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Saudi Arabia**

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## The Growth Standards of Saudi Infant and Pre-school Children in Riyadh — Saudi Arabia

A. R. Al Frayh, S. S. Wong and A. Bener

### ABSTRACT

Growth status data for Saudi infants and pre-school children are presented. A survey of growth and development of Saudi infants and pre-school children is currently being conducted in Riyadh, with the objective of developing a growth chart for Saudi infants and pre-school children. The sample includes 6400 infants and pre-school children, between the ages of 1 month — 5 years of age. The variables measured include height (cm), weight (kg), head circumference (cm) and chest circumference (cm) for boys and girls.

The main objective of this study is to construct physical growth standards for Saudi infants and pre-school children by indentifying and measuring a statistically adequate sample of a healthy and well-fed segment of the Riyadh population in Saudi Arabia.

### Introduction

Anthropometric measurements of children at given ages in most developing and developed countries are used as indicators of nutritional status. For example, increases in height, weight, head circumference, chest circumference and triceps skinfold and other anthropometric measures reflect the nutritional status of a population. Those are considered as sensitive indices of population health.<sup>1</sup>

Differences in growth and maturity status between upper and lower class children are well-documented. Children born and raised in better-off circumstances are larger age for age and mature earlier than those from poor socio-economic backgrounds.<sup>2</sup>

The study of growth has become an essential tool in the investigation of children's health related problems. Particularly in developing countries, pediatrici-

ans meet very big problems. The most important child growth standards, certain guidelines on children have been developed by experts in the field of auxology which are helpful in solving some of the theoretical as well as practical difficulties in initiating such a field survey research programme.<sup>3-6</sup>

The growth status of children, specifically height is influenced by genetical and environmental factors. Although there is biological variation among populations, the amount of variation in height attributed to population differences is quite small during infancy and childhood. In contrast, body weight is more sensitive to environmental stresses.<sup>7,8</sup>

Growth is a physiological process that provides excellent indices of health and nutritional status. Infant growth is related to short term outcomes including survival morbidity, and cognitive performance.

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Children from various ethnic groups, from various socio-economic strata within an ethnic group and from different geographic areas of the world show relatively small differences in birth dimension and generally grow rather uniformly during the first three to six months of life. After six months of age, the lengths and weights of children from low social strata in developing countries lag behind those of children from developed countries, while those from the higher social strata compare favourably with children of developed countries.<sup>8</sup>

The majority of differences in weight and length have their origin between six months and two years of age, for after these ages the differences between the better-off and poor children are relatively stable during the pre-school years. Suboptimum nutrition, infectious disease and interaction of the two are commonly the most important environmental factors underlying the differences between well-to-do and poor children.

Cultural variation in behaviour is also a significant factor in the growth of pre-school children.<sup>7</sup>

The main objective of this research is to construct physical growth standards for Saudi infants and pre-school children by identifying and measuring a statistically adequate sample of the healthy and well-fed segment of Riyadh population (capital city of Saudi Arabia). To our knowledge, these are the first published growth data from Riyadh population to contain a true longitudinal component for infant and pre-school children.

#### Material and Methods

A research team composed of fourteen faculty members and researchers has been set up to carry out all the stages of planning and implementation of the field survey as well as in the analysis of the data. Additional supporting research personnel composed of 7 nurses-anthropometricians, 7 female social workers, 7 drivers and 5 field su-

pervisors, were recruited to help in executing the field work. It was decided that a sample size of 6,400 infants and pre-school children was required for taking anthropometric measurements including, height, weight, head circumference, chest circumference, triceps skin-fold and mid-arm circumference.

In addition, data on ecological, environmental and cultural factors were collected during the interviews. Information regarding feeding pattern, size of the house-hold and number of siblings are also being compiled.

A pilot study was carried out during May and June 1984. The actual field survey began in September 1984 and it is still in process.

#### Sample Structure and Sample Size

Before starting the actual survey in September 1984, the sample structure and the sample design had to be composed. This stage was proceeded by pre-listing of the Saudi house-holds in Riyadh, and training of the field workers.

Based on the information compiled and analyzed by the Central Department of Statistics, a sample size of 6,400 pre-school children would produce a valid and representative result of growth variables, with a standard error not exceeding 10 percent.

According to the available statistics for the Riyadh area, the area under study that is, the total number of pre-school (0-5 year-old) children, represents about 20 percent of the current Riyadh population (approximately 200,000). Thus with sampling fraction of 1/30, a sample of about 6,400 healthy and well-fed pre-school children had to be randomly and, irrespective of demographic and socio-economic background of family to which they belong, included in the field survey.

Accordingly, the field survey has been programmed for taking growth measurements of 6,400 Saudi pre-school children, equally divided between male and female, distributed among the various age groups as indicated in Table 1.

TABLE 1  
DISTRIBUTION OF SAMPLE SIZE  
BY AGE AND SEX FOR THE FIELD  
SURVEY

AGE GROUP	Male	Female	Total
0— 1 month	200	200	400
1— 2 months	200	200	400
2— 3 months	200	200	400
3— 4 months	200	200	400
4— 5 months	200	200	400
5— 6 months	200	200	400
6— 7 months	200	200	400
7— 8 months	200	200	400
8— 9 months	200	200	400
9—10 months	200	200	400
10—11 months	200	200	400
11—12 months	200	200	400
1— 2 years	200	200	400
2— 3 years	200	200	400
3— 4 years	200	200	400
4— 5 years	200	200	400
Total	3.200	3.200	6.400

#### Sampling Design:

The sampling design is essentially based on quota sampling, using two interlocked quota controls; age and sex. On the other hand, in order to have an adequate and representative coverage of all socio-economic and demographic groups of Saudi population living in Riyadh, it was necessary to introduce an element of randomness during the actual sample selection process. Otherwise, there would have been the possibility of a bias arising in favour of certain socio-economic groups or other variables directly related to the subject matter under study.

#### Pilot survey

The first draft of the research protocol was tested during the pilot survey which was carried out in the months of May and June 1984 in Riyadh Children & Maternity Hospital and in one of the Riyadh administrative areas referred to as Olaya. The main objective of piloting the protocol was to ensure that the questionnaires elicit the required information and that they contain no unclear or ambiguous points.

The pilot was carried out under the supervision of one field manager and three field supervisors, with participation of three pediatricians.

The anthropometricians and the interviewers were divided into 7 teams. Two teams were assigned to the Children and Maternity Hospital, and 5 teams were assigned to carry out the pilot study in the Olaya Community.

Each team was equipped with a Harpenden Anthropometer, skinfold, stadiometer, infant-measuring table, tape measure and weighing machine.

