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A COMPARISON OF LENGTH, WEIGHT AND OFC OF SAUDI FULL-TERM NEWBORNS WITH THE KACST AND MOH STANDARD GROWTH CHARTS

ABDULRAHMAN S. AL-FRAYH, MD, FACHARZT[1] and ELIJAH A. BAMGBOYE, PhD (LOND)[2]

[1]*Professor of Pediatrics and Consultant Pediatrician, Department of Pediatrics, King Saud University, Riyadh, Saudi Arabia, 2Associate Professor and Consultant Medical Statistician, Department of Family and Community Medicine, King Saud University, Riyadh, Saudi Arabia*

The birth weight, supine length and head circumference of Saudi newborns delivered in ten different hospitals from five administrative regions of the Kingdom of Saudi Arabia, between July 1991 and June 1992 was measured. These anthropometric measurements were compared with the United States NCHS/CDC standard growth charts (based on the American population and currently used by the Ministry of Health (MOH) in Saudi Arabia as a reference) and the newly constructed King Abdulaziz City for Science and Technology (KACST) standard growth chart (based on the Saudi Arabian population) to assess the level of agreement between the two charts classification of Saudi newborns to low (less than 10th centile) or high (greater than 90th centile) categories. The results showed a similar pattern in the classification of individuals in the centile distribution of the standard growth charts. However, the proportions of Saudi newborn whose weight, length and head circumference were classified as below the 10th centile are significantly higher on the MOH reference standard than the KACST standard.

The conclusion is that the MOH standards tend to over estimate the proportions of Saudi newborn classified as below the 10th centile thereby exaggerating the number of Saudi Arabian newborn with poor intrauterine growth. Alternatively, the KACST growth chart appears to be more reflective of the newborn population of Saudi Arabia. The low incidence of low measurements by the KACST standard growth chart is not surprising considering the greatly improved socio-economic levels and quality of life standards.

KEY WORDS: Saudi, Newborns, Anthropometry, Intrauterine, Growth, Standards.

INTRODUCTION

The few studies on the anthropometry of Saudi newborns and growth at different ages have revealed that using reference growth standards based on populations from the Western countries to assess their growth patterns seem inappropriate.[1–4] It has long been recognized that there are diffrences in the body size, shape and growth rate of different populations. In consonance with this, Saudi growth patterns have been found to deviate significantly from the growth pattern of the

Address for Correspondence: Prof. Abdulrahman S. Al Frayh, Department of Pediatrics (39), College of Medicine, King Saud University, P.O. Box 2925, Riyadh 11461, Saudi Arabia.

Western populations.[3,4,6] Also, fetal growth are known to be influenced by factors related to the environment, maternal and genetic.[6] In Saudi Arabia, consanguinity is an additional factor affecting the fetal growth.[3,6,7] This premise suggest the need to develop a reference standard growth chart based on the local population. Al Frayh and others therefore examined intrauterine and fetal growth in a large sample of Saudis to construct the first national standard growth chart for Saudi newborn.[8] This is later referred to in this paper as the King Abdulaziz City for Science and Technology (KACST) standard growth chart.

The purpose of the present paper is to compare the percentage of small for gestational age newborns identified from using the KACST standards whose database was the Saudi population and the reference growth standards currently used by the Ministry of Health (MOH) in Saudi Arabia which were constructed from the American population.[9] The latter is subsequently referred to as the MOH standard. This paper also attempts to estimate broadly the level of agreement between the classifications of birth weight, length and head circumference into low (below expected percentile) and high (above expected percentile) categories when plotted on the KACST and MOH standard growth charts.

METHODS AND MATERIALS

Sample Selection and Data Collection

There were ten participating hospitals in this study, selected from each of the five administrative regions (North, East, West, South and Central) of the Kingdom of Saudi Arabia. The study took place between July 1991 and June 1992. The Maternal and Child Health (MCH) Center in Medina and Jeddah were included from the West while the MCH in Riyadh, (the main referral hospital of the Ministry of Health (MOH) for maternal and child health services), and four other hospitals were included from the central region. One hospital each was chosen from the other three regions.

The gestational age in weeks, weight, supine length and largest occipitofrontal head circumference of all Saudi newborns in these hospitals during the period under study were measured. The gestational age (GA) was determined by maternal dates and ultrasound when available. Each neonate underwent further clinical assessment to determine the GA, using the postnatal Dubowitz assessment protocol.[9] When discrepancies between gestational age were encountered, the clinical Dubowitz estimation was taken as the correct gestational age. The infant weight and crown heel length were measured within 12 hours of delivery. The objective of the study were explained to the neonatologist/pediatrician working in the postneonatal service units of the participating hospitals to ensure that the methods of measurements of the anthropometry and the determination of gestational age follow the same standard procedure. All babies with gross congenital malformation and products of multiple pregnancies were excluded from the study.

