritional stu-

dies in both developed and developing countries (13). The WHO Committee has also recommended standard deviation (SD) scores to be used for the presentation of population distribution where a high percentage of values are outside the 5th-95th percentile range.

The growth status of children, especially their height, is influenced by hereditary and environmental factors. In contrast, body weight is more sensitive to environmental factors (8,11). Cultural variations in behavior also have a significant influence on the growth of preschool children (1,5).

The present survey aimed to provide comprehensive and representative data on the growth patterns of Qatari preschool children aged 0-5 years, and to compare these patterns with the NCHS/CDC reference values.

Participants and Methods

The overall population of Qatar was 595,321 in 2001, of whom 200,000 were estimated to be Qatari (14). To construct

growth chart for Qatari preschool children, we had to identify and measure a statistically adequate sample of healthy and well-fed segment of Qatari children. Using an annual growth rate of 3.5% and projections from the 2001 data (14), we estimated there were 55,838 children aged 0-5 years in Qatar between 1999 and 2001, when the study was carried out.

Participants

In our cross-sectional growth survey, we used a multi-stage stratified random sampling technique. The sampling plan controlled for age, sex, and socio-economic status of children. The country was divided into 22 socio-economical urban or semi-urban areas. One health center (primary unit) was randomly selected from each socio-economic area. The sample of 9,000 subjects (4,500 males and 4,500 females) was allotted to the selected health centers with the probability proportional to the corresponding stratum size. Immunization centers, kindergartens, and nurseries in each selected district were stratified according to the sex and age of the children. Then, immunization centers, kindergartens, and nurseries were randomly drawn from each sub-stratum (second stage sampling). Finally, the number of children (units of the final sampling stage) to be sampled from each unit was chosen with probability proportional to the substrata sizes. A simple random sample of the above predetermined size was then drawn from each unit (third stage sampling). The selection procedures were based on a directory of names of children in each immunization center, kindergarten, or nursery.

Thus, this national cross-sectional growth survey of preschool children aged 0-5 years included 8,231 infants and preschool children, of whom 4,136 (50.2%) were boys and 4,095 (49.8%) were girls. The sample size (10.2% of the population) was determined to guarantee at least 500 children in each age-sex group and believed to be adequate for achieving precise and comparable estimates (12). Only infants and healthy children were included. Infants and children born prematurely, with major malformation, and/or chronic diseases diagnosed as clinically unsuitable by the pediatrician were excluded from the study. To standardize the parameters, the weight scale was calibrated and tested for accuracy by an object of known weight. The cross-sectional data for the study were obtained from weight and height measurements of a healthy population of Qatari preschool children selected from different socio-economic living urban areas.

Data Collection

The data and the anthropometric parameters of Qatari preschool children were collected at health centers by qualified and well-trained health educators and nurses. We performed the growth measurements of 9,000 Qatari infants and children (male-to-female ratio, 1:1) aged between 0 and 5 years. Standing height was measured with a Harpenden stadiometer (Holtain Ltd, Crymch, Dyfed, UK) and weight with a beam balance (seca) for children above 2 years of age. The Harpenden measuring board was used to measure supine length, and a baby scale was used to measure weight of the children below 2 years of age.

Statistical Analysis

The data were analyzed with Statistical Package for Social Sciences (Version 11.5, SPSS Inc., Chicago, IL, USA) (15) and LMS software (L – skewness, M – median, S – coefficient of variation) (16,17). Anthropometric data were statistically analyzed in the Department of Medical Statistics and Epidemiology. Growth charts were developed through fitting the least squares polynomial regression model to degree three, using age as an independent variable and the percentiles as dependent variable. The cubic

polynomial regression provided a very good fit to our data (18,19).

We have used the LMS computer program to fit smooth centile curves to reference data by using the LMS method described by Cole (16,17). For each set of percentile curves the initial smoothing methods were applied to the nine empirical percentiles (3rd, 5th, 10th, 25th, 50th, 75th, 90th, 95th, and 97th) for each sex and age in months. With the exception of stature, which tends to be normally distributed, for most other anthropometric measures neither the empirical nor the smoothed data strictly follow a normal distribution. Rather, the distribution contains some degree of skewness, a power transformation can be used so that one tail of the distribution is stretched while the other tail is shrunk. The final set of percentile curves was produced by using the modified LMS estimation procedure (16,17).