All the families who were included in the pilot were Saudis. As for infants and children, only single live born infants and healthy children were measured. Infants and children who were born prematurely, children with major malformations and chronic disease were excluded.

Throughout the pilot, 200 families and their children were interviewed and measured. At the end of the pilot, certain changes were accordingly made in the research protocol and the revised version is being used for collection of data during the actual field work which is still in process.

#### Results and discussion

A survey of growth and development of Saudi infants and pre-school children is currently being conducted in Riyadh, with the objective of developing a growth chart for Saudi infants and pre-school children.

The sample includes 6400 infants and pre-school children, between the ages of 1 month-5 years of age. The principal results are summarized in Tables 2 to 5. The anthropometric dimensions or measurements include height (cm), weight (kg), head circumference (cm) and chest circumference (cm), for boys and girls.

Height, weight, head circumference and chest circumference are given in Tables 2 to 5, which are plotted relative to age group in months and anthropometric measurement in Figures 1 through 8.

TABLE 2  
 SURVEY OF AUXOLOGICAL VARIANCE AND GROWTH STANDARDS FOR THE SAUDI PRE-SCHOOL IN RIYADH  
 BOYS PERCENTILES

AGE GROUP ANTHROPOMETRIC MEASUREMENTS (NUMBER)	MIN	3RD	5TH	10TH	25TH	50TH	75TH	90TH	95TH	97TH	MAX
BIRTH	21.2	24.3	30.3	40.0	40.0	49.0	51.6	54.0	54.5	56.0	57.0
(122)	1.9	2.0	2.0	2.0	2.0	3.3	3.8	4.2	4.7	4.8	5.4
HEAD CIRCUMFERENCE (CM)	15.0	15.5	17.3	24.0	24.0	30.0	36.0	37.0	38.0	38.0	39.0
CHEST CIRCUMFERENCE (CM)	20.0	23.0	24.0	27.0	30.0	31.5	34.0	35.0	36.0	37.0	38.5
1-2.99 MO.	46.0	50.5	51.5	52.8	54.9	57.0	58.8	60.3	61.3	62.5	64.5
HEIGHT (CM)	2.0	3.1	3.6	4.0	4.4	5.0	5.4	5.8	6.2	6.4	6.9
WEIGHT (KG)	32.0	35.0	36.0	36.4	37.5	38.0	39.2	40.0	41.0	41.0	44.0
HEAD CIRCUMFERENCE (CM)	30.0	33.0	34.0	34.8	35.7	37.0	38.6	40.0	41.0	41.5	48.0
CHEST CIRCUMFERENCE (CM)	49.0	55.8	57.1	58.3	60.0	62.0	64.0	66.1	67.5	68.0	78.3
3-5.99 MO.	3.1	4.5	4.8	5.0	5.7	6.3	6.9	7.6	8.0	8.4	9.7
HEIGHT (CM)	29.0	37.5	38.0	39.0	39.8	40.8	42.0	42.5	43.0	43.6	48.8
WEIGHT (KG)	30.0	36.0	36.0	37.0	38.0	39.6	41.0	42.0	43.0	44.0	53.5
HEAD CIRCUMFERENCE (CM)	48.0	60.0	61.2	62.3	64.9	67.1	69.2	71.4	72.8	73.3	87.9
CHEST CIRCUMFERENCE (CM)	4.0	5.5	6.0	6.3	7.0	7.6	8.3	9.0	9.4	9.8	12.9
HEIGHT (CM)	34.0	39.8	40.0	41.0	42.0	43.0	44.0	45.0	45.5	46.0	47.5
WEIGHT (KG)	31.1	38.0	38.5	39.0	41.0	42.0	44.0	45.0	46.0	46.5	48.0
HEAD CIRCUMFERENCE (CM)	49.0	64.0	65.4	67.0	69.0	71.0	73.1	75.0	76.6	77.7	88.0
CHEST CIRCUMFERENCE (CM)	4.3	6.6	6.9	7.2	7.9	8.5	9.3	10.2	10.8	11.0	15.0
HEIGHT (CM)	35.0	42.0	42.0	43.0	43.8	44.8	45.8	46.5	47.0	47.2	48.8
WEIGHT (KG)	35.0	40.0	40.8	41.1	42.5	44.0	45.0	47.0	48.0	48.0	51.0
HEAD CIRCUMFERENCE (CM)	35.0	40.0	40.8	41.1	42.5	44.0	45.0	47.0	48.0	48.0	51.0
CHEST CIRCUMFERENCE (CM)											

TABLE 3  
 SURVEY OF AUXOLOGICAL VARIANCE AND GROWTH STANDARDS FOR THE SAUDI PRE-SCHOOL IN RIYADH  
 BOYS PERCENTILES

AGE GROUP (NUMBER)	ANTHROPOMETRIC MEASUREMENTS	M(N)	3RD	5TH	10TH	25TH	50TH	75TH	90TH	95TH	97TH	MAX
1-1.99 YEAR (260)	HEIGHT (CM)	64.5	71.3	72.0	73.5	75.4	79.0	82.0	86.5	87.5	90.0	100.0
	WEIGHT (KG)	7.0	7.8	8.0	8.7	9.6	10.0	11.0	12.6	13.0	14.0	16.0
	HEAD CIRCUMFERENCE (CM)	37.5	43.0	44.0	44.5	45.0	46.1	47.2	48.5	49.4	50.0	53.0
	CHEST CIRCUMFERENCE (CM)	37.5	42.0	43.0	44.0	45.5	47.0	48.5	50.0	51.0	52.0	55.0
2-2.99 YEAR (223)	HEIGHT (CM)	72.5	79.0	80.0	82.5	85.0	88.8	92.0	95.8	98.0	101.0	118.5
	WEIGHT (KG)	9.0	9.5	10.0	10.6	11.0	12.5	13.7	15.0	16.0	16.0	18.0
	HEAD CIRCUMFERENCE (CM)	43.5	45.0	45.2	46.0	47.0	48.0	49.0	50.0	50.4	51.0	52.0
	CHEST CIRCUMFERENCE (CM)	41.3	45.0	45.2	46.0	47.5	49.0	50.0	52.0	52.5	53.0	55.0
3-3.99 YEAR (216)	HEIGHT (CM)	83.0	87.8	89.0	90.0	92.0	95.5	98.1	101.2	104.3	108.0	128.1
	WEIGHT (KG)	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	25.5
	HEAD CIRCUMFERENCE (CM)	45.0	46.0	46.0	47.0	47.8	49.0	50.0	51.0	51.0	52.0	53.0
	CHEST CIRCUMFERENCE (CM)	6.5	46.0	47.0	47.5	49.0	50.0	51.5	53.0	53.5	54.5	60.0
4-5 YEARS (213)	HEIGHT (CM)	74.9	90.0	91.0	93.0	97.3	102.0	106.0	111.2	121.0	139.0	140.8
	WEIGHT (KG)	10.0	12.0	12.5	13.0	14.0	15.0	17.0	18.0	20.0	20.5	22.2
	HEAD CIRCUMFERENCE (CM)	45.0	46.0	47.0	47.0	48.0	49.0	50.1	51.0	52.0	52.4	54.0
	CHEST CIRCUMFERENCE (CM)	44.0	47.0	48.0	49.0	50.0	51.0	53.0	55.0	55.5	57.0	59.0