Statistical Analysis

The anthropometry data were then plotted separately on the KACST and MOH standard growth charts to determine (their location) on the standard growth curves and hence estimate their centile points. Each child, was classified into either of four categories, below the 10th percentile, above 10th percentile but less than 50th percentile, 50th percentile and above but less than 90th percentile, 90th percentile and above according to the chosen anthropometric measurements. The number of children in each centile category was therefore seperately computed for the KACST and MOH charts. The purpose of a standard growth chart was to identify those children who suffer poor fetal growth and development and these were indicated by those below the 10th percentile on the standard growth charts. Thus in this analysis the children below 10th percentile have been designated arbitrarily as 'high risk' and those above this but below 90th percentile as 'low risk'. Each authropometry i.e., weight, length and head circumference was thus classified by the two charts into high and low risk groups and were subsequently presented in four-fold contingency tables to ascertain level of agreement. The rows of the four-fold contingency tables represent the classification using the MOH standards and the columns, the classification using the KACST standards. The null hypothesis tested was that the proportion classified as high risks by the MOH and KACST standard growth charts is the same. Because these are paired observations, McNemar's test for paired proportions was used to test this hypothesis at the 1% level of significance.

To further assess the interrater reliability of the two charts in determining the growth status of newborns, the Kappa statistics was used. This test allowed us to estimate the magnitude of agreement of classifications by the two growth charts. A two-way analysis of variance was used to test the significance of the main effects of region and sex on the mean values of the chosen anthropometric measurements at the 1% probability level of significance. The data was processed using the STAT-PAC Gold program for data entry and statistical analysis on a microcomputer.[10]

RESULTS

There were 5008 newborns comprising 51.9% males and 48% females for which data were available. But 445 (8.9%) were excluded from the analysis because they were below 38 weeks of gestation. Thus, 4,563 newborns comprising 2,376 (52.1%) males and 3,169 (47.9%) females were compared with the MOH and KACST standard charts. The mean and standard deviation of the chosen anthropometric measurements of these full-term babies between the ages of 38 weeks and 42 weeks of gestation from each of the five regions are presented in Table 1 for males and females. The result of a two-way analysis of variance showed that there were no statistically significant differences in the mean values of these anthropometric measurements between the regions ($P > 0.6$), but the difference between males and females were statistically significant ($P < 0.01$). The interaction of sex and region was also not statistically significant ($P > 0.7$).

Birthweight

There is very little doubt that the MOH standard growth chart classified a larger proportion of Saudi newborns into low weight for gestational age than the KACST standards. The proportions of newborns' birthweight classified below the 10th percentile given as 8.7% in the MOH chart was significantly higher than the 3.7%

Table 1 The means and standard deviations (SD) of anthropometric measurements for full-term Saudi newborns in the five administration regions of the kingdom of Saudi Arabia

Administrative Regions	Sex	Sample Size	Anthropometric measurements Weight (SD)	Length (SD)	Head Circumference (SD)
1. Central	B	1344	3.29 (0.47)	50.6 (2.6)	34.8 (1.6)
	G	1195	3.16 (0.44)	50.1 (2.4)	34.4 (1.4)
2. West	B	422	3.27 (0.50)	50.5 (3.0)	34.8 (1.5)
	G	393	3.18 (0.44)	50.3 (2.3)	34.2 (1.3)
3. East	B	265	3.26 (0.43)	50.5 (2.5)	34.7 (1.7)
	G	144	3.21 (0.48)	50.5 (2.2)	34.4 (1.3)
4. South	B	202	3.26 (0.46)	50.7 (2.6)	34.6 (1.5)
	G	265	3.15 (0.46)	50.4 (2.2)	34.1 (1.6)
5. North	B	143	3.30 (0.45)	50.7 (2.3)	34.6 (1.4)
	G	190	3.22 (0.42)	50.3 (2.3)	34.5 (1.6)
TOTAL	B	2376	3.28 (0.47)	50.6 (2.6)	34.8 (1.6)
	G	2187	3.17(0.44)	50.2 (2.3)	34.3 (1.5)

B = Boys.
G = Girls.

on the KACST chart. It is therefore statistically proven beyond reasonable doubt that the current MOH standard growth chart, classified a greater proportion of newborns birthweight below the 10th percentile compared to the KACST standard charts. The proportion classified above 90th percentile (4.6%) on this MOH standard chart appears similar to the proportion classified above the 90th percentile (3.8%) on the KACST standard growth chart. But the apparent small difference of 0.8% is statistically significant at the 5% level. The 95% confidence limits for the difference between the proportions classified as less than 10th percentile on the two standard growth charts which are given as 4.5% and 5.9% is much higher than the difference observed in the classification into high birthweight for gestational age (90th percentile and above) given as between 0.42% and 1.2%.

