Original Article

Recent intrauterine growth parameters of term Sudanese neonates in Khartoum compared to the findings three decades earlier

Sirag Eldin M. Kheir Abdel Rahman (1), Ghada O. Ibrahim (2)

(1)   Department of Paediatrics, Alzaiem Alzahri University, Khartoum North, Sudan
(2)   Khartoum North Hospital, Federal Ministry of Health, Sudan

ABSTRACT

The objective of this paper was to present anthropometric measurements of term Sudanese neonates which will reflect intrauterine growth. Secondly, to compare such parameters with that of a previous study done about three decades ago to show if there is any secular changes. Normal term neonates born to healthy mothers between the period of October 2010 to January 2011 at Khartoum Teaching Hospital were included in the study. There were certain criteria for inclusion and exclusion of the newborns and their mothers.

Measurements of birth weight, crown-heel length and head circumferences were done in the first twenty four hours after birth. Statistical test of the difference between the means was used to show any significant difference. The means of birth weight, crown-heel length and head circumference for both sexes against gestational age were obtained. Comparing this study with the previous one showed no statistical significant difference for both sexes regarding the birth weight, crown-heel length but there is some difference between males head circumference. There is no evidence of upward secular trend regarding the intrauterine parameters.

Key words: Intrauterine growth parameters; Newborn; Sudan.

INTRODUCTION

During the last four decades of the last century there was increasing interest in perinatology. This had necessitated the construction of intrauterine growth standards to be as reliable and useful as the standards for weight and height of children after birth [1]. It was pointed that anthropometric measurement of weight, length and circumference of the head and chest drawn against gestational age provided adequate assessment for intrauterine growth [2]. The intrauterine growth is affected by variety of determinants which include sex of the baby, race, parity [3, 4] , maternal age, height and weight, socio-economic level, maternal nutrition and altitude [5, 14]. Marital status, smoking and medical diseases complicating pregnancy are also important factors [14]. Intrauterine growth had been studied

Correspondence to:

Dr. Sirag Eldin M. Kheir,

Department of Paediatrics,

Alzaiem Alzahri University,

Khartoum North, Sudan

E-mail: Sirageldin89@hotmail.com

for many populations [6-10]. Likewise intrauterine growth parameters had been obtained for Sudanese newborns in 1982 [11]. Intrauterine growth curves from Japanese data collected in 1945-1946, 1957-1958 and 1963-1964 has been studied and showed a marked upward secular trend in intrauterine growth [5]. Recently a Canadian study showed secular trend in fetal growth between 1981 and 1997 [12].

During the last three decades a lot of socioeconomic changes had happened in the Sudan. This led to melting and incorporation of the middle class in the low social class. The high class of prosperous people prefers utilizing the private medical services. The low socioeconomic people use the public medical services which were previously utilized by the whole community. Some authors reported a positive relationship between birth weight and socioeconomic status, while others contested that [5, 13, 14].

The objective of this study was to obtain recent intrauterine growth parameters for Sudanese term neonates. This is necessary since the last study was done about three decades ago. It is mentioned that the intrauterine growth parameters should be updated every 5-10 or 15-20 years, as a result of changes not only in parity and maternal age and size, but also in socioeconomic or environmental conditions and obstetrics or neonatal care [12]. The second objective of this study was to compare with the previous study to show if there are secular trends with passage of time.

MATERIAL AND METHODS

This study was conducted in Khartoum Teaching Hospital from October 2010 to January 2011. Khartoum, being the Capital, is centrally located and densely populated with different social strata, and is of low attitude (390 meters above sea level). Khartoum Teaching Hospital was chosen for its good facilities and large number of hospital deliveries (77 deliveries/ week) attended by well trained midwives and doctors. All single live births during that period were included.

The inclusion criteria were:

Both parents are Sudanese

The mother was sure of her date of last menstrual period (LMP)

The mother should have regular cycle of 21-35 days duration and must have experienced at least two normal periods before the pregnancy.

The exclusion criteria were:

If the mother had any serious medical complication during pregnancy that is known to cause intrauterine growth retardation.

If the mother was smoker.

If there was congenital malformation of the newborn or if the sex was not determined.

Multiple pregnancy.

Gestational age was calculated in completed weeks according to the recommendations of the World Health Organization (WHO) Experts on Health Statistics and the American Academy of Pediatrics [15].