The NCHS/CDC data reference values were used for comparisons, as recommended by the WHO Nutrition Unit (20,21). The centile distribution of weight for height, weight for age, and height for age of children in relation to the reference population and their standard deviation (SD) score distributions were constructed. The cut-off points of the z-scores were +2 SD scores. The children with z-score values outside the range from -4 to +6 were excluded from the analysis (22). $P < 0.05$ was considered statistically significant.

Results

The cross-sectional data on age, weight, and height were obtained for a total of 8,231 infants and preschool children, 4,133 (50.2%) boys and 4,095 (49.8%) girls aged 0-5 years. The boys were significantly taller than girls in the following age groups: 0-6 months (58.3 ± 4.1 vs 57.4 ± 4.0 cm, respectively; $p < 0.001$), 6-12 months (66.7 ± 4.0 vs 66.2 ± 5.1 cm, respectively; $p = 0.018$), 48-54 months (102.1 ± 3.6 vs 100.9 ± 3.9 cm, respectively; $p < 0.001$), and 54-60 months (106.0 ± 4.8 vs 103.1 ± 3.5 cm, respectively; $p < 0.001$; Table 1). The weight patterns for boys were higher than those for girls in all age groups ($p < 0.001$). Boys were between 58.3 cm and 106 cm tall, and girls were between 57.4 cm and 103.1 cm tall. The weight range for boys was 5.4-17.6 kg, and 5.1-16.8 kg for girls.

Standard Deviation Score

Height for age. The percentages of height for age of boys and girls in each age group were expressed as a multiple of the SD of the reference values from the growth charts of the NCHS/CDC (Tables 2 and 3). There were 11.4% of boys and equal percentage of girls who had stunted growth, ie, who fell in the group of less than -2 SD. The deficits in height for age compared with the NCHS/CDC standard did not show any significant linear trend with age. Almost the same percentage of boys and girls, 2.9%, were below -3 SD of the median NCHS/CDC reference value, which is a cut-off point for severely stunted growth; this percent-

Table 1. Mean values (\pm standard deviation) of height and weight of Qatari children aged 0-5 years by age and sex

Age group (months)	Children					
	boys (n=4,136)	height (cm)	weight (kg)	girls (n=4,095)	height (cm)	weight (kg)
0-6	1,412	$58.3 \pm 4.1^*$	$5.4 \pm 1.2^*$	1,126	57.4 ± 4.0	5.1 ± 1.0
6-12	1,000	$66.7 \pm 4.0^\dagger$	$8.0 \pm 1.2^*$	1,030	66.2 ± 5.1	7.6 ± 1.2
12-24	206	75.2 ± 3.3	$10.2 \pm 1.2^*$	224	74.8 ± 2.8	9.6 ± 1.2
24-36	685	82.4 ± 5.5	$11.5 \pm 1.5^*$	622	82.0 ± 5.6	10.9 ± 1.6
36-48	170	90.9 ± 3.9	$13.7 \pm 1.3^*$	292	90.5 ± 4.3	13.0 ± 1.0
48-54	295	$102.1 \pm 3.6^*$	$17.0 \pm 1.7^*$	316	100.9 ± 3.9	14.8 ± 0.9
54-60	368	$106.0 \pm 4.8^*$	$17.6 \pm 2.2^*$	485	103.1 ± 3.5	16.8 ± 1.5

* $p < 0.001$ vs. girls, Student t-test.

† $p = 0.018$ vs. girls, Student t-test.

Table 2. Height for age of Qatari boys aged 0-5 years in standard deviation (SD) scores according to the growth reference charts developed by American National Center for Health Statistics and Centers for Disease Control and Prevention

Age (months)	No. of boys*	No. (%) of boys with SD score		
		<-2	-1.99 to 1.99	>2
<6	1,412	45 (3.2)	1,315 (93.1)	52 (3.7)
6-12	1,000	350 (35.0)	619 (61.9)	31 (3.1)
All <12	2,412	395 (16.4)	1,934 (80.2)	83 (3.4)
12-24	206	21 (10.2)	179 (86.9)	6 (2.9)
24-36	685	71 (10.4)	576 (84.1)	38 (5.5)
36-48	170	10 (5.9)	154 (90.6)	6 (3.5)
48-54	295	2 (0.7)	284 (96.3)	9 (3.1)
54-60	368	22 (6.0)	331 (89.9)	15 (4.1)
All age groups	4,136	521 (12.6)	3,458 (83.6)	157 (3.8)

*Boys with z-scores outside the range of -4 to +6 were excluded from the analysis.

