

## Sudanese Standard Curves for Intrauterine Growth

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### SUMMARY

Intrauterine growth parameters of birth weight, crown-heel length and head circumference were obtained for six hundred and fifty single newborn Sudanese infants of gestational age of 28-44 weeks. All were born in hospitals in Khartoum to healthy mothers from different social classes and different ages.

The gestational age was calculated depending on the last menstrual period. All mothers included were sure of their dates.

Mean birth weight, crown-heel length and head circumference, with standard deviation were obtained for each gestational age where the percentiles could be obtained at term only.

At week 40 mean birth weight ( $\pm$  SD) was  $3087 \pm 439$  gm, mean crown-heel length ( $\pm$  SD) was  $49.3 \pm 2.4$  cm and mean head circumference ( $\pm$  SD) was  $34.5 \pm 1.1$  cm while the 50<sup>th</sup> percentile were 3050 gm, 49.3 cm, and 34 cm for girls and 3050 gm, 49.3 cm and 35 cm for boys respectively.

It is suggested that the best curves of birth weight, crown-heel length and head circumference obtained represent the normal growth parameters for Sudanese newborns.

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## INTRODUCTION

There was considerable interest in perinatal biology, which necessitated construction of intrauterine growth chart. It was pointed by Yerushalmy, J. (1) that anthropometric measurements of weight, length and circumference of the head and chest drawn against gestational age provided adequate assessment for intrauterine growth. However, it has been well documented that these measurements are affected by variety of determinants that should be taken in consideration. These factors include sex of the baby, race, parity, Bjerkedal, T. (2) Freeman, M.G. Graves, W.I & Thompson, R.I (3) maternal age, maternal height and weight, socioeconomic level, maternal nutrition and altitude. Ounsted, M. (4). Also marital status, smoking together with medical diseases associated with pregnancy are important factors. During the last four decades curves for intrauterine growth have been constructed for many population including English, American, Lubchenco, L.O. Hausman, C. Dressler, M & Boyd, T. (5). Chinese, Henrietta, M. (6), Swedish, Sterky, G. (7) Danish, Ulrich, M. (8) & Nigerian, Olowe, S. (9). Similar detailed measurements of intrauterine growth of Sudanese babies at different gestational ages have not been reported, such information is needed to identify different categories of small babies with special needs for their appropriate management. These charts should be derived from the very population for which they are meant to be used. Olowe, S. 99).

A prospective study based on deliveries in two main hospitals in Khartoum, was conducted to obtain a mean birth weight, crown-heel length and head circumference for each week of gestation and hence to draw the curves of birth weight, crown-heel length and head circumference against gestational ages.

## MATERIAL AND METHODS

This study was conducted in two main hospitals in Khartoum state, Khartoum Teaching Hospital (K.T.H.) and Soba University Hospital (S.U.H.) between the first of March and thirty first of December, 1982.

Khartoum being the capital, centrally located and densely populated was chosen for it's good facilities and large number of hospital deliveries.

It's resided by people coming from all parts of the country and are composed of different social strata. K.T.H. & S.U.H. are the biggest hospitals in the country, receiving women of risk and normal pregnancy. Normal labour tend to occur in hospitals more than in the past due to the rise of the health standard of the public. The mothers are coming from different

social classes; upper class whose husbands are professionals, merchants and businessmen; middle class whose husbands are employees and military people and lower class whose husbands are worker.

All single livebirth in both hospitals during that period without any obvious congenital abnormalities were included.

The inclusion criteria was as follows:

1. Both parents are Sudanese.

1. The mothers were very sure of their date of last menstrual period L.M.P.

The mothers have regular cycles of 21 – 35 days duration and must have experienced at least two normal periods before this pregnancy.

1. If the mothers have any serious medical complications during pregnancy that known to cause intrauterine growth retardation such as; preclampsia, hypertension, diabetes, chronic nephritis, anaemia, severe malnutrition and other debilitating diseases.

2. If the mothers were smokers.

3. Congenital malformation in newborns.

4. Multiple pregnancy

Gestational age was calculated in completed weeks according to the recommendation of WHO experts on health statistics. American Academy of Paewdiatrics(10).

### **Definitions:**

Preterm babies means babies born before 37 weeks of gestation.

Term babies means babies born between 37 weeks to 42 weeks of gestation.

Post term babies means babies born after 42 weeks of gestation.

### *Measurements*

For each baby admitted to the study a birth history form was filled by the author or one of two nurses. The measurements were then taken. The two nurses were instructed and trained sufficiently for measurement. All babies were measured completely naked within the first twenty four hours of birth.