TABLE 4  
 SURVEY OF AUXOLOGICAL VARIANCE AND GROWTH STANDARDS FOR THE SAUDI PRE-SCHOOL IN RIYADH  
 GIRLS PERCENTILES

AGE GROUP (NUMBER)	MIN	3RD	5TH	10TH	25TH	50TH	75TH	90TH	95TH	97TH	MAX	
BIRTH (97)	HEIGHT (CM)	30.1	31.7	33.3	40.0	40.0	49.0	51.6	53.4	54.1	64.3	
	WEIGHT (KG)	1.7	2.0	2.0	2.0	2.5	3.2	3.8	4.0	4.3	5.7	
	HEAD CIRCUMFERENCE (CM)	12.0	16.2	22.0	23.0	25.0	30.5	36.0	37.0	37.0	37.1	38.0
	CHEST CIRCUMFERENCE (CM)	15.0	21.0	22.0	25.0	30.0	30.0	34.0	35.0	36.0	37.0	37.0
1-2.99 MO. (310)	HEIGHT (CM)	40.0	49.4	50.2	51.5	53.6	55.7	57.5	59.0	60.5	62.3	66.6
	WEIGHT (KG)	2.0	3.1	3.2	3.6	4.0	4.5	5.1	5.6	6.0	6.8	8.0
	HEAD CIRCUMFERENCE (CM)	25.0	35.0	35.0	35.5	36.5	37.5	38.0	39.0	39.5	40.0	45.0
	CHEST CIRCUMFERENCE (CM)	30.0	31.5	32.1	33.5	35.0	36.0	37.0	38.5	39.5	40.0	43.0
3-5.99 MO. (784)	HEIGHT (CM)	45.0	55.2	55.6	56.7	58.5	60.5	62.5	64.6	66.0	67.2	77.5
	WEIGHT (KG)	3.3	4.4	4.5	4.8	5.3	5.8	6.5	7.1	7.7	8.0	10.0
	HEAD CIRCUMFERENCE (CM)	25.0	37.0	37.5	38.0	38.8	39.8	40.5	41.8	42.2	42.5	54.0
	CHEST CIRCUMFERENCE (CM)	30.0	35.0	35.5	36.0	37.0	38.5	40.0	41.5	42.0	43.0	54.0
6-8.99 MO. (595)	HEIGHT (CM)	43.4	58.7	60.0	61.5	63.6	65.5	67.6	69.3	70.7	71.5	80.0
	WEIGHT (KG)	4.0	5.4	5.6	6.0	6.5	7.1	7.9	8.6	9.0	9.3	12.0
	HEAD CIRCUMFERENCE (CM)	35.0	39.0	39.5	40.0	41.0	42.0	43.0	44.0	44.5	45.0	47.0
	CHEST CIRCUMFERENCE (CM)	35.0	37.0	38.0	38.8	40.0	41.0	42.5	44.0	44.5	45.0	48.0
9-11.99 MO. (619)	HEIGHT (CM)	50.1	62.5	63.9	65.5	67.6	69.5	71.8	73.8	75.3	76.6	95.8
	WEIGHT (KG)	4.1	6.3	6.5	6.9	7.5	8.1	8.8	9.7	10.0	10.4	14.9
	HEAD CIRCUMFERENCE (CM)	35.0	41.0	41.0	42.0	42.8	43.5	44.5	45.0	46.0	46.0	49.0
	CHEST CIRCUMFERENCE (CM)	33.0	39.0	40.0	40.0	41.5	43.0	44.0	46.0	47.0	47.5	50.5

TABLE 5  
SURVEY OF AUXOLOGICAL VARIANCE AND GROWTH STANDARDS FOR THE SAUDI PRE-SCHOOL IN RIYADH

AGE GROUP (NUMBER)	ANTHROPOMETRIC MEASUREMENTS	GIRLS PERCENTILES										
		MIN	3RD	5TH	10TH	25TH	50TH	75TH	95TH	97TH	90TH	MAX
1-1.99 YEAR (304)	HEIGHT (CM)	23.5	67.0	69.0	70.0	73.6	77.7	81.2	85.0	88.0	91.5	114.0
	WEIGHT (KG)	6.0	7.1	7.5	8.0	9.0	10.0	10.0	12.0	13.0	13.6	16.0
	HEAD CIRCUMFERENCE (CM)	35.2	40.5	42.0	43.0	44.0	45.5	47.0	48.0	48.5	49.0	53.0
	CHEST CIRCUMFERENCE (CM)	30.0	40.0	41.0	42.5	44.0	46.0	47.5	48.5	50.0	50.2	53.0
2-2.99 YEAR (200)	HEIGHT (CM)	74.0	78.1	79.8	81.0	84.0	87.3	91.0	94.0	98.0	103.6	122.8
	WEIGHT (KG)	9.0	9.0	10.0	10.9	11.0	12.0	13.0	14.0	14.3	15.0	16.0
	HEAD CIRCUMFERENCE (CM)	41.0	44.0	45.0	45.0	46.0	47.0	48.0	49.0	49.5	50.0	53.0
	CHEST CIRCUMFERENCE (CM)	42.0	44.0	45.0	45.5	46.5	48.0	49.0	50.0	50.5	51.9	53.0
3-3.99 YEAR (195)	HEIGHT (CM)	74.7	83.0	86.0	89.0	91.1	93.8	97.3	101.2	104.5	113.0	140.0
	WEIGHT (KG)	8.0	10.0	11.0	11.0	12.0	14.0	15.0	16.0	17.0	19.0	20.0
	HEAD CIRCUMFERENCE (CM)	43.0	45.0	45.0	45.8	47.0	48.0	49.0	50.0	50.0	50.5	51.5
	CHEST CIRCUMFERENCE (CM)	43.0	45.0	45.5	46.0	47.5	49.0	50.0	52.0	54.0	54.5	64.0
4-5 YEARS (216)	HEIGHT (CM)	73.7	91.0	92.6	94.5	98.0	101.0	104.0	108.0	110.0	112.6	132.0
	WEIGHT (KG)	10.0	12.0	12.0	13.0	14.0	15.0	16.5	18.0	19.0	20.0	27.0
	HEAD CIRCUMFERENCE (CM)	45.0	45.8	46.0	46.5	47.5	49.0	49.7	50.5	51.0	51.4	58.0
	CHEST CIRCUMFERENCE (CM)	45.0	46.0	47.5	47.5	49.0	50.1	52.0	54.0	55.0	55.5	64.3



