Longitudinal Growth of Infants in Qatar: Comparison with WHO and CDC Growth Standards

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Longitudinal growth data for infants in Qatar were compared to growth standards published by the CDC and WHO. 300 randomly selected full-term normal infants (150 males, 150 females) in Qatar were followed-up and weight and length were sequentially recorded at 2 months, 4 months, 6 months, 12 months and 18 months age. The mean length for age of girls was higher than those published by the CDC and WHO at 12 and 18 months of age. Using the CDC standard for weight for length detected more wasted infants (9.0% and 6.5%) compared to using WHO standards (6.27% and 6.0%) for males and females, respectively. When WHO and CDC standards are compared, more infants were identified as overweight when the former were used. The WHO standards are preferable because they are based on a leaner breastfed reference and because overweight is likely to be a greater problem in Qatar in the future.

Key words: *Growth, Growth chart, Infants, Qatar, Standards.*

The Centers for Disease Control (CDC) released new growth charts for children in year 2000, replacing the older charts of 1977. These charts represent the multicentric USA children with mixed methods of infant feeding [2-4]. The new infant growth charts of World Health Organization (WHO) were released in 2006 and represent breast fed infants of non-smoking mothers [5-7]. These standards are recommended for international comparisons and secular trend analysis in developing countries [8,9].

The evaluation of child growth trajectories and the interventions designed to improve child health are highly dependent on the growth charts used. The WHO charts are based on a prescriptive, prospective, international sample of infants selected to represent optimum growth. Comparison of the respective means of growth data distribution of the WHO and CDC shows differences which are particularly important during infancy. These are likely due to differences in study design and characteristics of the sample, such as type of feeding. Shorter measurement intervals in the WHO charts result in a better tool for monitoring the rapid and changing rate of growth in early infancy [10].

When feasible, a National Growth reference is also valuable and such charts need to be compared to the accepted standard provided by CDC and WHO. To obtain these data in Qatar and to test the suitability of either CDC and/or WHO standards for wide application, a longitudinal survey was conducted on infants born in Qatar.

METHODS

This prospective study included 300 randomly selected full-term normal infants (150 males and 150 females) with normal birthweight (>2.5 kg and <4 kg) and gestational age (>38 weeks and <42 weeks) born in Qatar after January 2006. The mothers were non-smokers and the babies were breastfed and/or

receiving breast and bottle (formula) feeding. Measurements were done sequentially for weight and length at birth and at every vaccination visit (2 months, 4 months, 6 months, 12 months and 18 months), with evaluation of their feeding practice. Data were recorded by two Pediatricians and/or two Pediatric nurses during the vaccination visits. Weight was measured using a Siemens digital weight balance accurate to 50 g, and length was measured using Siemens infantometer accurate to 1 mm. The mean and mean +/- 2SD of growth data of infants were plotted against those published by the WHO and the CDC. In addition, the differences between these 3 groups, at each time interval (mean +/- 2SD) were calculated. The difference between the mean (central tendency) , as well as the mean +/-2SD (dispersion) for weight and length at the six time intervals was calculated and subtracted from those published by the CDC and WHO to compare among the 3 groups of data. The following definitions were used: underweight: (weight-for-age <2SD), stunting: (length-for age <2SD), wasting: (weight-for-length <2SD), overweight: weight-for-age >2SD, and obesity: weight-for-length >2SD.

Informed consent was obtained from all parents of the study infants and the proposal of the study was approved by the Ethics Research Committee of Hamad Medical Center (HMC), Doha, Qatar.

RESULTS

The number of total observations was 1691 (300/300 at birth, 291/300 at 2 months, 282/300 at 4 months, 280/300 at 6 months, 272/300 at 12 months, and 266 /300 at 18 months). In this study, the percentage of exclusively breast-fed babies was 45.5% at 4 months and 26% at 6 months. The rate of continued breastfeeding at 12 months was 38.46%.

Linear growth for Qatari infants compared to WHO and CDC standards for girls and boys are shown in *Table* I. Visual inspection of the trajectories for mean length-for-age suggested that the length for these infants (girls and boys) was closer to those published by the WHO than to the CDC values. However, the difference between the means at the 6 point intervals did not differ statistically among Qatari infants and those published by the WHO or

CDC. The mean length of girls in Qatar was higher than those published by the CDC and WHO at 12 months (1.17 cm and 0.95 cm, respectively) and at 18 months of age (1.76 and 1.37 cm, respectively). None of the infants in the study was stunted.

