

# Growth Patterns in Saudi Arabian Children

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## ABSTRACT

THE MEASUREMENTS of head and chest circumferences of 6623 Saudi Arabian pre-school children are presented for the first time. The data were collected through a large scale cross-sectional growth study carried out in Riyadh, the capital of the Kingdom of Saudi Arabia. The results indicate that the average head and chest circumference measurements of the girls were smaller than the boys in all age groups. The analysis of variance results confirmed that these differences were statistically significant.

The data indicated that among the average-build (the 50th centile) pre-schoolers, the head circumference measurements of the newborns were larger than the chest circumference measurement by 4.5%. By one year of age, these measurements were equal. After one year, the chest circumference grew larger than the head circumference. However, among the small-build pre-schoolers (the 3rd centile), the chest circumference measurements did not reach the head circumference measurements until nearly 30 months after birth.

## INTRODUCTION

SINCE NEURAL tissue grows rapidly in intra-uterine life and in the first six months after birth, the head of the newborn baby is relatively big compared to an older child, and the head circumference is larger than chest circumference until the age of one year, when they are equal<sup>1</sup>. In a well nourished and normally developed children, the chest circumference becomes larger than head circumference after one year due to normal development of the thoracic cage.

As part of a series of anthropometric investigations of Saudi pre-school children, in this paper, for the first time, we present head and chest circumference distributions of Saudi pre-school children. The data used in this analysis are based on a large cross-sectional growth survey which we carried out in Riyadh, drawn from a defined and reproducible sample of 6623 well-nourished Saudi pre-schoolers. The sampling procedures are only briefly discussed here. Detailed discussion of the survey design, and various methodological issues are presented in another paper<sup>2,3</sup>.

## MATERIALS AND METHODS

A GROWTH survey of Saudi pre-school children was carried out in Riyadh, the capital city of Saudi Arabia in 1985. This was the first large scale cross-sectional growth study carried out in this part of the world and from the basis on which the first set of Saudi growth standards are to be developed.

The sampling design and sample selection was essentially based on quota sampling, using two inter-

locked quota control age and sex. In order to have an adequate and representative coverage of all socio-economic and demographic group of the Saudi population in Riyadh, an element of randomness was introduced by dividing Riyadh into 93 administrative areas. These areas were further divided into six strata according to socio-economic homogeneity. In each stratum, the number of areas were identified and one-fifth of areas in each stratum were chosen randomly to be included in the study.

Each of the randomly selected areas was further subdivided into roads. Altogether, there were 1376 roads in the 17 randomly selected areas. So as to obtain an overall sampling fraction about 1.30, one-sixth of the roads in each of the 17 areas selected for the first state were chosen randomly. Finally, 224 roads were randomly selected and considered for the study. Each road was subsequently divided into smaller manageable blocks of approximately equal size and a sample of such blocks were randomly selected.

A sample of 40 effective interviews combined with taking anthropometric measurements were allocated to each randomly selected block in order to provide an adequate geographical coverage of the city and consequently all socio-economic family backgrounds. For each child included in the survey, five anthropometric measurements were recorded. These were height, weight, head and chest circumference, and triceps skinfold. Also, date of birth, age, birth order, race, family socio-demographic and economic background, family size, fertility and mortality pattern and housing condition were recorded on a standard questionnaire.

All the anthropometric measurements were taken using procedures recommended by Jelliffe<sup>4</sup>. Standing height was measured using a stadiometer (Harpender), and weight using a beam balance (Seca). For children below two years of age, Harpenden measuring board was used to measure the supine length, and the weight was measured on a baby scale. Weights were measured with the children in their under-wear. Head and chest circumferences were measured using Harpenden Cloth Tape-measure and skinfold thickness using Harpenden Calliper. Height, head and chest circumferences were measured to the nearest millimeter. Weight was measured to the nearest 0.1 kg and skinfold thickness to the nearest 0.1 mm.

In this paper, we present the head and chest circumference distribution of the Saudi boys and girls. The rest of the measurements are discussed in another paper<sup>5</sup>.

## RESULTS

ALTOGETHER 6,623 Saudi pre-school children were measured. The number of boys and girls in the sample was almost even — there were 49.9% of boys and 50.1% of girls. The age distributions of the sample is shown in Table 1. The data are presented in the age groups recommended by Waterlow *et al*<sup>6</sup>.

Tables 2 and 3 indicate the means and standard

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Table 1: Age Distribution of the Sampled Saudi Pre-School Children.