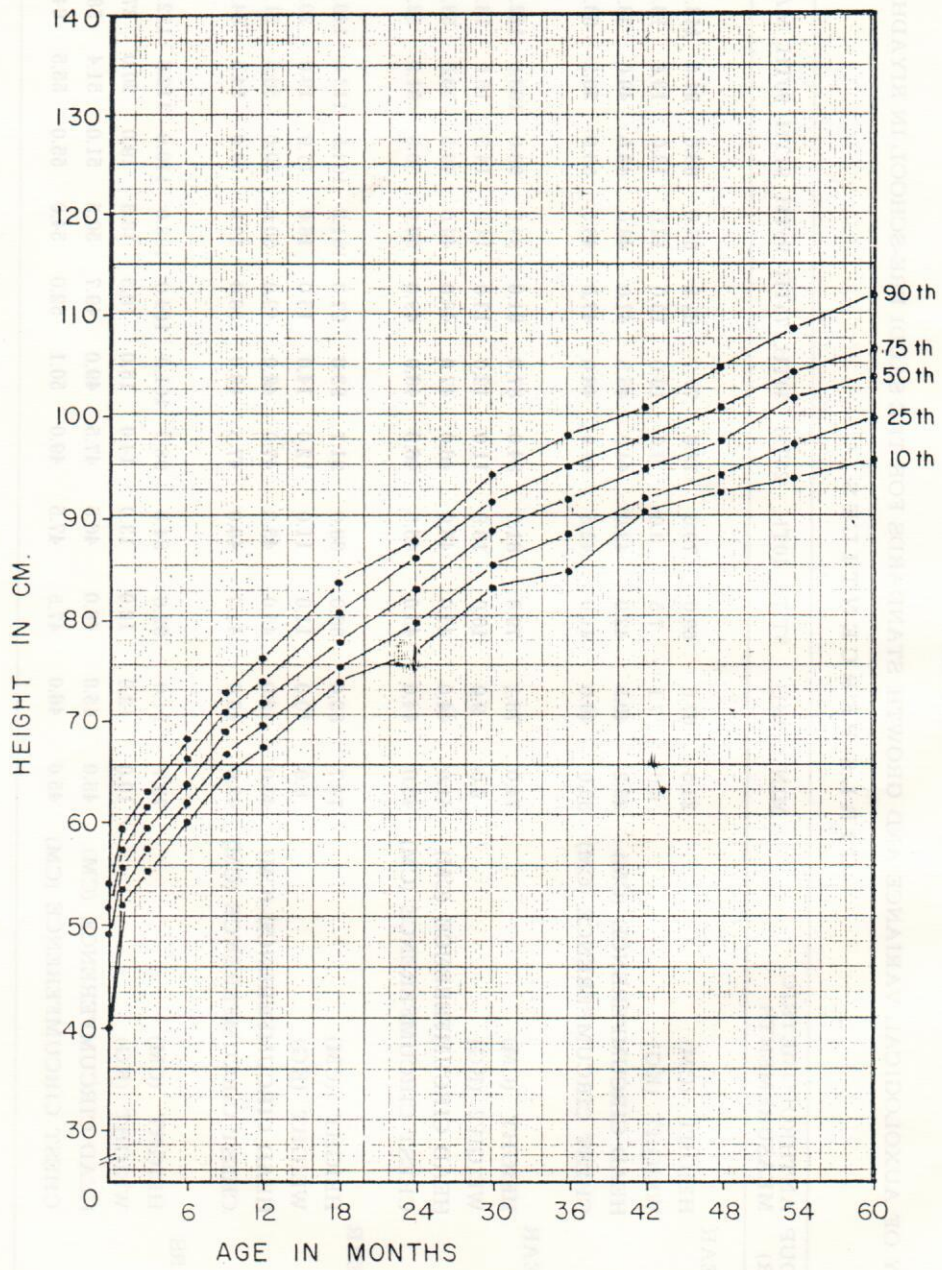


Fig. 1. Height by age percentiles of Saudi boys.