Weight-for-age growth data of Qatari infants compared to WHO and CDC standards (*Table* II and *Fig* 1c,d) showed that at 12 months of age the mean weight was higher than WHO standards by 0.7 kg for boys and 0.5 kg for girls. At 18 months, the mean weight was higher than WHO standards by 0.9 kg for boys and 1.3 kg for girls (*Table* I). At the age of 12 or 18 months, none of the girls was under-weight compared to the WHO and CDC standards, and at 18 months, no boy was underweight compared to WHO standards (*Table* III).

At all time intervals, comparing the weight-for-length data of the Qatari infants to CDC standards diagnosed more wasted infants (9.0% and 6.5%) than using WHO standard (6.27% and 6.0%) for males and females, respectively. Diagnosis of obesity was less when using CDC standards (4.26 % and 2.6%) versus using the WHO standard (5.1% and 3.19%) for males and females, respectively (*Table* III and *Fig* 2a-d). Observation of longitudinal data of weight-for-length (*Fig* 2 c-d) showed that more obese children (>2SD) are observed on the right hand side of the curve whereas more wasted infants were diagnosed on the left hand side of the curve.

DISCUSSION

In this study, visual inspection of the trajectories for mean length for age suggested that the linear growth (mean values) for Qatari infants (girls and boys) was closer to those published by the WHO compared to CDC values. However, the difference between the means at the 6 point-intervals did not differ statistically among these infants, compared to WHO and CDC standards.

Comparing weight growth data with the WHO (weight-for-age and weight-for-length) standards has detected more overweight and obese children at the age of 12 months and 18 months (*Table* III). This can be explained by the generally heavier children in the CDC standards *vs* WHO standards. The majority of infants in Qatar, a country with rich economy, were

TABLE I LENGTH FOR AGE FOR QATAR INFANTS *VS* CDC AND WHO STANDARDS

Age (mo)	0	2	4	6	12	18	Mean of 6 intervals	SD
Q-Girls Mean leanth	50.14	57.02	62.49	66.37	74.96	82.06	65.51	11.68
WHO-Girls Mean length	49.15	57.07	62.09	65.73	74.02	80.71	64.79	11.41
Difference Q-WHO	0.99	–0.04	0.40	0.64	0.95	1.36	0.71	0.49
CDC-Girls Mean length	49.29	56.69	61.50	65.26	73.79	80.31	64.47	11.30
Difference Q-CDC	0.85	0.33	0.99	1.10	1.17	1.76	1.03	0.46
Q-Boy Mean length	50.49	58.51	63.86	67.78	75.29	81.70	66.27	11.29
WHO-boys Mean length	49.88	58.42	63.89	67.62	75.75	82.26	66.30	11.69
Difference Q-WHO	0.61	0.09	–0.03	0.16	–0.46	–0.56	–0.03	0.43
CDC-Boys Mean length	49.99	58.12	63.15	66.99	75.52	82.41	66.03	11.72
Difference Q-CDC	0.50	0.39	0.72	0.78	–0.23	–0.71	0.24	0.59

**TABLE II** WEIGHT FOR AGE FOR QATAR INFANTS *VS* CDC AND WHO STANDARDS

Age (mo)	0	2	4	6	12	18	Mean of 6 intervals	SD
Q-Girls Mean Wt	3.15	5.04	6.41	7.71	9.40	11.57	7.21	3.03
WHO-Girls Mean Wt	3.20	5.10	6.40	7.30	8.90	10.20	6.85	2.54
Difference Q-WHO	–0.05	–0.06	0.01	0.41	0.50	1.37	0.36	0.55
CDC-Girls Mean Wt	3.40	4.89	6.15	7.21	9.52	10.99	7.03	2.84
Difference Q-CDC	–0.24	0.15	0.26	0.50	–0.12	0.58	0.19	0.33
Q-Boy Mean Wt	3.18	5.33	6.77	7.85	9.91	11.85	7.48	3.12
WHO-boys Mean Wt	3.30	5.60	7.00	7.90	9.60	10.90	7.38	2.74
Difference Q-WHO	–0.12	–0.27	–0.23	–0.05	0.31	0.95	0.10	0.47
CDC-Boys Mean Wt	3.53	5.28	6.72	7.90	10.31	11.71	7.57	3.07
Difference Q-CDC	–0.35	0.05	0.06	–0.05	–0.40	0.14	–0.09	0.23