Age in Months	Boys		Girls	
	No.	%	No.	%
Birth — 00.99	122	(03.7)	97	(02.9)
01 — 02.99	309	(09.4)	310	(09.3)
03 — 05.99	763	(23.1)	784	(23.6)
06 — 08.99	575	(17.4)	595	(17.9)
09 — 11.99	622	(18.8)	619	(18.6)
12 — 17.99	146	(04.4)	164	(04.9)
18 — 23.99	114	(03.5)	140	(04.2)
24 — 29.99	114	(03.5)	103	(03.1)
30 — 35.99	109	(03.3)	97	(02.9)
36 — 41.99	128	(03.9)	104	(03.1)
42 — 47.99	88	(02.7)	91	(02.7)
48 — 53.99	110	(03.3)	98	(03.0)
54 — 60	103	(03.1)	118	(03.6)
Total	3,303	(100.0)*	3,320	(100.0)*

(\*The percentage may not add up to 100.0 in total because of rounding).

Table 2: The Means and Standard Deviations of Head Circumference (cm) Measurements of Saudi Pre-School Children.

Age in Months	Boys		Girls	
	Means	S.D.	Means	S.D.
Birth — 00.99	—*	—	—	—
01 — 02.99	38.30	1.57	37.30	1.80
03 — 05.99	40.70	1.71	39.71	1.70
03 — 08.99	42.96	1.72	42.08	1.58
09 — 11.99	44.62	1.63	43.54	1.55
12 — 17.99	46.13	1.45	44.72	2.22
18 — 23.99	46.68	2.11	46.16	1.93
24 — 29.99	47.65	1.49	46.70	1.59
30 — 35.99	48.00	1.55	47.29	1.56
36 — 41.99	48.68	1.65	47.56	1.59
42 — 47.99	48.74	1.48	47.92	1.54
48 — 53.99	49.15	1.64	48.36	1.51
54 — 60	49.32	1.55	48.84	1.68

(\*Statistical information of the age group is not available).

Table 3: The Means and Standard Deviations of Chest Circumference (cm) Measurements of Saudi Pre-School Children.

Age in Months	Boys		Girls	
	Means	S.D.	Means	S.D.
Birth — 00.99	—	—	—	—
— 02.99	37.11	2.27	36.05	2.12
3 — 05.99	36.95	2.19	38.64	2.23
06 — 08.99	42.11	2.32	41.17	2.02
09 — 11.99	44.00	2.16	42.99	2.28
12 — 17.99	46.40	2.21	44.84	2.96
18 — 23.99	47.44	2.70	46.52	2.57
24 — 29.99	48.40	2.05	47.47	2.01
30 — 35.99	49.41	2.19	48.02	1.74
36 — 41.99	49.61	4.38	48.47	2.13
42 — 47.99	50.43	2.37	49.65	2.90
48 — 53.99	51.03	2.41	50.26	2.39
54 — 60	51.89	2.45	50.79	2.68

deviations for the head circumference and chest circumferences of the Saudi pre-school children. Tables 4 and 5 show the 3rd, 50th and 97th centiles distributions of these measurements of the sampled children; while Table 6 presents the comparisons of the two anthropometric measurements between the Saudi boys and the girls. Table 7 presents results of the analysis of variance between boys and girls with respect to their head circumference and chest circumference measurements. Finally, Table 8 illustrates the comparisons between head circumference and chest circumference measurements of the sampled pre-school children.

Table 4: Percentiles of Head Circumference Measurements (cm) of Saudi Pre-School Children.

Age in Months	Boy's Percentiles			Girl's Percentiles		
	3rd	50th	97th	3rd	50th	97th
Birth — 00.99	—	33.0	38.0	—	30.5	37.1
01 — 02.99	35.0	38.0	41.0	35.0	37.5	40.0
03 — 05.99	37.5	40.8	43.6	37.0	39.8	42.5
06 — 08.99	39.8	43.0	46.0	39.0	42.0	45.0
09 — 11.99	42.0	44.8	47.2	41.0	43.5	46.0
12 — 17.99	43.5	46.0	49.0	40.0	45.0	49.0
18 — 23.99	42.5	47.0	51.0	43.0	46.5	49.0
24 — 29.99	45.0	48.0	50.5	44.0	47.0	50.0
30 — 35.99	45.5	48.0	51.1	44.0	47.2	50.0
36 — 41.99	45.5	49.0	51.7	44.5	48.0	50.2
42 — 47.99	46.0	48.5	52.0	45.0	48.0	51.0
48 — 53.99	46.0	49.0	52.0	45.5	48.5	51.0
54 — 60	46.5	49.1	52.5	46.0	49.0	51.6

Table 5: Percentiles of Chest Circumference Measurements (cm) of Saudi Pre-School Children.