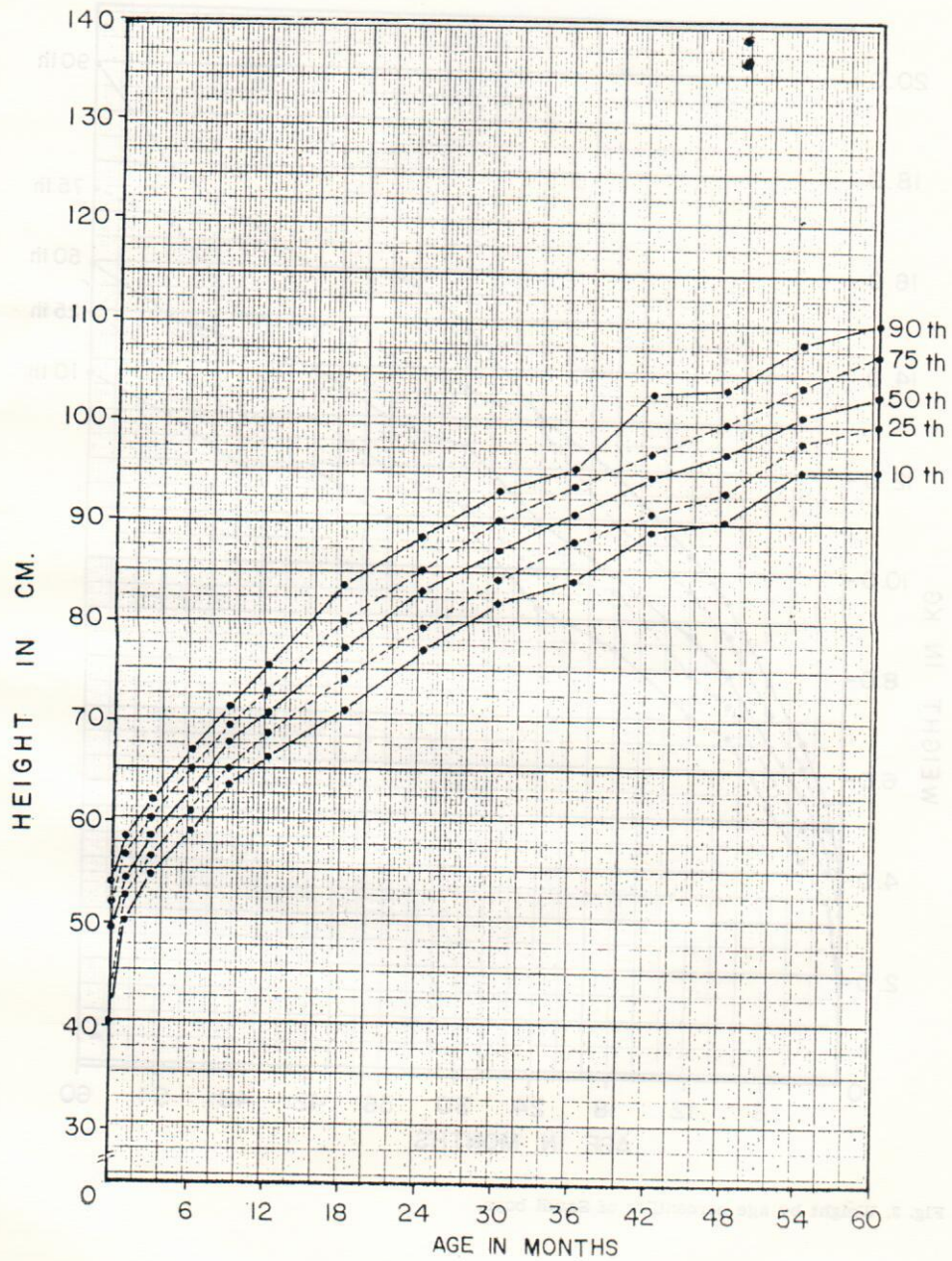


Fig. 2. Height by age percentiles of Saudi girls.

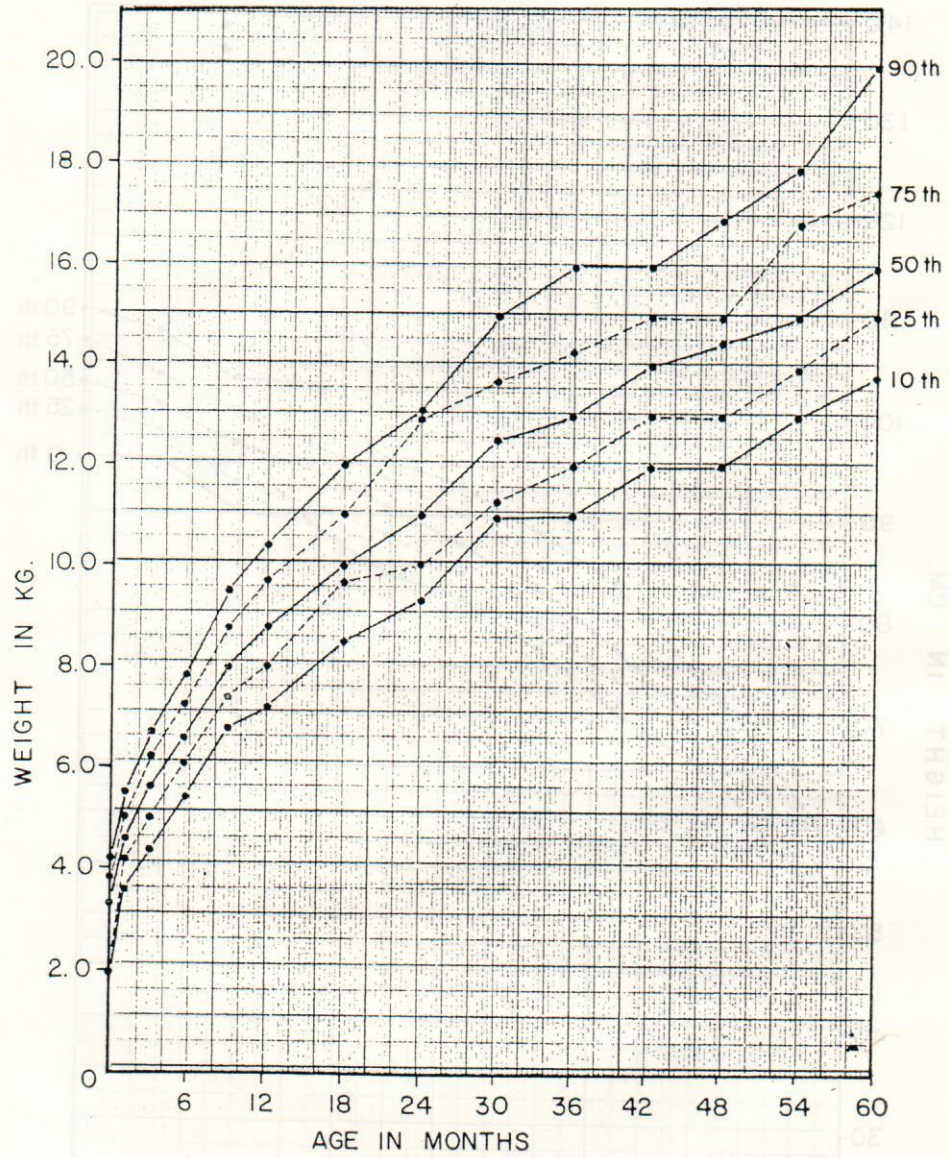


Fig. 3. Weight by age percentiles of Saudi boys.