Measurements

The data was collected using a typed questionnaire filled by one of the authors. The measurements were taken within the first twenty four hours after birth, the baby being completely naked. The birth weight was determined using standard baby scale that has an accuracy of up to 10 gm, and was checked and adjusted to zero point each day before weighing. The crown-heel length was determined with the newborn lying supine and the lower limbs were fully extended by pressing down on the knees; using the neonatometer that can read to the nearest millimeter. The head circumference was measured using a non-stretchable tape that can read to the nearest millimeter. Head was measured around the largest occipitofrontal diameter.

Statistical Analysis

The means of birth weight, crown-heel length and head circumference of each gestational age were analyzed manually between sexes of the study and compared to

the previous study. The test of significance used for the comparison of the difference between the means was:

$$d = \frac{X_1 - X_2}{\sqrt{\dfrac{S_1 2}{n1} + \dfrac{S_2 2}{n2}}}$$

When (d) is the standard normal variable deviation, (X) is the mean, (n) the number of the sample, and (S) is the standard deviation. Where (d) value is greater or equal to 2.576, the difference is considered statistically significant to P value of less or equal to 0.01; assuming the population in the study is normally distributed. The (d) value showing statistically significant difference is underlined in the tables.

RESULTS

The study included 310 newborns, 159 (51.3%) were males and 151 (48.7%) were females. The mean birth weight, length and head circumference for all neonates (together) were 3.04 kg (2.7 SD), 47.4 cm (2.5 SD) and 34.9 cm (1.6 SD) with range of 1.8 – 3.8 kg, 41.8 – 50.8 cm and 32.9 – 38 cm, respectively (Table 1). The means of birth weight, crown-heel length and head circumference for each gestational age for each sex of the current study are shown in Table 2. It shows also the ponderal index which is > 2 and this indicates that the neonates are of appropriate size for their

gestational ages. The means of birth weight, crown-heel length and head circumference with standard deviation by gestational age for combined sex of the previous study done in 1982 are shown in Table 3. It also shows the parameters for the pre-term neonates which were not done in the current study. Tables 2 and 3 reveal the general pattern of increase of intrauterine parameters with the increase of gestation. Comparison of the means of birth weight of the males between this and the previous study is shown in Table 4A, whereas Table 4B shows the comparison of the females. Both comparisons do not show significant difference as the (d) values are less than 2.576 i.e. the p value is > 0.01. Comparison of the means of males' crown-heel length for each gestational age between the current and previous study is shown in Table 5A, that for the females is shown in Table 5B. Also both comparisons do not show any significant difference. Comparison of means of head circumference of males of each gestational age between this and the previous study is shown in Table 6A. It shows significant difference at weeks 39, 40 and 42 where (d) values are > 2.576 and p value is < 0.01. Comparison of means of head circumference of the females between this and the previous study is shown in Table 6B. It reveals no significant difference except at week 42 (p value is < 0.01).

Table 1 - Mean, range and standard deviations of anthropometric measurements

	Minimum	Maximum	Mean	SD
Weight (kg)	1.8	3.8	3.04	2.8
Length (cm)	41.8	50.8	47.4	2.6
Head circumference (cm)	32.9	38.0	34.9	1.7
PI			2.68	5.0

PI - ponderal index, SD - standard deviation

Table 2 - Anthropometric data by gestational age and sex*

Gestation [weeks]	Sample size		Birth Weight [g]		Birth length [cm]		Head circumference [cm]		Ponderal index	
	M	F	M	F	M	F	M	F	M	F
37	33	39	2.530	2.513	47. 1	47.4	33.8	33.9	2.3498	2.3498
			(.487)	(.420)	(2.02)	(1.76)	(1.32)	(.99)	(.287)	(0.3)
38	55	58	2.971	2.900	48.6	48.6	35.1	34.8	2.4706	3.12
			(.456)	(.532)	2.24) .	(3.99)	(1.22)	(2.58)	(.319)	(4.5)
39	31	22	2.977	2.982	49.3	48.9	35.3	34.9	2.6197	3.8
			(.403)	(.364)	(1.77)	(1.54)	(1.32)	(1.37)	(.627)	(6.3)
40	24	17	3.133	3.018	49.7	49.1	35.8	34.7	2.5397	2.5
			(.429)	(.494)	(1.90)	(1.84)	(1.02)	(1.16)	(.238)	(0.3)
41	9	9	3.289	3.028	49.8	49.9	36.1	35.3	2.6253	2.56
			(.643)	(.436)	(2.20)	(2.20)	(1.19)	(1. 19)	(.191)	(0.2)
42	7	6	3.214	3.117	50.9	50.8	36.7	36.1	2.4272	2.38
			(.397)	(.278)	(1.43)	(2.03)	(.85)	(1.44)	(.196)	(0.2)