TABLE III GROWTH DATA FOR QATAR INFANTS VS CDC AND WHO STANDARDS

	Age (months)	Qatar Males vs CDC	Qatar Males vs WHO	Qatar Females vs CDC	Qatar Females vs WHO
Underweight	12	2.9%	1.46%	0%	0%
	18	2.27%	0%	0%	0%
Overweight	12	1.49%	2.2%	1.45%	2.18%
	18	1.5%	3%	1.5%	3%
Wasting	2-18	9%	6.27%	6.5%	6%
Obesity	2-18	4.26 %	5.2%	2.6%	3.19%

on formula or mixed formula and breast feeding. Therefore, applying the WHO weight standards can pick up early more obese and overweight children compared to CDC charts [10]. Data from a cross sectional study suggested that the risk of obesity in children at the time of school entry can be reduced by breast feeding and 35% reduction occurs if children are breastfed for 3 to 5 months [11]. In addition,
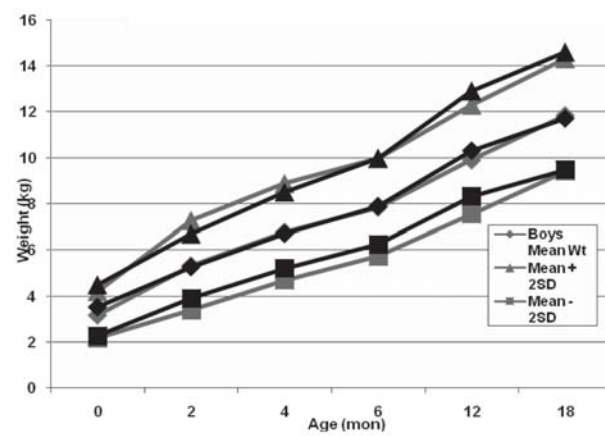
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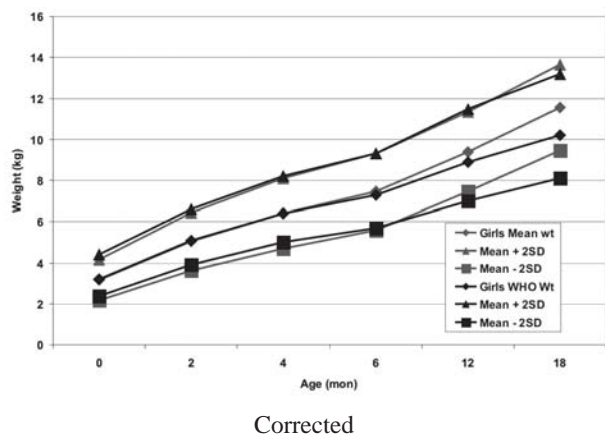
FIG. 1a *Weight gain of girls in Qatar (n=150) vs WHO standards.*

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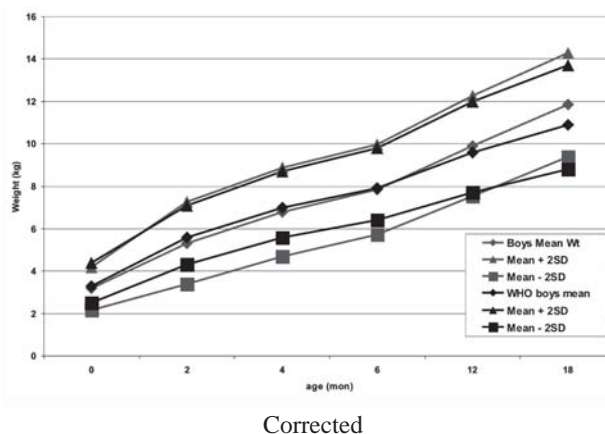
FIG. 1b *Weight gain of boys in Qatar (n=150) vs WHO standards.*
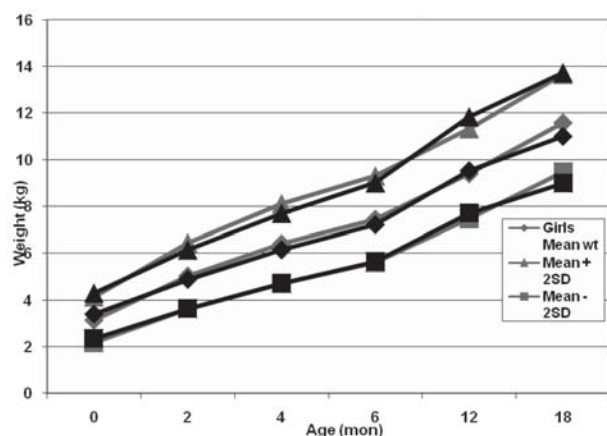
FIG. 1c *Weight gain of girls in Qatar (n=150) vs CDC standards.*

**FIG. 1d** *Weight gain of boys in Qatar (n=150) vs CDC standards.*

infants in Qatar have shown greater variability in terms of +/- SD scores for weight and length. This phenomenon has been observed in other populations around the world including India and other Asian countries [12].