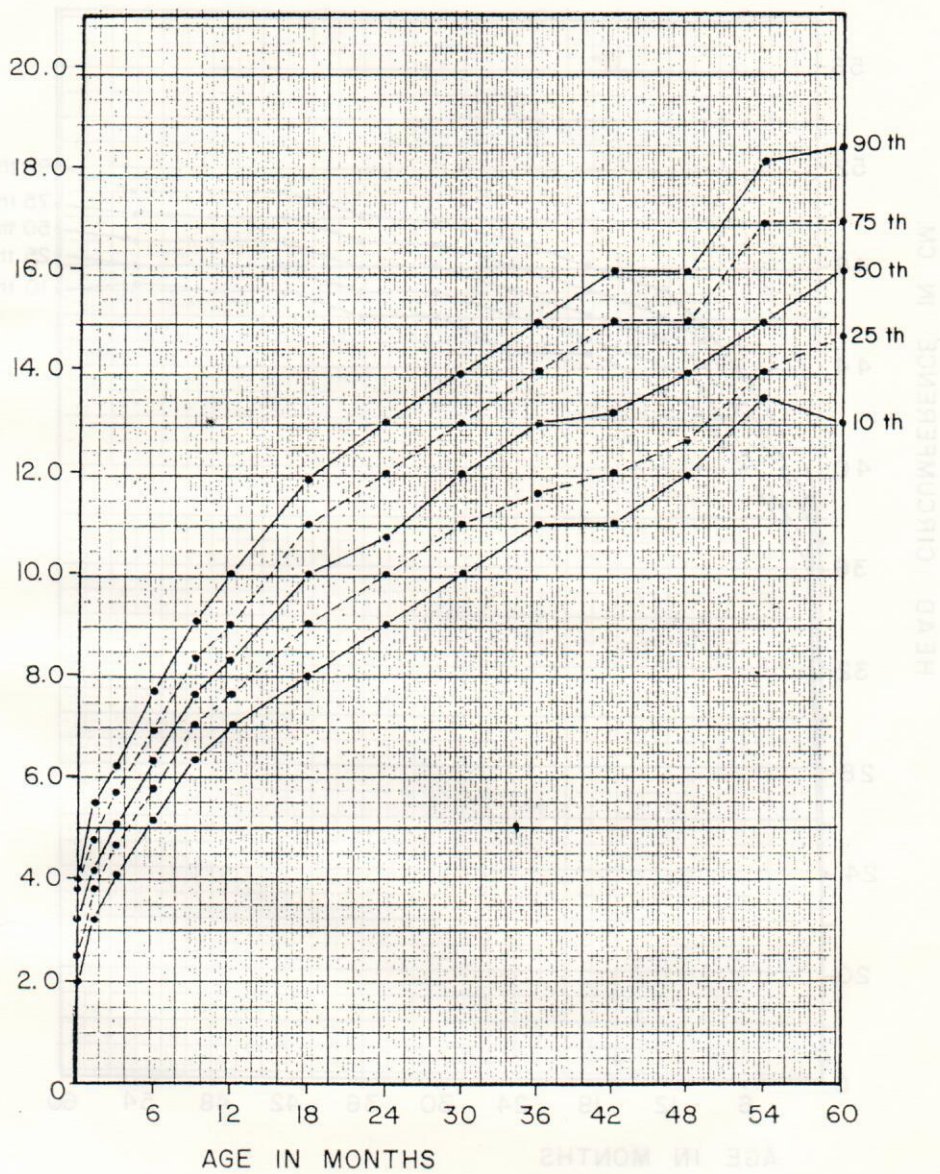


Fig. 4. Weight by age percentiles of Saudi girls.

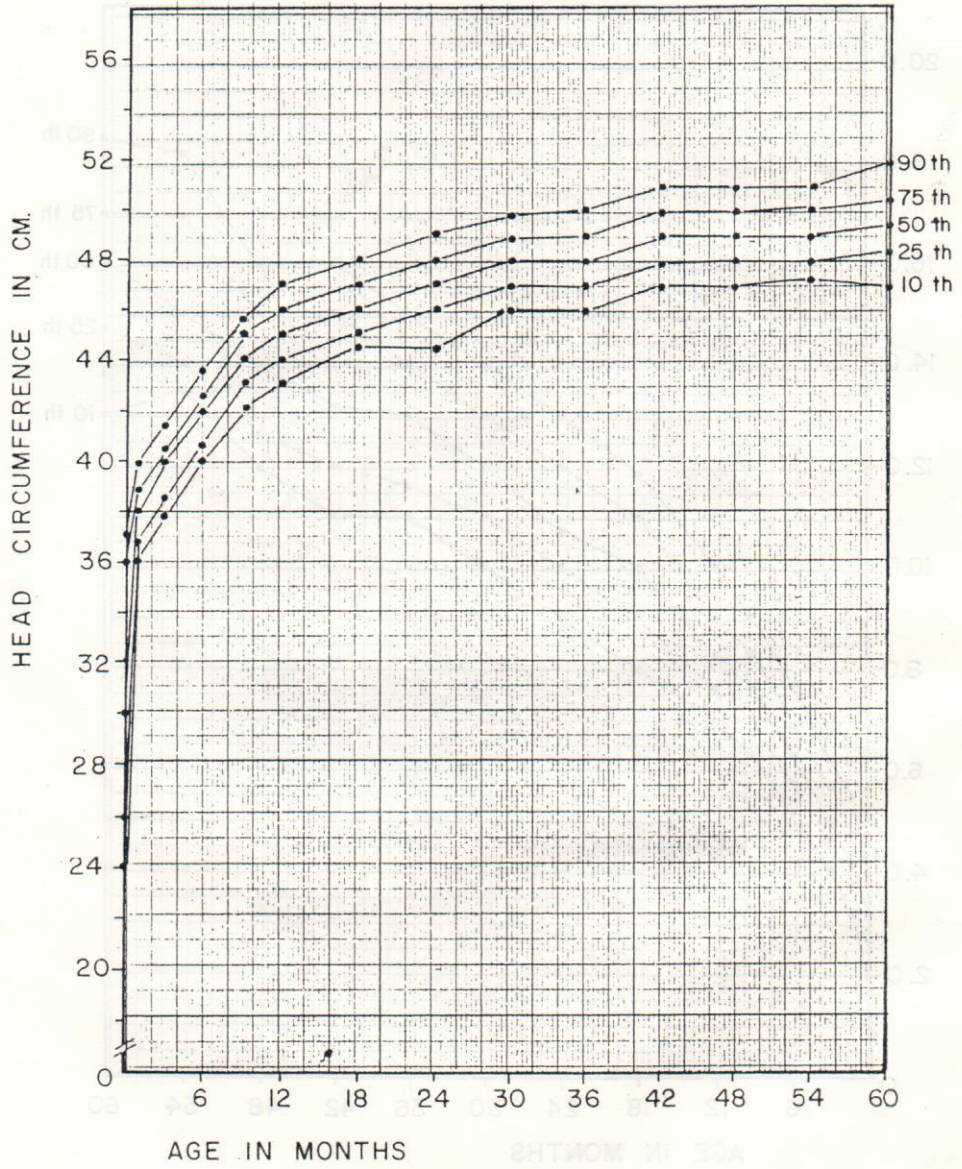


Fig. 5. Head circumference by age percentiles of Saudi boys.

