Standard fetal growth curves for normal pregnant women living in Cairo

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Abstract: Objective: To create fetal growth curves for normal pregnant women living in the Capital City- Cairoas a part of multicenter study that will include all the Egyptian governorates to validate a standardized national fetal growth curves. **Study design**: This study include two thousands pregnant women living in Egypt, and all women are singleton pregnancy were admitted to the antenatal care clinic at NRC and implemented in cross-sectional study. The ages of participating women were ranged between 18 and 40 years, living in grand Cairo. The estimated gestational age was ranged between 12 and 42 weeks (1st day of last menstrual period was used for estimation of pregnancy). Ultrasonographic fetal biometric measurements, which includes head and abdominal circumferences, biparietal diameter and length of femur, were done once for every fetus. **Results**: Ultrasonographic fetal biometry was obtained for fetuses of normal pregnant women living in Cairo. New charts of BPD, HC, AC and FL were established for our local populations. Comparing our data with Italian, Korean, and Saudi Arabian populations confirm the presence of variations. **Conclusion**: The currently used fetal growth curves was not coordinate with the data recorded for Western people and may be unsuitable as standard for Egyptian foeti, therefore, the implementation of native developed charts is suggested.

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1. Introduction

Fetal growth is one of the most important issues for the fetal well-being. Indeed a normally growing fetus with its growth within the normal limits reflects fewer complications during prenatal and postnatal stages[1]. Establishing appropriate reference charts of biometric parameters is crucial for increasing the accuracy of intrauterine growth restriction (IUGR) diagnosis. The most precise method for estimation of IUGR was through measurement of head circumference (HC), biparietal diameter (BPD), femur length (FL) and abdominal circumference (AC) by using the ultrasonographic examination [2].

The prenatal measurement of fetal biometry and estimated fetal weight (EFW) vary among different populations, depending on their race, demographic characteristics and nutrition. Fetal biometric curves for one group of people may overestimate or underestimate the gestational age when used for another group with different demographic characteristics[3]. In the last twenty years, many curves have been designed by many investigators to estimate fetal weight using ultrasound[4]. Many formulas to calculate EFW were published, and they use different combinations of fetal parameters[5]. The most accurate results of EFW calculation are achieved by measuring different fetal anthropometrical parameters[4].

Using charts designed for different populations is still present despite the significant ethnic variations in fetal size and growth[6]. Marked variations in the fetal measurements are present among various inhabitants, speciallyat the extreme ranges of fetal parameters (5th and 95th centiles). Clinical application of charts based on data obtained from different inhabitants could be possibly increase the risk of misdiagnosis (increase or decrease IUGR foeti [7]. It is very important to initiate own native charts for growth of fetus during gestational period for the purposes of perfect fetal assessments [8].

2. Patients and methods

This is a cross-sectional study, which was carried out over a period of 3 years (2014 –2017). The Medical Research Ethics Committee of the National Research Centre approved the work. Informed consents were obtained from all participants before their scans. The study population consisted of 2000 pregnant women of different gestational ages ranging from 12 to 42 weeks of gestation. They were referred to the antenatal care clinic at the National Research Centre. Participating women were living in grand

Cairo, their age ranged between 18 and 40 years. The gestational age was established by reference to the first day of last menstrual period in women who were sure of their LMP. Exclusion criteria included an uncertain date of the last menstrual period, fetal congenital anomalies at time of scan, Medical disorders during pregnancy that affect the fetal growth such as diabetes mellitus, hypertension, autoimmune disorders e. g. Antiphospholipid antibody syndrome, drugs intake during pregnancy that can affect the placental functions such as aspirin and other anticoagulants, and multifetal pregnancy. Fetal biometric measurements (BPD, HC, AC, and FL) were done for women who fulfilled the inclusion criteria. One experienced operator in obstetric ultrasound performed fetal biometric measurements for all participated women, in order to avoid inter-operator variability. Cases were evaluated by the Sonoace X8 system (Medison, Seoul, Korea) with a 3.5MHz convex probe.

BPD was measured on a transverse view of the fetal head at the level of the Thalami, with symmetrical appearance of both hemispheres, continuous midline echo (falx cerebri), broken in middle by the cavum septum pellucidum and thalamus. Measurement was done from the outer edge of the closest temporo-mandibular bone to the inner edge of the opposite temporo-mandibular bone[9]. HC was obtained at a level that showed a smooth symmetric head, a well-defined midline echo, paired thalami, cavum septum pellucidum, and the third ventricle. Calipers that are opened to the outline of fetal HC were used[10].