M - male, F - female. *Values in parentheses are standard deviation

Table 3 - Mean birth weight, crown-heel length and head circumference with SD by gestational age

n	Weeks of gestation	Birth weight (gm)		Crown-heel length (cm)		Head circumference	
		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	.8
7	31	1454	298	40.6	3.2	29.7	3.5
5	32	1914	349	45.1	1.9	32.5	3.1
5	33	2144	692	44.2	3.8	30.2	3
6	34	2228	484	45.5	3.6	30.7	3.4
7	35	2586	135	49.1	.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	554	50.5	2.6	34.8	1.7
15	44	3197	321	49.9	2.0	34.5	1.0

SD - standard deviation, n - number

Table 4A - Comparison between means of birth weight of males of this study with previous study

Gestation (weeks)	Birth weight Current study			Birth weight (g) Previous study [11]			
	no	X	SD	no	X	SD	d
37	33	2.530	487	17	2780	553	1.576
38	55	2.971	456	27	3042	448	0.645
39	31	2.977	403	50	3181	516	1.985
40	24	3.133	429	79	3093	480	0.389
41	9	3.289	643	77	3277	469	0.0543
42	7	3.214	397	41	3223	570	0.0459

no – number, X – mean, SD - standard deviation, d - standard normal variable deviations

Table 4B - Comparison of means of birth weight of females by gestational age of this study to previous study

Gestation (weeks)	Birth weight Current study			Birth weight (g) Previous study [11]			
	no	X	SD	no	X	SD	d
37	39	2513	420	13	2775	593	1.474
38	58	2900	532	18	3037	450	1.0787
39	22	2982	364	53	2987	471	0.049
40	17	3018	494	83	3081	398	0.494
41	9	3028	436	62	3174	364	0.9573
42	6	3117	278	30	3085	396	0.2378

no – number, X – mean, SD - standard deviation, d - standard normal variable deviations

Table 5A - Comparison of means of males crown-heel length by gestational age of this study to previous study

Gestation (weeks)	Crown heel Current study			Crown heel length Previous study [11]			
	no	X	SD	no	X	SD	d
37	33	47.1	2.02	17	48.2	3.4	1.438
38	55	48.6	2.24	27	49.7	2.5	1.936
39	31	49.3	1.77	50	49.7	2.5	0.841
40	24	49..7	1.9	79	49.3	2.6	0.733
41	9	49.8	2.2	77	50.4	2.1	0.778
42	7	50.9	1.43	41	50.2	2	1.121

no – number, X – mean, SD - standard deviation, d - standard normal variable deviations

Table 5B - Comparison of means of females crown-heel length by gestational age of this study to previous study

Gestation (weeks)	Crown heel Current study			Crown heel length Previous study [11]			
	no	X	SD	no	X	SD	d
37	39	47.4	1.76	13	48.2	2.2	0.695
38	58	48.6	3.99	18	49.7	1.8	1.335
39	22	48.9	1.54	53	48.9	2.1	Zero
40	17	49.1	1.84	83	49.3	2.3	0.390
41	9	49.9	2.2	62	49.9	1.8	Zero
42	6	50.8	2.03	30	50.1	1.6	0.797

no – number, X – mean, SD - standard deviation, d - standard normal variable deviations

Table 6A - Comparison of means of males head circumference by gestational age of this study
to previous study

Gestation (weeks)	Head circumference Current study			Head circumference Previous study [11]			
	no	X	SD	no	X	SD	d
37	33	33.8	1.32	17	34.1	2.6	0.440
38	55	35.1	1.22	27	34.4	1.9	1.746
39	31	35.3	1.32	50	34.5	1.2	2.744*
40	24	35.8	1.02	79	34.7	1.1	4.541*
41	9	36.1	1.19	77	35.0	1.4	2.171
42	7	36.7	0.85	41	35.1	1.5	4.024*

no – number, X – mean, SD - standard deviation, d - standard normal variable deviations
*Significant difference