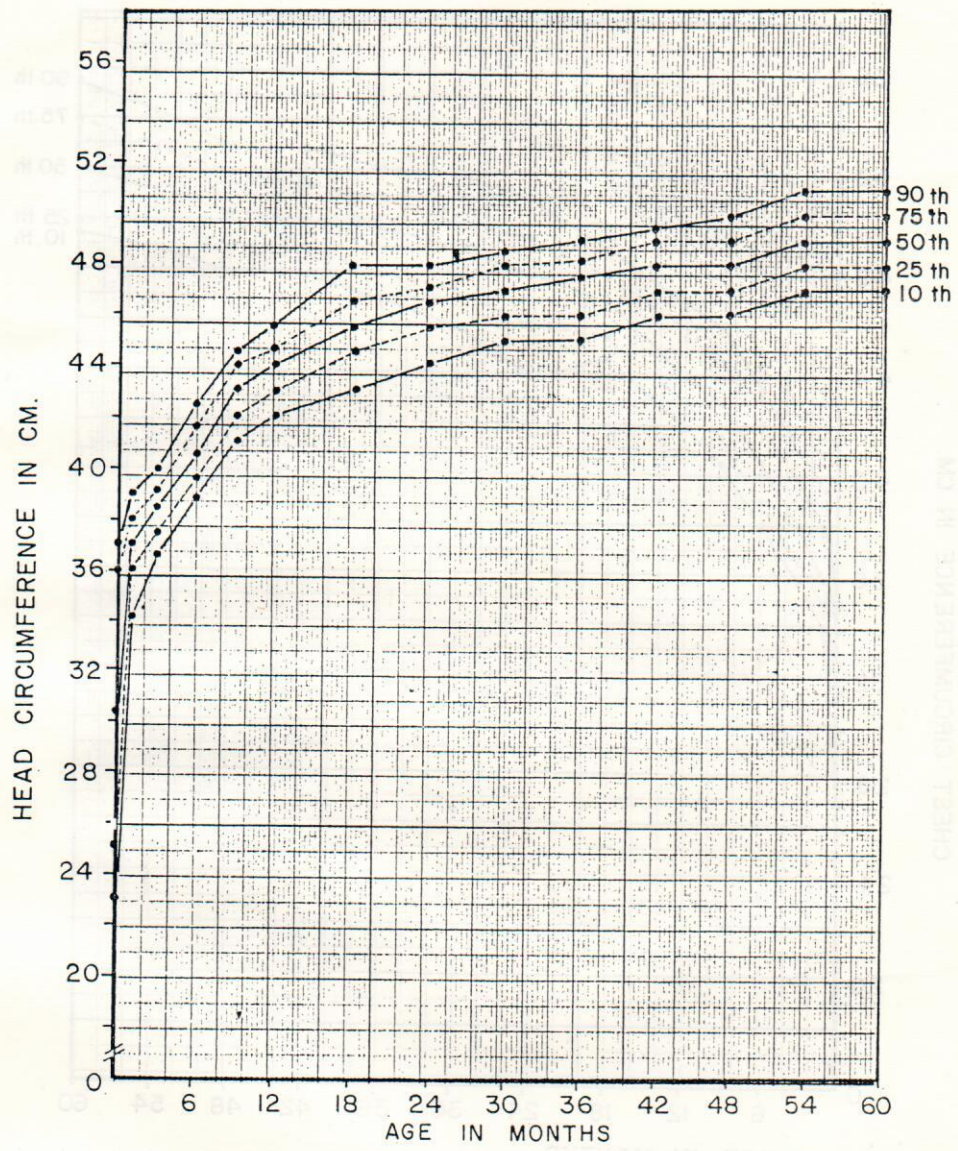


Fig. 6. Head circumference by age percentiles of Saudi girls.

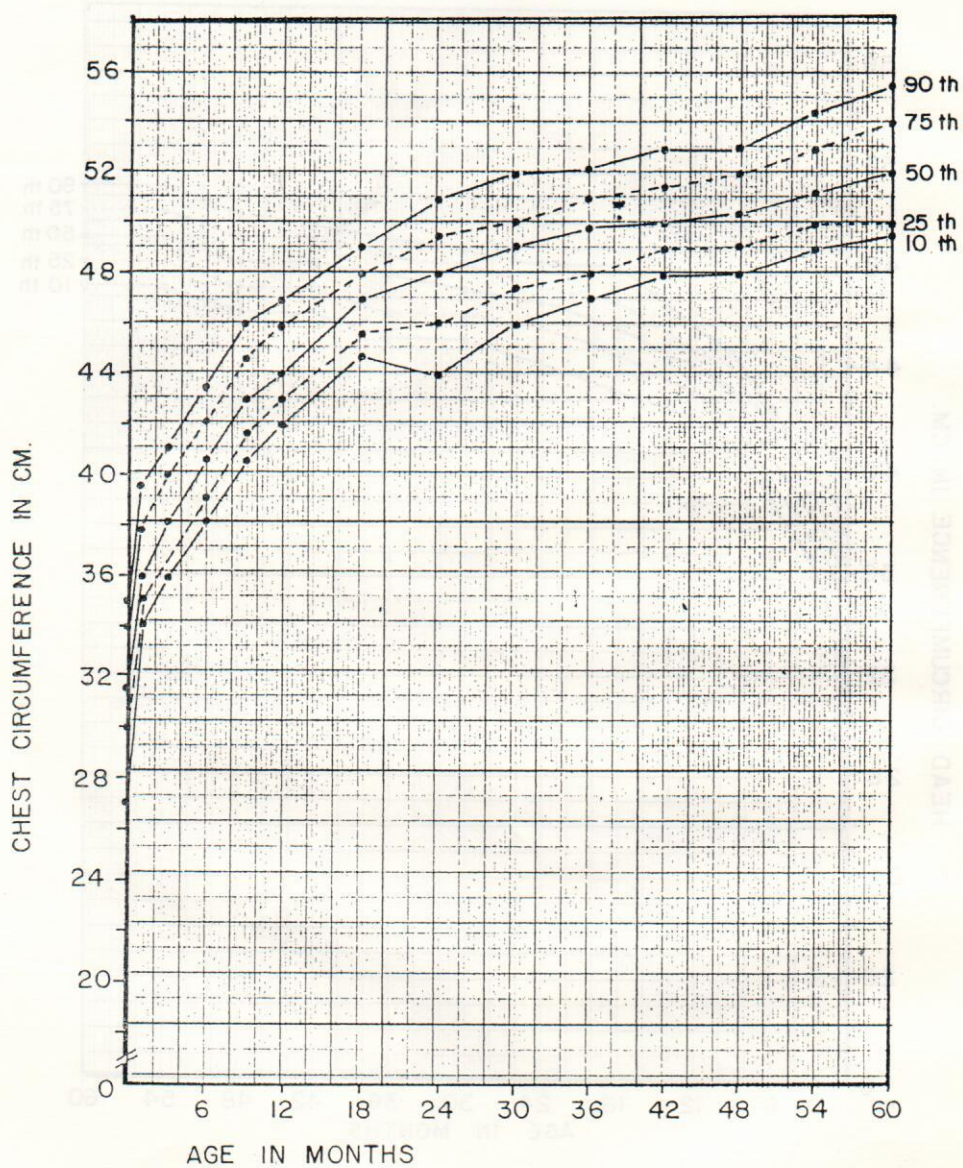


Fig. 7. Chest circumference by age percentiles of Saudi boys.