AC measurements were obtained through tracing the appropriate circumference by calipers that are opened to the outline of fetal abdomen. This transverse section of the abdomen was obtained at the level of the stomach, portal vein and hepatic portion of the umbilical vein which appear like a hockey stick[1]. The technique of measuring the femur length (FL) involves an initial determination of the lie of the fetus and locating the femur. Once the femur has been located, an attempt is made to define both ends of the calcified portion, which is measured by electronic calipers[10]. The measurements of each parameter were used to calculate the mean, 5^{th}, 50^{th} (median) and 95^{th} centiles.

Statistical analysis

Data of fetal measurements at each week from 12 to 42 weeks were coded and entered using the Statistical Package for the Social Sciences (SPSS) version 16. Data was summarized to obtain descriptive statistics: Number of observations (n), Mean, Standard Deviation (SD), the 5th, 50th and 95th centiles.

3. Results

As shown in table (1), the means of HC, BPD, AC, and FL are tabulated in consistence with gestational age in completed weeks. BPD showed an increase with GA. Its maximum increase was between 21 and 22 weeks, with an increase equal to 5.86mm. The minimum increase was between 30 and the 31 weeks. This increase was 0.45 mm. In addition, HC showed an increase with GA. The maximum increase was between 16 and 17 weeks (24.2 mm), whereas the least increase was between 36 and 37 weeks, with an increase equal to 2.97mm.

Table (1): The mean values of BPD, HC, AC, and FL according to gestational age in completed weeks in Egyptian singleton pregnancies:

		BPD (mm)			**HC (mm)**			**AC (mm)**			**FL (mm)**		
GA (Weeks)	**N**	**Mean**	**±**	**SD**	**Mean**	**±**	**SD**	**Mean**	**±**	**SD**	**Mean**	**±**	**SD**
12	**16**	21.98	±	1.47	77.34	±	1.33	59.89	±	2.06	9.62	±	0.49
13	**27**	26.64	±	2.12	91.28	±	6.54	77.59	±	10.16	10.67	±	0.60
14	**15**	30.83	±	2.73	106.83	±	7.04	90.16	±	2.83	13.84	±	2.01
15	**74**	33.54	±	1.76	118.49	±	6.02	98.86	±	3.57	17.84	±	1.55
16	**34**	36.88	±	1.89	126.54	±	5.76	105.09	±	3.12	20.45	±	1.76
17	**76**	42.57	±	2.86	150.72	±	8.34	119.23	±	6.90	25.33	±	2.55
18	**142**	44.75	±	2.97	159.98	±	7.17	129.82	±	3.43	27.84	±	2.42
19	**36**	50.09	±	2.75	174.35	±	5.54	141.71	±	2.82	32.37	±	2.20
20	**60**	52.82	±	2.70	182.41	±	5.14	150.75	±	4.23	34.56	±	2.25
21	**46**	54.06	±	3.02	190.68	±	5.18	157.35	±	1.73	37.06	±	2.25
22	**59**	59.92	±	4.02	210.23	±	7.63	169.27	±	6.92	39.88	±	2.30
23	**75**	61.61	±	3.20	217.67	±	6.08	186.12	±	5.39	41.46	±	1.92
24	**62**	64.19	±	3.20	227.24	±	5.07	196.14	±	4.60	44.43	±	2.30
25	**34**	67.45	±	3.89	237.51	±	4.44	207.42	±	4.99	46.11	±	2.23
26	**39**	68.33	±	4.21	247.45	±	5.49	216.48	±	4.81	49.17	±	2.53