It is important to decide which of the two reference standards is more useful in identifying obesity/overweight. Overweight and obesity are independent risk factors for increased morbidity and mortality throughout life and major risk factors for chronic diseases and the 'metabolic' syndrome. In addition, obesity in childhood frequently tracks into adulthood [13,18]. Childhood obesity and overweight is common in children and adolescents in Qatar [19-21].

In this longitudinal study, the proportion of underweight infants as well as wasted Qatari infants (***Table*** II, ***Fig***. 2) decreased gradually between ages

of 12 to 18 months. Our data is supported by a previous cross-sectional survey performed on infants and preschool children in Qatar, that showed decreased prevalence of underweight in infants aged 2-3 years compared to those below one year [22].

Our data showed a small but important differences between the growth data of Qatari infants and those published by the CDC and WHO (***Tables*** I, II). Using the WHO standards as a reference for growth in weight for age and weight for length gives the advantage of early recognition of overweight and obese infants. This early recognition of overweight and obesity during infancy and child-hood and early management of these children are necessary steps to prevent obesity and its compli-cations in Qatar [17]. Limitation of this study is the relatively small number of infants (150 boys and 150 girls) followed
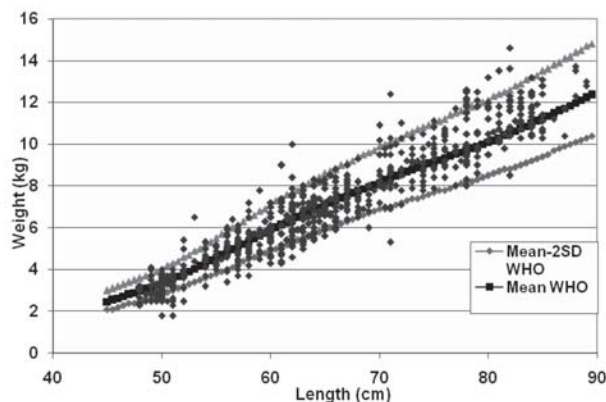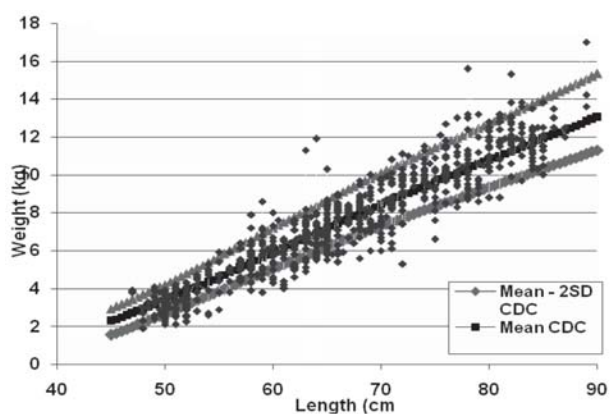
FIG. 2a *Weight for length data for Qatari girls (n=150) vs WHO standards.*
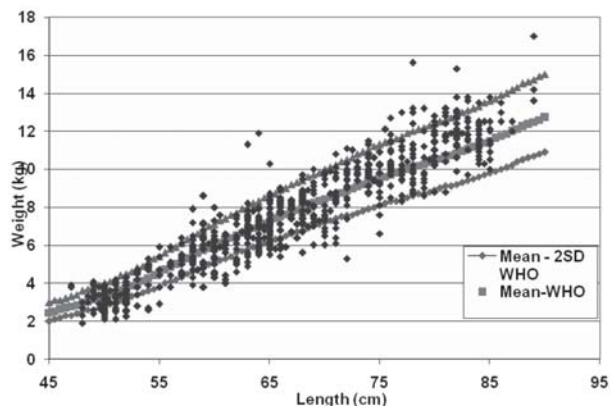
FIG. 2b *Weight for length data for Qatari boys (n=150) vs WHO standards.*
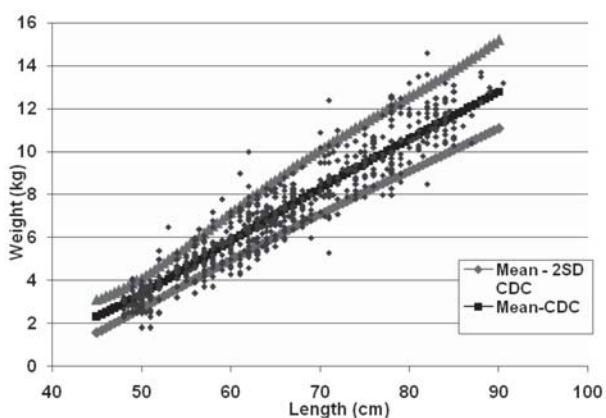
FIG. 2c *Weight for length data for Qatari girls (n=150) vs CDC standards.*

FIG. 2d *Weight for length data for Qatari boys (n=150) vs CDC standards.*

longitudinally and the short period of follow up (18 months). Further follow up for these children can find out more accurately longitudinal trends of growth in Qatar.