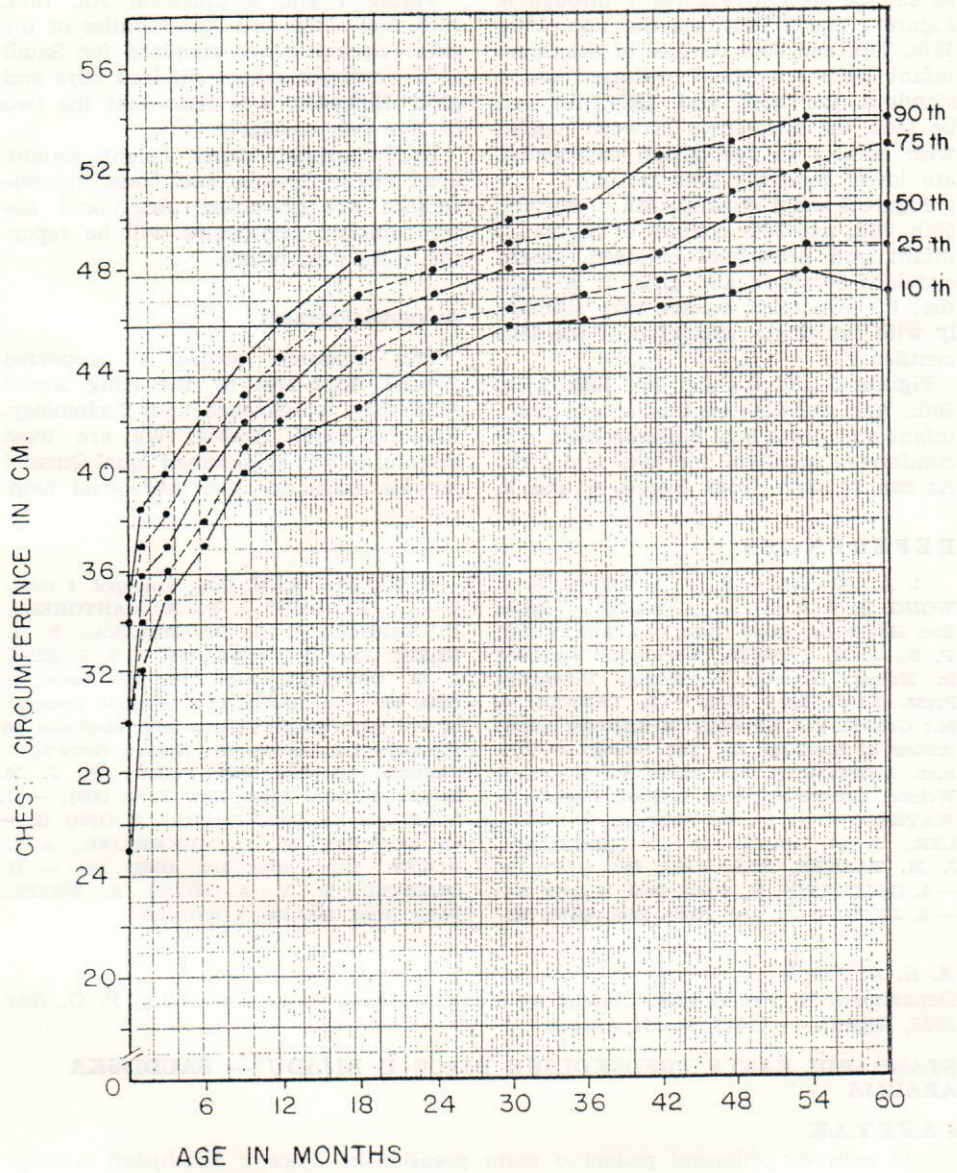


Fig. 8. Chest circumference by age percentiles of Saudi girls.



Differences are least in the two sexes, as can be seen in Figures 1 through 8. Figure 1 and 2 illustrate the 10th, 25th, 50th, 70th and 90th centiles of the Saudi infant and pre-school children height standard for boys and girls. As can be seen, the differences between height, with respect to age group in months, are lower for girls than for boys.

Figure 3 and 4 illustrate 5th, 10th, 25th, 50th, 70th and 90th centiles of the Saudi infant and pre-school children weight standard for boys and girls. It is clear that the two sexes behave very similarly with the single exception of the 95th centile.

Figures 5 and 6 show 5th, 10th, 25th, 50th, 70th and 90th centiles of the Saudi infant and pre-school children head circumference standard for boys and girls. As can be seen from figures 5 and 6,

the two sexes behave very similarly.

Figure 7 and 8 illustrate 5th, 10th, 25th, 50th, 70th and 90th centiles of the chest circumference standard for Saudi infant and pre-school children boys and girls. However, it is clear that the two behave very similarly.

In the present paper, height, weight, head circumference, and chest circumference are presented. Additional anthropometric dimensions will be reported in the near future.

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#### STANDARDI RASTA PREDŠKOLSKE DJECE U RIJADU — SAUDIJSKA ARABIJA

##### SAŽETAK

U radu su prikazani podaci o rastu predškolske djece u Saudijskoj Arabiji. Istraživanje rasta i razvoja predškolske djece provodi se u Rijadu s ciljem uspostavljanja normalnih vrijednosti za predškolsku djecu u Saudijskoj Arabiji. Uzorak uključuje 6400 predškolske djece, od mjesec dana do 5 god. na starosti. Mjerene varijable uključuju visinu (cm), težinu (kg), opseg glave (cm) i opseg grudnog koša u dječaka i djevojčica.

Glavni cilj rada je uspostavljanje standarda rasta za predškolsku djecu u Saudijskoj Arabiji na temelju mjerenja vršenih na statistički odgovarajućem uzorku zdrave i dobro uhranjene djece u Rijadu.