Length

A similar result to birthweight was observed in the determination of low length at birth for gestational age (less than 10th percentile) which was 7.4% on the MOH standard growth chart and 1.4% on the KACST standard growth chart. The difference is highly statistically significant at less than 1 in 1,000. The 95% confidence limits for the difference between the proportions classified as less than 10th percentile on the two growth charts which were given as 5.1% and 6.9% were lower than the difference observed in the classifications into high length at birth, i.e., greater than 90th percentile, the 95% confidence limits for this difference (which was also statistically highly significant) were 8.6% and 10.6%. The proportions of newborns whose length were classified as above 90th percentile on the MOH and KACST charts were 19.0% and 9.4% respectively.

Table 2 The classification into poor and normal growth of male anthropometric data by MOH and KACST Standard Growth Charts

		Outcome of classification KACST Growth Chart		
Anthropometry	MOH Growth Chart	High Risk	Low Risk	Total
1. Weight	High risk	193	137	330
	Low risk	21	2245	2266
	Total	214	2382	2596
		$X^2 = 83.7, P < 0.0001$		
2. Height	High risk	287	468	755
	Low risk	16	1824	1840
	Total	303	2292	2595
		$X^2 = 420.25, P < 0.0001$		
3. Head circumference	High risk	109	468	577
	Low risk	9	2010	2019
	Total	118	2478	2596
		$X^2 = 439.75, P < 0.00001$		

Poor < 10th percentile + > 90th percentile
Normal 10th – 90th percentile

Head Circumference

Classifications of the newborns' head circumference into high risk group (less than 10th percentile) was statistically significantly greater on the MOH growth chart (with a percentage of 12.9%) than the KACST growth chart of 1.6%. The 95% confidence limits for the difference between the proportion less than 10th percentile on the two standard growth charts are 10.5% and 12.3% while the equivalent for proportion greater than 90th percentile are 5.4% and 1.7%.

The classifications of these anthropometry are further examined for low and high anthropometry for gestational age (less than 10th percentile and greater than 90th percentile respectively and the results presented in Tables 2 and 3). It is clear that the MOH growth chart significantly classifies more newborns into the high or low category as shown by the McNemar's Chi-square tests.

Sex Differential

On the average, boys weighed more than girls and the difference was statistically significant ($P < 0.001$). The 95% confidence interval for the difference in birth weight between boys and girls was 80 gms to 140 gms. Also, significantly higher in boys were supine length and head circumference for which the 95% confidence intervals for the difference were (0.26 cms; 0.54 cms) and (0.41 cms; 0.59 cms) respectively. There was indeed no sex differential in the pattern of classification of the anthropometric measurement by MOH and KACST standard growth charts. The number of infants classified as either below the 10th percentile (low) or above the 90th percentile (high) on the centile distribution of the standard growth charts

Table 3 The classification into poor and normal growth of female anthropometric data by MOH and KACST Standard Growth Chart

		Outcome of classification KACST Growth Chart		
Anthropometry	MOH Growth Chart	High risk	Low risk	Total
1. Weight	High risk	139	191	330
	Low risk	13	2058	2071
	Total	152	2249	2401
		$X^2 = 153.57, P < 0.0001$		
2. Height	High risk	221	343	564
	Low risk	13	1824	1837
	Total	234	2167	2401
		$X^2 = 304.05, P < 0.0001$		
3. Head Circumference	High risk	94	432	526
	Low risk	9	1866	1875
	Total	103	2298	2401
		$X^2 403.82, P < 0.00001$		

Poor < 10th percentile + > 90th percentile
Normal 10th — 90th percentile

are designated as 'high risk' for perinatal complications, while those in the 10th-90th percentile as 'low risk'.

The frequency of newborns classified as low risk or high risk by the MOH and KACST standards for each anthropometry are shown in the four-fold contingency Tables 2 and 3 for males and females respectively. The Kappa statistics, an indicator of the magnitude of agreement gave values between 0.4 for head circumference and 0.8 for weight. This suggests an agreement of between 70% and 98% in the pattern of classifications of the Saudi newborns by the two standard growth chart according to these anthropometric measurements. But the result of the McNemar's test showed a statistically significant difference between the frequency of infants classified as low risk on the KACST standard but high risk on the MOH standards ($P < 0.001$).