Table 3. Height for age of Qatari girls aged 0-5 years in standard deviation (SD) scores according to the growth reference charts developed by the American National Center for Health Statistics and Centers for Disease Control and Prevention

Age (months)	No. of girls*	No. (%) of girls with SD score		
		<-2	-1.99 to 1.99	>2
<6	1,126	58 (5.2)	1,024 (90.9)	44 (3.9)
6-12	1,030	240 (23.3)	714 (69.3)	76 (7.4)
All <12	2,156	298 (13.8)	1,738 (80.6)	120 (5.6)
12-24	224	5 (2.2)	211 (94.2)	8 (3.6)
24-36	622	86 (13.8)	473 (76.0)	63 (10.1)
36-48	292	10 (3.4)	261 (89.4)	21 (7.2)
48-54	316	4 (1.3)	255 (80.7)	57 (18.0)
54-60	485	15 (3.1)	454 (93.6)	16 (3.3)
All age groups	4,095	418 (10.2)	3,392 (82.8)	285 (7.0)

*Girls with z-scores outside the range of -4 to +6 were excluded from the analysis.

age was slightly lower for girls. There were 5.4% of the children taller than normal for their age, ie, above +2 SD of the NCHS/CDC reference value.

Weight for age. There were 4.4% of children of both sexes below -2 SD of the NCHS/CDC median reference value for weight for age, which is an indicator of undernourishment, and less than 0.61% were below the cut-off point of -3 SD, which indicates severe under-nutrition (Tables 4 and 5). Only 4.9% of children were above +2 SD, with values slightly higher for girls than for boys.

Overall, height for age and weight for height percentiles of Qatari boys and girls aged 0-5 years shows that majority of children were within the 5th-95th percentile range (Table 6). The nutritional indicators ob-

Table 4. Weight for age of Qatari boys aged 0-5 years in standard deviation (SD) scores according to the growth reference charts developed by American National Center for Health Statistics and Centers for Disease Control and Prevention

Age (months)	No. of boys*	No. (%) of boys with SD score		
		<-2	-1.99 to 1.99	>2
<6	1,412	17 (1.2)	1,320 (93.5)	75 (5.3)
6-12	1,000	108 (10.8)	851 (85.1)	41 (4.1)
All <12	2,412	125 (5.2)	2,171 (90.0)	116 (4.8)
12-24	206	9 (4.4)	186 (90.3)	11 (5.3)
24-36	685	24 (3.5)	618 (90.2)	43 (6.3)
36-48	170	6 (3.5)	163 (95.9)	1 (0.6)
48-54	295	2 (0.7)	274 (92.9)	19 (6.4)
54-60	368	9 (2.4)	353 (95.9)	6 (1.6)
All age groups	4,136	175 (4.2)	3,765 (91.0)	196 (4.7)

*Boys with z-scores outside the range from -4 to +6 were excluded from the analysis.

Table 5. Weight for age of Qatari girls aged 0-5 years in standard deviation (SD) scores according to the growth reference charts developed by the American National Center for Health Statistics and Centers for Disease Control and Prevention

Age (months)	No. of girls*	No. (%) of girls with SD scores		
		<-2 SD	-1.99 to 1.99	>2 SD
<6	1,126	16 (1.4)	1,046 (92.9)	64 (5.7)
6-12	1,030	133 (12.9)	836 (81.2)	61 (5.9)
All <12	2,156	149 (6.9)	1,882 (87.3)	125 (5.8)
12-24	224	2 (0.9)	211 (94.2)	11 (4.9)
24-36	622	19 (3.1)	547 (87.9)	56 (9.0)
36-48	292	7 (2.4)	281 (96.2)	4 (1.4)
48-54	316	3 (0.9)	310 (98.1)	3 (0.9)
54-60	485	8 (1.6)	470 (96.9)	7 (1.4)
All age groups	4,095	188 (4.6)	3,701 (90.4)	206 (5.0)

*Girls with z-scores outside the range from -4 to +6 were excluded from the analysis.