Due to the growing problem of obesity in Qatar, it appears that the use of WHO standards which are based on a breastfed infant population as reference for evaluation of growth for infants has the advantage of detecting more overweight and obese infants early than the arguably overweight infants in the CDC reference.

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REFERENCES

1. Department of Economic and Social Affairs Population Division. (2009). World Population Prospects, 2008. United Nations.

2. De Onis M, Garza C, Onyango AW, Borghi E. Comparison of the WHO Child Growth Standards and the CDC 2000 Growth Charts. J Nutr. 2007;137;144-8.

3. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, Flegal KM, Guo SS, Wei R, *et al*. CDC growth charts: United States. Advance data from vital and health statistics, no. 314. Hyattsville (MD): National Center for Health Statistics; 2000.

4. Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, *et al.* 2000 CDC growth charts for the United States: methods and development. Vital Health Stat 11. 2002;246:1–190.

5. Annonymous. 2000 CDC Growth Charts for the United States: Methods and Development. Series Report 11, No. 246. 201 pp.

6. Babson SG, Benda GI: Growth graphs for the clinical assessment of infants of varying gestational age. J Pediatr 1976; 89: 814-20.

7. Catrine KF. Anthropometric assessment. *In:* Groh-Wargo S, Thompson M, Hovasi-Cox J. Eds. Nutritional Care for High Risk Newborns, 3rd Edition: Chicago, Precept Press 2000.

8. Yang H, de Onis M. Algorithms for converting estimates

of child malnutrition based on the NCHS reference into estimates based on the WHO Child Growth Standards. BMC Pediatrics. 2008;8:19.

9. de Onis M, Garza C, Adelheid W. Onyango, Borgh E. Comparison of the WHO Child Growth Standards and the CDC 2000 Growth Charts. J Nutr. 2007;137:144-8.

11. von Kries R, Koletzko B, Sauerwald T, von Mutius E, Barnert D, Grunert V, *et al.* Breast feeding and obesity: cross sectional study. BMJ. 1999;319:147-50.

12. Khadilkar V, Khadilkar AV, Chiplonkar SA. Growth performance of affluent Indian preschool children: A comparison with the new WHO growth standard. Indian Pediatr. 2010;48:869-72.

13. Curhan GC, Chertow GM, Willlett WC, Spiegelman D, Colditz GA, Manson JE, *et al.* Birth weight and adult hypertension and obesity in women. Circulation. 1996;94:1310-5.

14. World Health Organization: Obesity: Preventing and Managing the Global Epidemic. World Health Organization Technical Support Series No. 894. Geneva, Switzerland: World Health Organization, 2000.

15. Dietz WH, Gortmaker SL. Preventing obesity in children and adolescents. Annual Rev Public Health. 2001; 22:337-53.

16. Martorell R, Kettel Khan L, Hughes ML. Overweight and obesity in preschool children from developing countries. Int J Obes Relat Metab Disord.2000;24:959-67.

17. Onis M, Blossner M. Prevalence and trends of overweight among preschool children in developing countries. Am J Clin Nutr. 2000;72:1032-9.

18. Williams C. Can childhood obesity be prevented? *In*: Primary and Secondary Preventive Nutrition. Bendich A and Deckelbaum RJ (Eds). Totowa, NJ: Humana Press, 2001. P. 185-204.

19. Kerkadi A, Hassan AS, Eltayeb A, Yousef M. High prevalence of the risk of overweight and overweight among Qatari children ages 9 through 11. Nutrition Food Science. 2009;39:36-45.

20. AlKhateeb M, Qotba H, Algemily A, Algawalda A, Benner A. Obesity in school children in Qatar (2009). Qatar Children Cultural Center (www.c-c-center.org and WHO publication, 2009, Doha Qatar.

21. Benner A. Prevalence of obesity, overweight, and underweight in Qatari adolescents. Food Nutr Bull; 2006;27:39-45.

22. Abdulaziz A. Kamal L, Bener A, Ahmed MA, Al-Mulla K. Growth pattern of Qatari preschool children. Croat Med J 2004;45:461-5.