The birth weight was determined using the nursery baby scale, the Cherub (manufactured by Herbert and sons Ltd. Angle RD Edmenton, London, W. 18) that have an accuracy of up to 10 gm. And was checked before hand and adjusted to zero point each day.

The crown-heel length was determined with the infant lying supine and the legs were fully extended by pressing down on the knees; using the neonatometer, the Holtain neonatometer (manufactured by Holtain Limited crymych, pemp, U.K.) that can read to the nearest millimeter.

The head circumference was determined using a non-stretchable tape that can read to the nearest millimeter. Head was measured around the largest occipitofrontal circumference.

For obtaining the curves of birth weight, crown-heel length and head circumference by weeks of gestation, a computer was used to obtain the graphs with 95% confidence bands around, using the least square method.

## RESULTS

A total of 650 newborns were studied, babies born before 37 weeks (preterm) were 57 (8.8%), 550 (84.6%) babies were born at term (37-42 weeks). The post term (>42 weeks) were 43 (6.6%); males were 342 (52.6%) and females were 308 (47.4%) Table (1).

The mean and one standard deviation of actual measurements of birth weight, crown-heel length and head circumference at different stages of gestation are shown in table z(2); however only the percentile (10<sup>th</sup>, 50<sup>th</sup> and 90<sup>th</sup>) of birth weight, crown-heel length and head circumference respectively from week 37 to 44 could be obtained and due to small sample size in weeks 37, 43 and 44 combined percentiles were calculated for both sexes, table (3) a, b and c.

Fig. (1) shows the smoothed graph of the means of birth weight against weeks of gestation with 95% confidence bands around shown on the figure as a dotted line. The equation obtained of the graph of birth weight is  $-3059 + 152.29$  weeks.

Fig. (2) shows the smoothed graph of the means of crown-heel length with 95% confidence bands around, shown on the figure as a dotted line. The equation obtained of the graph of crown-heel length is  $9.7 + 0.99$  weeks.

Fig. (3) shows the smoothed graph of means of head circumference against weeks of gestation with 95% confidence bands around; shown on the graph as a dotted line. The equation obtained of the graph of head circumference is  $7.78 + 0.665$  weeks.

Table 1

Distribution of the newborn by sex and gestational age

Weeks of Gestation	Males %	Females %
Total		
28	2 (0.31)	5 (0.77)
29	5 (0.77)	6 (0.92)
30	1 (0.15)	5 (0.77)
31	4 (0.62)	7 (1.08)
32	3 (0.46)	5 (0.77)
33	1 (0.15)	5 (0.77)
34	7 (1.08)	8 (1.23)
35	1 (0.15)	7 (1.08)
36	5 (0.77)	9 (1.39)
37	13(.2)	30(4.62)
38	27(4.15)	45(6.92)
39	50(7.69)	103(15.84)
40	79(12.15)	162(24.92)
41	77(11.85)	134(21.39)
42	41(6.31)	71(10.93)
43	17(2.62)	28(4.31)
44	9(1.39)	15(2 )
TOTAL	342(52.6)	650 (100)

**Table 2**  
**Mean and Standard Deviation of Birth Weight**  
**Crown-heel length and Head Circumference By Gestational Age**

N.	Weeks of Gestation	Birth Weight		Crown-heel Length (cm)		Head Circumference (cm)	
		Mean	SD	Mean	SD	Mean	SD
5	28	1100	187	34.2	1.1	24.3	1.3
6	29	1066	79	36	1.7	25.2	2.3
5	30	1142	64	34.9	0.3	23.3	0.8
7	31	1454	298	40.6	3.2	29.7	3.5
5	32	1914	349	45.1	1.9	32.5	2.1
5	33	2144	692	44.2	3.8	30.2	3
7	34	2228	484	45.4	3.6	30.7	2.4
7	35	2586	135	49.1	0.8	34.3	0.4
9	36	2793	538	47.9	3.9	33.4	2.2
30	37	2778	561	48.1	2.9	33.7	2.2
45	38	3018	466	49.7	2.5	34.2	1.8
103	39	3081	501	49.3	2.3	34.2	1.3
162	40	3087	439	49.3	2.4	34.5	1.1
139	41	3224	431	50.2	2.0	34.9	1.3
71	42	3165	505	50.1	1.9	35.0	1.3
28	43	3223	559	50.5	2.6	34.8	1.7
15	44	3197	321	49.9	2.0	34.5	1.0