Table 6. Height for age and weight for height (percentiles)* of Qatari children aged 0-5 years according to sex

Parameters	No (%) of children in percentiles			
	<5th	5th to 95th	95th to 97th	≥97th
Height for age:				
boys (n=4,136)	669 (16.2)	3,198 (77.3)	94 (2.3)	175 (4.2)
girls (n=4,095)	524 (12.8)	3,148 (76.9)	83 (2.0)	340 (8.3)
Total (n=8,231)	1,193 (14.5)	6,346 (77.1)	177 (2.2)	515 (6.3)
Weight for height:				
boys (n=4,136)	214 (5.2)	3,486 (84.3)	69 (1.7)	367 (8.9)
girls (n=4,095)	381 (9.3)	3,235 (79.0)	73 (1.8)	406 (9.9)
Total (n=8,231)	595 (7.2)	6,721 (81.7)	142 (1.7)	773 (9.4)

*In comparison with the growth reference charts developed by the American National Center for Health Statistics and Centers for Disease Control and Prevention.

tained in this study for Qatari children were comparable to values previously obtained for Saudi Arabia and some other Middle East countries (Table 7). Nine percentiles (3rd, 5th, 10th, 25th, 50th, 75th, 90th, 95th, and 97th) of height for age and weight for age plotted separately for boys and girls (Fig. 1) showed that their growth pattern was consistent with NCHS/CDC reference values.

Discussion

This is the first study conducted at the national level comparing growth patterns of Qatari preschool children aged 0-60 months with the reference WHO growth charts. The 5th, 50th, and 95th percentiles of growth standards for Qatari preschool children have been consistent with the growth standards of their counterparts according to the NCHS/CDC percentiles for weight for age, height for age, and weight for height. Similar findings were also reported for Gulf States and developing countries, such as Saudi Arabia (1-3,7), Kuwait (5,6), Bahrain (8), and Iran (9).

In our study, the analysis of weight for height, an indicator of the degree of wasting of a child, defined as his/her weight in relation to the median height of the NCHS/CDC reference population of that age (13) in SD scores, showed that 3.6% were below the usual cut-off point of -2 SD scores. This observed rate of acute malnutrition of Qatari preschool children is comparable with that reported previously for Middle East countries such as Saudi Arabia (1-4), Kuwait (5,6), and Bahrain (8). The rate was also considerably

Table 7. Comparison of anthropometric indicators of nutritional status of children in Middle Eastern countries

Year	Preschool children in	Reference No.	No. of children	Less than -2 SD (%)		
				weight/height	height/age	weight/age
1988	Saudi Arabia – rural	23	842	12.0	41.0	44.0
1988	Saudi Arabia – privileged	23	315	1.0	2.0	3.0
1988	Saudi Arabia – less privileged	23	270	3.0	14.0	14.0
1995	Kuwait	5	2,554	2.6	12.2	6.4
1982/3	Yemen	24	1,493	5.6	38.8	26.3
1982	Iran – rural	9	404	7.2	55.7	36.6
1985/6	Lebanon – rural	24	117	1.7	4.4	3.4
1978	Egypt – national	24	6,965	1.0	38.8	16.6
1975	Tunisia	24	1,799	1.3	39.5	20.2
1993	Saudi Arabia	4	3,517	19.6	11.5	19.5
2003	Qatar	present study	8,231	3.6	11.4	4.4

higher than in Kuwait, where preschool children were found comparable with the reference population, and similar or higher than in other Middle East countries (5,6). However, the results obtained for preschool children in rural areas of Saudi Arabia could have been affected by the small sample size in each age group of children (5-9,13). The observed faltering growth started during the second half of the first year of life and peaked in the same period in both sexes. This is in agreement with other reports on the "effects of dietary deficiencies on infant's growth" and "increase in diarrhea diseases in infants" aged 12-24 months (20,21).

It is possible that in Qatar the interval between two pregnancies is short in comparison with that in other countries. During the pregnancy, the previous child is weaned, which may contribute to the deficit

in tissue and fat mass when compared with the mass expected for a child of the same height in the reference population (5,6,20-21). The proportion of boys was lower than proportion of girls with acutely decreased weight for height (<-2 SD scores). However, girls improved in weight after the age of two years.

Another finding was that weight for age, as an indicator of under-nourishment, showed a pattern similar to that of weight for height, an indicator of current malnutrition. We found that 4.4% of the children were under-nourished (<-2 SD scores). This percentage is quite satisfactory compared with previous reports from less privileged children in urban areas of Riyadh, and lower than 44% reported for preschool children in rural areas of Saudi Arabia (23). Also, it is similar or slightly lower than the rates reported for some Arab countries, like Egypt, Tunisia, Jordan, and