Age in Months	Boy's Percentiles			Girl's Percentiles		
	3rd	50th	97th	3rd	50th	97th
Birth — 00.99	—	31.5	37.0	—	30.5	37.0
01 — 02.99	33.0	37.0	41.5	31.5	36.0	40.0
03 — 05.99	36.0	39.6	44.0	35.0	38.5	43.0
06 — 08.99	38.0	42.0	46.5	37.0	41.0	45.0
09 — 11.99	40.0	44.0	48.0	39.0	43.0	47.5
12 — 17.99	42.0	46.2	51.0	40.0	45.0	50.2
18 — 23.99	42.0	47.5	53.0	42.0	47.0	50.5
24 — 29.99	44.5	48.5	52.0	44.0	47.0	52.0
30 — 35.99	46.0	49.0	54.0	45.0	48.0	51.0
36 — 41.99	46.0	50.0	54.0	45.0	48.5	54.0
42 — 47.99	47.0	50.0	57.0	45.5	49.0	56.0
48 — 53.99	47.0	51.0	56.3	47.0	50.0	55.0
54 — 60	48.1	52.0	57.0	46.5	50.8	55.5

Table 6: Comparisons of Head Circumference and Chest Circumference Measurements between Pre-School Saudi Boys and Girls. (Figures indicate the Girl's measurement as a percentage of the boy's).

Age in Months	Head Circumference			Chest Circumference		
	3rd	50th	97th	3rd	50th	97th
Birth — 00.99	—	92	98	—	95	100
01 — 02.99	100	99	98	95	97	96
03 — 05.99	99	98	97	97	97	98
06 — 08.99	98	98	98	97	98	97
09 — 11.99	98	97	97	98	98	99
12 — 17.99	92	98	100	95	97	98
18 — 23.99	101	99	96	100	99	95
24 — 29.99	98	98	99	99	97	100
30 — 35.99	97	98	98	98	98	94
36 — 41.99	98	98	97	98	97	100
42 — 47.99	98	99	98	97	98	98
48 — 53.99	99	99	98	100	98	98
54 — 60	99	100	98	97	98	97

(a) *Head Circumference.* The average head circumference measurements of the Saudi pre-school girls were relatively smaller than the boys in each age groups, with a difference of about 1 to 3% (see Table 2). Further comparisons also indicated that the differences in head circumference were consistently smaller among the girls than the boys for the average, small and large children (see Table 4). Among the average-size children (the 50th centile group), the head circumference of the girls at birth were about 2% larger than the boys. Afterwards, however, the girls' head circumferences were about 1 to 3% smaller than the boys in all the older age groups from 1 to 53.99 months. The oldest age group in the sample (between 54 to 60 months) showed that the boys and the girls were about equal in the head circumference measurements.



Table 7: Analysis of variance between Saudi Pre-School Boys and Girls Head Circumference and Chest Circumference Measurements.

Age in Months	Head Circumference	Chest Circumference
Birth — 00.99		
01 — 02.99	7.319*	5.997*
03 — 05.99	11.319*	9.000*
06 — 08.99	9.081*	7.416*
09 — 11.99	12.046*	8.030*
12 — 17.99	6.559*	5.208*
18 — 23.99	2.052*	2.765*
24 — 29.99	4.576*	3.401*
30 — 35.99	3.307*	5.011*
36 — 41.99	5.249*	2.433*
42 — 47.99	3.606*	1.983*
48 — 53.99	3.598*	2.317*
54 — 60	2.154*	3.164*

(NOTE: The above results were calculated using the pooled T-test; where [\*] refers to significant at 95 per cent level).

Table 8: Comparisons between Head Circumference and Chest Circumference Measurements of the Pre-School Saudi Boys and Girls. (Figures indicate the chest circumference as a percentage of the head circumference measurement).