Table 6B - Comparison of means of females head circumference by gestational age of this
study to previous study

Gestation (weeks)	Head circumference Current study			Head circumference Previous study [11]			
	no	X	SD	no	X	SD	d
37	39	33.9	0.99	13	33.3	1.3	1.523
38	58	34.4	2.58	18	34	1.7	1.525
39	22	34.9	1.37	53	34	1.4	2.574
40	17	34.7	1.16	83	34.4	1.1	0.980
41	9	35.3	1.19	62	34.7	1.1	1.427
42	6	36.1	1.44	30	34.6	0.9	2.638*

no – number, X – mean, SD - standard deviation, d - standard normal variable deviations
*Significant difference

DISCUSSION

The morbidity of newborns of any population depends, to a large extent, on gestation and size of a baby at birth. Proper classification and management of neonates, therefore, require the use of valid intrauterine growth standard, as important determinants of intrauterine growth, such as race, socioeconomic level and altitude vary from population to another [10].

This paper aims at obtaining recent intrauterine growth parameters to help to classify at-risk neonates according to their position in growth curves and hence to dictate the care they should have. Although the international growth curves are valid, those derived from the same population may be more appropriate for detecting deviant fetal growth in the same community.

The sample comprises healthy mothers, non smokers and the Khartoum City itself is of low altitude so the babies may have normal intrauterine growth. Khartoum Teaching Hospital was chosen because of

easiness of collecting data as it has got good facilities and large hospital deliveries. Ideally, the parameters should include preterm neonates in order to construct intrauterine growth curves but the short time of the study did not allow collection of reasonable numbers of neonates in the preterm gestation.

Many workers in the past tried to determine the mean birth weight for Sudanese children. A figure of 3009 gm was reported by Mudawi in 1963 [16]. Also Ahmed and Abdalla [17] reported a mean birth weight of 3039 + 0.36 in 1967 from a hospital sample of 525 single newborns. Omer [18] reported a mean birth weight of 2740 + 785 gm. In all these studies, a gestation length was not considered so it is invalid to compare statistically these figures with the figures of the present study. Ahmed and Abdalla [17] found the mean crown-heel length to be 51.1 + 2.2 cm and the mean head circumference to be 34 + 1.2 cm in 1967.

The first Sudanese intrauterine growth parameters by gestational ages were obtained in 1982 [11]. As it is recommended to update the intrauterine growth parameters every 5-10 or 15- 20 years [12], and because almost three decades had passed since the last study was done, so it is justified to obtain recent intrauterine growth parameters. The mean birth weight of the present study (3.040 kg) is approximate to that of a previous study at weak 40 [11], is near to that reported by Mudawi [16], almost the same as that reported by Ahmed and Abdalla [17], but much higher than what was reported by Omer [18]. Nevertheless, the statistical difference was not feasible to perform due to disregard of gestation ages in previous studies. However, it is possible to compare with the previous study done in 1982 [11]. Comparison of means of birth weight, crown-heel length of both sexes with the 1982 study did not show any significant difference. When comparing the means of head circumferences of males with that study it showed a significant difference at week 39, 40 and 42, and this remains to be explained. When comparing the means of head circumferences of females with that study, it showed a significant difference at week 42 only, and the general pattern showed no statistical significant difference. Although there is no significant difference between the means of birth weight and crown-heel length, the figures of the previous study is slightly higher than the present study. The reverse is true regarding the means of head circumference.

One would have expected to find significant difference on all parameters of intrauterine growth in favor of the present study since secular trends tend to show upward increase in intrauterine growth [5, 12]. The explanation may be due to socioeconomic changes of the community which happened in the last three decades that caused the high class people to refrain from using public medical services. The public medical services are now utilized by the low social strata. Therefore, these newborns, being delivered in public health facility, may represent the low social class that is known to affect birth weight [13]. Also one might blame the nutrition of the mothers [5, 19, 20]. Probably the nutrition and the care of the mothers had declined compared to that in 1982.

It is recommended that large scale, community based study to be carried out on healthy mothers involving the whole country in order to obtain standard intrauterine growth curves for Sudan, and this should be updated at least every 20 years.

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