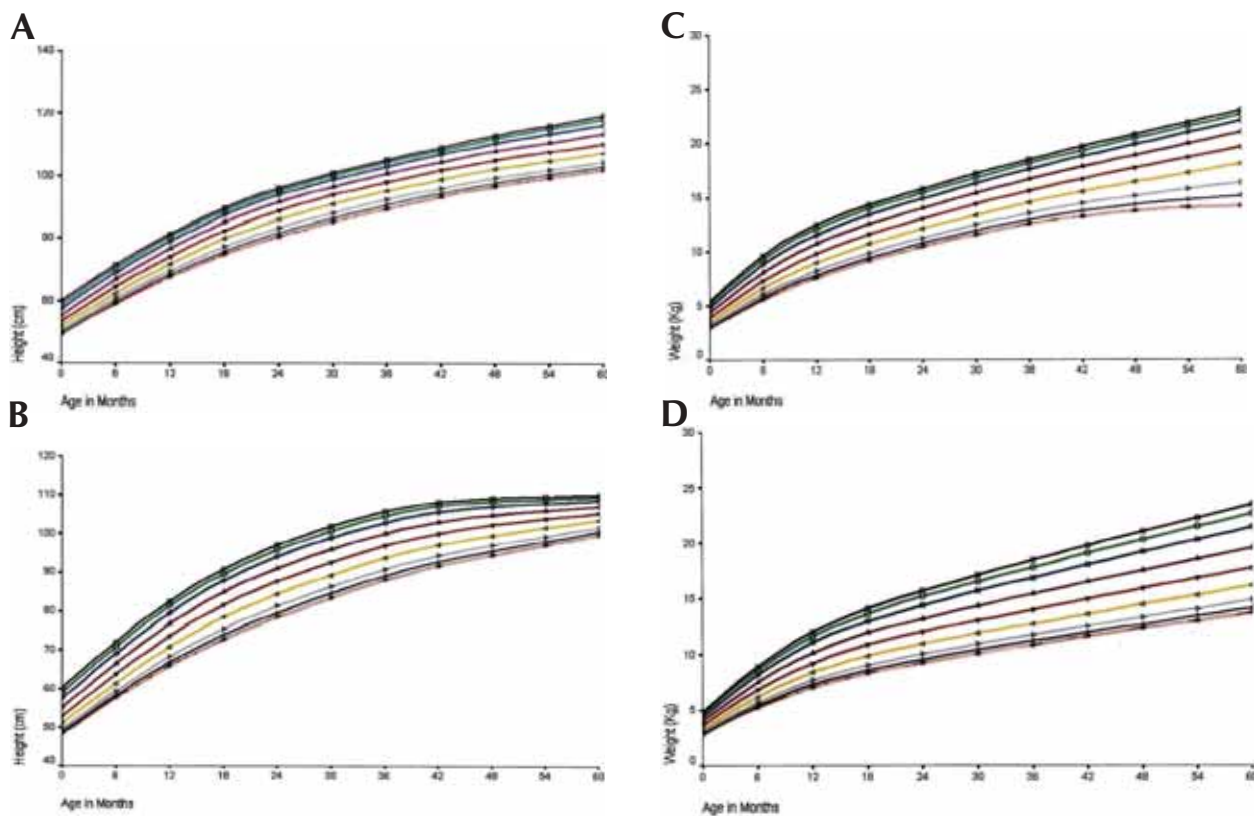


Figure 1. Height for age percentiles for Qatari boys (A) and girls (B), and weight for age percentiles of Qatari boys (C) and girls (D), aged 0-60 months. Percentiles: dark purple – 97th, green – 95th, blue – 90th, light purple – 75th, dark red – 50th, yellow – 25th, light grey – 10th, dark grey – 5th, pink – 3rd.

Yemen (24) and higher than the rate in Kuwait (5,6). However, the data from which the indicator (weight for age) of the privileged and less privileged Saudi children was calculated were collected on less than 300 children, which is too small a sample compared with the recommended 2,000 for each age group (12). The deficiency in height for age was slightly higher among boys than among girls in Qatar, but it did not reach statistical significance.

In conclusion, our study revealed that the boys were significantly taller than girls in the age groups < 6, 6-12, 48-54, and 54-60 months. The weight patterns of boys were higher than that of girls in all age groups. Nearly 2.4% of the male children were below -2 SD scores of the median reference population value, which indicated low proportion of wasted children. Also, after 36 months of age, 2.0% of children were considered wasted. In spite of the high income *per capita* in Qatar, the deficit found in the nutritional status was probably due to nutritional habits of Qatari, which often includes fast food. The growth pattern presented in this study may also be used as a standard in monitoring the growth of children in Qatar as well as other Gulf countries.

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