The MOH charts consistently recorded significantly higher number of infants below the 10th percentile than the KACST chart ($P < 0.0001$). Also, more infants were classified as above the 90th percentile on the MOH standard growth charts than the KACST standard growth chart. The differences were statistically significant for length and head circumference ($P < 0.001$), but not for weight ($P > 0.16$).

DISCUSSION

The differences of the anthropometric measurements between males and females which were found to be highly statistically significant should be interpreted with caution. The fact that the sample sizes are large will certainly make any difference however small statistically significant as the standard error of the difference will be small. Therefore, the 95% confidence interval for the differences given should be

Table 4 Means and standard deviation of body weight, supine length and head circumference at 40 weeks' gestation in SAudi Arabia

Author	Sample size (n)	Sex	Body weight mean (SD)	Supine length mean (SD)	Head circumference mean (SD)
1. Riyadh, KSA	169	B	3.47 (0.48)	50.3 (2.4)	34.9 (1.5)
Taha *et al.* (1)	63	G	3.34 (0.37)	49.6 (2.5)	34.3 (1.4)
2. Jeddah, KSA	89	B	3.32 (0.42)	50.0 (3.00)	34.7 (1.43)
Jan MY (6)	74	G	3.23 (0.36)	49.8 (2.40)	34.2 (1.28)
3. Najran, KSA	364	B	3.23 (0.43)	51.7 (2.7)	34.7 (1.5)
Krueger (2)	343	G	3.13 (0.41)	51.2 (2.4)	34.2 (1.5)
4. KSA	2029	B	3.29 (0.45)	50.7 (2.50)	34.8 (1.59)
Present study	1874	G	3.20 (6.44)	50.3 (2.29)	34.4 (1.41)

examined to determine their clinical significance. Review of previous studies on the anthropometry of Saudi newborns examined in Table 4, showed that the mean body weight, length and head circumference obtained at 40 weeks of gestation in these studies were comparable with the values obtained in the present study. These studies were carried out on small samples less than 500 and in some cases less than 200 in each sex group. With such small sample sizes one would not truly represent the true population values of the chosen anthropometric variables. The sample size in this study is however almost 2000 in each sex group and the estimates of anthropometry could therefore be said to have a high degree of accuracy with the true population values as it is more than 1000 recommended by Healy and Tanner for accurate representation of the population anthropometric measurements in each group.[12–13]

The difference in the proportions classified as low for anthropometry between the MOH and KACST standard growth charts indicated by those below the 10th percentile, observed in this study is not unexpected. In fact the issue prompting the development of standard growth chart based on data collected from the immediate environment where it would be used like this KACST standard chart constructed from the Saudi population is as a result of likely misclassification of Saudi newborns into high risk group by a standard growth chart constructed using the American population as a base.[1–3] Anthropometric measurements has long been recognized as good indicators of intrauterine and fetal growth as well as nutritional status.[7] These indicators also reflect the environment and socioeconomic conditions of the people. Therefore, the choice a reference or standard population that presupposes that children of all distinct population or ethnic groups are expected to grow at the same rate raises serious doubts.[12] Often, the cumulative effects of chronic malnutrition have been offered as explanation for any observed differential in growth patterns between the developed and developing populations.[14–17,19] Whereas the improvement of the socioeconomic level of the people of the Kingdom of Saudi Arabia in the last 20 years has influenced a wide increase in the available health services and the quality of life of the people.[18] Thus, the greater proportion of Saudi newborns low for gestational age for each of the chosen anthropometric measurements (body weight, length and head circumference) indicated by the current MOH standard growth chart whose database was the American population[10] may not be attributed to the nutrition of their mothers. Besides, there are no genetic differences between the Middle East countries and the Western population.[6–7] Incidentally, the figures of the summary statistics of birthweight, supine length and head circumference obtained in this study are compatible with other figures already obtained in previous studies from the different parts of the Kingdom.[1–3,8]

In conclusion, a significant number of full-term babies considered as having good or normal intrauterine growth and development when plotted on the KACST standard chart were more likely to be categorized as having poor intrauterine growth when compared with the MOH standard growth chart. Therefore, the large difference in the proportions of full-term babies with low anthropometry noted between the MOH and KACST growth charts maybe taken as an overestimation of the proportions classified in 'high risk' groups by using the reference population standards of the American NCHS/CDC population.[17] Thus the proportion of newborns classified as having low anthropometry for gestational age on the KACST standard growth chart could be said to truly reflect the pattern of intrauterine and fetal growth in the Saudi community. The low frequency of high risk newborns measured on this KACST standard chart is not surprising considering the greatly improved socio-economic status and quality of life enjoyed by the people of Saudi Arabia.[6,18,19] The KACST standard growth chart may thus be recommended for use as reference standards to assess the intrauterine growth pattern in the Middle East Community.

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