**Table 3.a**  
**Percentiles of birth weight by sex and gestational age**

		BIRTH WEIGHT					
		10 <sup>th</sup> Percentile		50 <sup>th</sup> Percentile		90 <sup>th</sup>	
Weeks of Gestation	Percentile	M	F	M	F	M	F
	37	2007		2810		3483	
38	2256	2285	3000	2900	3640	3710	
39	2540	2300	3125	3000	3998	3580	
40	2500	2612	3050	3050	3700	3700	
41	2578	2630	3240	3200	3910	3755	
42	2470	2565	4200	3090	4080	3737	
43	293		3200		3781		
44	2660		3300		3556		

M : Male  
 F : Female



Table 3.b

Percentiles of crown-heel length by sex and gestational age

Weeks of Gestation	CROWN-HEEL LENGTH (cm)					
	10 <sup>th</sup> Percentile		50 <sup>th</sup> Percentile		90 <sup>th</sup> Percentile	
	M	F	M	F	M	F
37	44.6		48.4		51.5	
38	45.2	47.4	50.5	49.8	52.8	51.8
39	46.9	46.0	50.0	49.0	53.0	52.3
40	47	47	49.3	49.1	52.0	52.6
41	48.1	47.5	50.1	50	52	52.5
42	47.5	48.1	50.2	50.1	52.1	51.5
43	48.0		50.9		53.6	
44	46.9		50		52.9	

M : Male  
 F : Female

Table 3.c

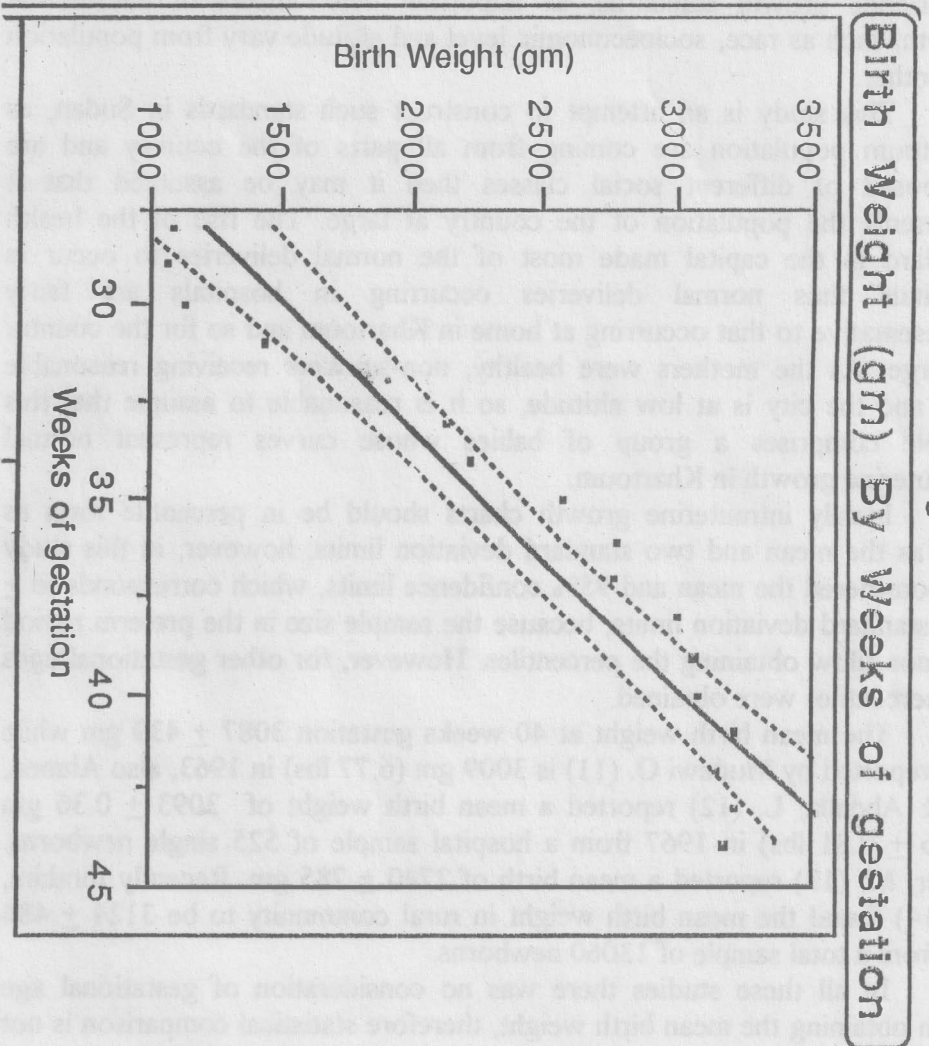
Percentiles of head circumference by sex and gestational age