Age/Months	Boy's				Girl's			
	3rd	50th	97th	Mean	3rd	50th	97th	Mean
Birth — 00.99	—	95.5	97.4	—	98.4	99.7	—	—
01 — 2.99	94.3	97.4	101.2	96.9	90.0	96.0	100.0	96.6
03 — 05.99	96.0	97.1	100.9	97.4	94.6	96.7	101.2	97.3
06 — 08.99	95.5	97.7	101.1	98.0	94.9	97.6	100.0	97.8
09 — 11.99	95.2	98.2	101.7	98.6	95.1	98.9	103.3	98.7
12 — 17.99	98.6	100.4	104.1	100.6	100.0	100.0	102.4	100.3
18 — 23.99	98.8	101.1	103.9	101.6	97.7	101.1	103.1	100.8
24 — 29.99	98.9	101.0	103.0	101.6	100.0	100.0	104.0	101.6
30 — 35.99	101.1	102.1	105.7	102.9	102.3	101.7	102.0	101.5
36 — 41.99	101.1	102.0	104.4	101.9	101.1	101.0	107.6	101.9
42 — 47.99	102.2	103.1	109.6	103.5	101.1	102.1	109.8	103.6
48 — 53.99	102.2	104.1	108.3	103.8	103.3	103.1	107.8	103.9
54 — 60	103.4	105.9	108.6	105.2	101.1	103.7	107.6	104.0

Among the third centile group of children, the girls at the age of 1 to 2.99 months were about even with the boys in their head circumference measurements. However, from the age of 3 months and above, the girls were about 1 to 2% smaller than the boys — the only exceptions were the 12 to 17.99 months old and the 18 to 23.99 months old groups where the girls' head circumferences were about 8% smaller and 1% larger than the boys respectively.

The bigger-built boys (the 97th centile group) had slightly larger head circumferences than the girls in all age groups — the differences were between 1 to 3%. The only exception was between the 12 to 17.99 months old group where both the boys and the girls had the same head circumference measurements.

Finally, results from the analysis of variance confirmed that the differences of head circumferences between the pre-school Saudi boys and the girls were statistically significant in all age groups (see Table 7).

(b) *Chest Circumference.* The average chest circumference measurements of the Saudi pre-school girls were consistently smaller than the boys by about 2 to 3% in all age groups (see Table 3). Further analysis of the chest circumference measurements between the boys and the girls among the average, small and large sizes of the sample confirmed the above finding (see Table 5). Among the average-built children (the 50th centile group), the girls, at birth, had chest circumference about 5% smaller than the boys. Afterward, the girls' chest circumferences were about 1 to 3% smaller than the boys in all the age groups.

Among the third centile group of children, the girls

were generally smaller by 1 to 5% than the boys in their chest circumference for the age of 1 month and above. While in the age groups of 18 to 23.99 months and 48 to 53.99 months, the boys and girls had about the same chest circumference measurement.

As for the large-built children the newborn boys and the girls had the same measurements of chest circumference. From the age group of 1 to 2.99 and those above, the boys showed larger measurements of chest circumference than the girls by about 1 to 6% — except in the age groups of 24 to 29.99 months and 36 to 41.99 months when the measurements were about equal.

Finally, results of the analysis of variance showed that the chest circumference between the boys and girls in all age groups were significantly different (see Table 7).

## DISCUSSION

THE RESULTS of other anthropometric studies in Colombia, Pakistan, Syria and Egypt indicate that in general for all intervals, boys measurements are larger as compared to girls regardless of geographical and social status<sup>7</sup>. For example, Egyptian boys are taller than girls in the age groups under 1 year of age and 4-5 years. However, in the remaining age groups, no consistent pattern is observed. On the other hand, Egyptian boys were heavier than girls at all ages, with the exception of urban girls who were slightly heavier than boys at 2 and 3 years of age. As far as the head and chest circumference measurements are concerned, such data have not been reported in the above studies.

As for the Saudi pre-schoolers, the average head circumference measurements of the Saudi girls were relatively smaller than the boys, whereas, results of the analysis of variance confirmed that the differences were statistically significant in all age groups. On the other hand, the average chest circumference measurements of the Saudi girls were also consistently smaller than the boys by about 2 to 3% in all age groups. Furthermore, the analysis of variance results confirmed that the differences were statistically significant.

Further comparisons between the head circumference and chest circumference measurements of the Saudi pre-school children revealed some significant findings (Table 8).

Among the average-built boys (the 50th centile group), the head circumferences of the newborns were larger than the chest circumference by about 4.5%. This difference was gradually reduced until the boys reached one year of age, when both measurements were about equal. Afterwards, the chest circumference grew larger than the head circumference by 1% in the age group of 18 to 23.99 months up to nearly 6% in the 54 to 60 months old age group (see Table 8).

However, among the small-built boys (the 3rd centile group), the chest circumference did not match the head circumference measurements until the boys reached nearly 30 months old. On the contrary, among the large-built boys (the 97th centile group), the chest circumference measurements already exceeded the head circumference one month after birth.

The difference between the head and chest circumference among the Saudi pre-school girls were similar to the boys specially with respect to the average-built girls (50th centiles).

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