Weeks of Gestation	HEAD CIRCUMFERENCE (cm)					
	10 <sup>th</sup> Percentile		50 <sup>th</sup> Percentile		90 <sup>th</sup> Percentile	
	M	F	M	F	M	F
37	31.1		33.7		36	
38	30.9	31	34.4	34.3	36.7	36.1
39	33	31.9	34.5	36.1	36.1	35.5
40	33	33	35	34	36	36
41	33	33	35	35	37	36
42	33	33.1	35	34.7	37	36
43	33.0		34.0		37.1	
44	33.3		34.4		36.5	

M: Male

F: Female

Fig.(11)



## DISCUSSION

Olowe, S (9) pointed out that morbidity of any population depends, to a large extent, on gestation and size of a baby at birth. Proper classification and management of neonate therefore requires the use of valid intrauterine growth standards, as important determinants of intrauterine growth, such as race, socioeconomic level and altitude vary from population to another.

This study is an attempt to construct such standards in Sudan, as Khartoum population are coming from all parts of the country and are composed of different social classes then it may be assumed that it represents the population of the country at large. The rise of the health standard in the capital made most of the normal deliveries to occur in hospitals thus normal deliveries occurring in hospitals are fairly representative to that occurring at home in Khartoum and so for the country at large. As the mothers were healthy, non-smokers receiving reasonable care and the city is at low altitude, so it is reasonable to assume that this sample comprises a group of babies whose curves represent normal intrauterine growth in Khartoum.

Ideally intrauterine growth charts should be in percentile form as well as the mean and two standard deviation limits, however, in this study we considered the mean and 95% confidence limits, which corresponds to  $\pm$  two standard deviation limits, because the sample size in the preterm period will not allow obtaining the percentiles. However, for other gestational ages the percentiles were obtained.

The mean birth weight at 40 weeks gestation  $3087 \pm 439$  gm while that reported by Mudawi O. (11) is 3009 gm (6.77 lbs) in 1963, also Ahmed, N. & Abdalla, L. (12) reported a mean birth weight of  $3093 \pm 0.36$  gm ( $6.96 \pm 0.81$  lbs) in 1967 from a hospital sample of 525 single newborns. Omer, M. (13) reported a mean birth of  $2740 \pm 785$  gm. Recently Ibrahim, S. (14) found the mean birth weight in rural community to be  $3124 \pm 484$  gm from a total sample of 13060 newborns.

In all these studies there was no consideration of gestational age when obtaining the mean birth weight, therefore statistical comparison is not feasible.

In spite of this fact the mean birth weight at week 40 gestation in this study is approximate to that found by Ahmed, N et al (12) and Ibrahim, S. (14), slightly higher than Mudawi, O. (11) and much higher than Omer, M. (13).

It is also invalid to compare a hospital sample with a community one of Ibrahim, S. (14) who, beside not considering gestational age included preterm and twin babies in his study.

There is no significant difference of mean birth at week 40 gestation when compared to Taiwan, Singapore and Hong Kong Chinese, (6) but it is significantly smaller ( $p < 0.001$ ) when compared to Oregon, Baltimore and English series (6) and smaller than that of Nigerian series (9).

Ahmed, N et al (12) found the mean crown-heel length to be  $51.1 + 2.2$  cm ( $20.1 + 0.67$ ) and the mean head circumference to be  $34 \pm 1.2$  cm ( $13 + 0.46$ ) in 1967. These figures although seemed near to the figures of this study but their disregard of the gestational age made statistical comparison to show any kind of difference not possible.

The best curves of the figures of birth weight – crown-heel length and head circumference are obtained by the computer using the least square method, the relation of intrauterine parameters to the weeks of gestation is shown by the equation quoted in the results. It evident that the graphs show the smoothed pattern of increase of parameters with the increase of gestation. For intrauterine growth curves to be useful for detecting deviant fetal growths in a community, it should be derived from sections of that community living in the same conditions. As all mothers involved in the study are healthy and non smoked cigarettes and as the city is of low altitude, therefore the curves obtained in Fig. 1, 2 and 3 represent the normal pattern of intrauterine growth of Sudanese newborns. They are logical, practical and convenient in allocating the positions of the newborns and hence dictating the carte they should have.

#### *ACKNOWLEDGEMENT*

I am greatly indebted to Prof. M. Ibrahim Ali Omer who stimulated, supported and facilitated this study. I am grateful to Prof. Zein Karar for his valuable criticism and comments and to Dr. Gamal Hassan Mohd. For statistical advise and work.

I acknowledge the nurses Nur and Batoul for their help.

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