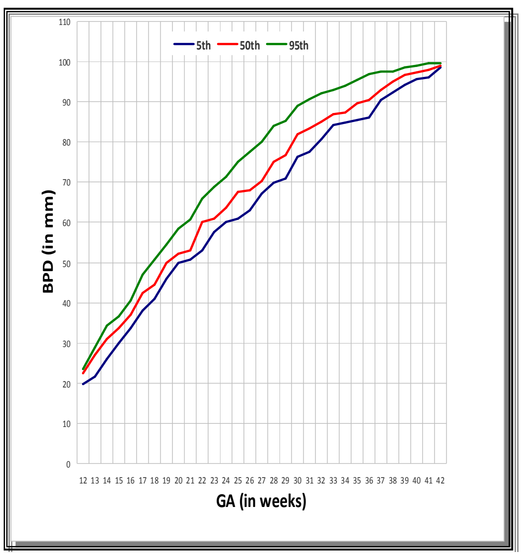
		BPD (mm)			HC (mm)			AC (mm)			FL (mm)		
GA (Weeks)	**N**	**Mean**	**±**	**SD**	**Mean**	**±**	**SD**	**Mean**	**±**	**SD**	**Mean**	**±**	**SD**
27	**53**	71.29	±	3.66	255.99	±	3.77	229.00	±	4.89	52.03	±	2.22
28	**116**	75.99	±	4.50	269.38	±	5.84	238.61	±	3.72	53.98	±	2.27
29	**36**	76.87	±	4.03	280.31	±	2.70	250.55	±	3.11	55.45	±	1.82
30	**67**	82.57	±	4.31	285.68	±	4.55	261.80	±	5.28	59.27	±	2.90
31	**90**	82.98	±	4.10	292.58	±	4.07	277.88	±	3.48	61.06	±	2.22
32	**82**	85.09	±	3.05	301.07	±	5.85	288.10	±	8.63	62.30	±	2.00
33	**79**	87.04	±	3.38	307.02	±	4.73	295.38	±	5.56	63.78	±	2.43
34	**69**	87.85	±	2.76	311.95	±	4.10	303.71	±	7.06	66.12	±	2.51
35	**99**	89.55	±	2.52	316.86	±	15.11	314.67	±	9.17	67.83	±	2.76
36	**14**	90.56	±	2.82	323.99	±	2.71	328.44	±	4.22	72.69	±	1.72
37	**135**	93.27	±	1.77	326.96	±	2.74	329.39	±	12.84	73.20	±	1.44
38	**143**	95.15	±	1.46	333.70	±	2.54	340.65	±	10.93	74.32	±	1.56
39	**111**	96.42	±	1.21	345.11	±	5.25	341.43	±	16.02	75.51	±	1.66
40	**83**	97.35	±	1.05	352.53	±	11.54	342.27	±	9.57	75.73	±	1.57
41	**20**	97.48	±	1.54	355.75	±	3.01	354.44	±	10.22	77.14	±	2.06
42	**8**	98.99	±	0.24	359.28	±	1.97	359.68	±	8.07	80.13	±	0.86

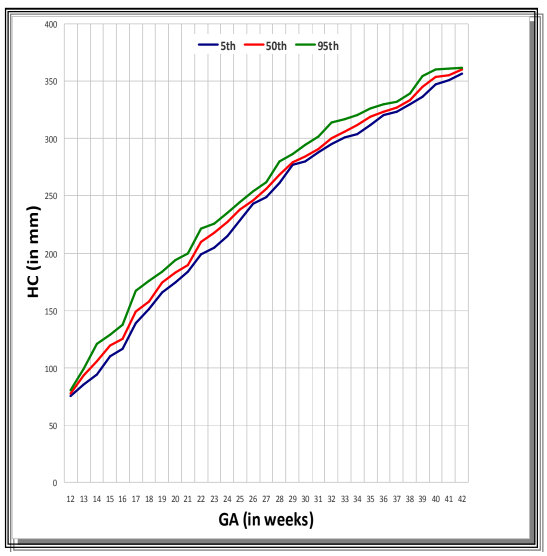
(**GA):** gestational age (**N**): number of cases in each week

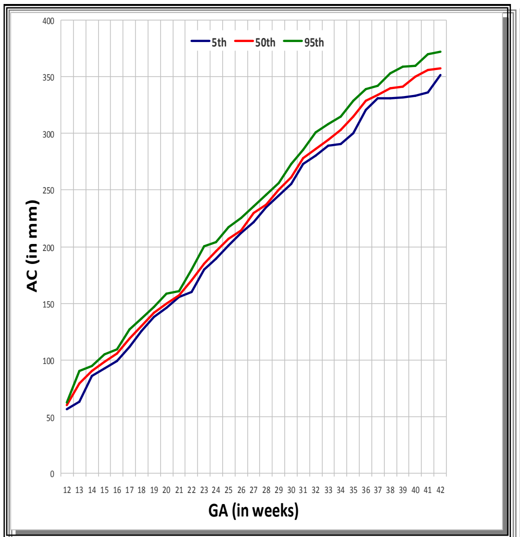
Along the same lines, AC showed an increase with GA, with maximum increase between 12 and 13 Weeks (17.7 mm). Its least increase was between 38 and 39 weeks, and was equal to 0.78 mm. FL showed the same trend. The maximum increase was between35 and 36weeks (4.86 mm), however the least increase was between 39 and 40 w. of gestational age, and the average increase was 0.22 mm.

Also, Fig. 1 illustrate that, the gestational age specific centile curves (5th, 50th, and 95th centiles) for BPD, HC, AC, and FL. The range of variations between measurements on 5th, 50th, and 95th centiles was present throughout the weeks of gestation for each of the biometric measurements.

Tables 2-5 demonstrate the fetal measurements (BPD, HC, AC, and FL) at weeks 18, 28 and 38 of gestational age which obtained from the results of present study, together with some of the studies done on Western, Asian, and Arabian populations. The minimum and maximum of the variation ranges in the measurements are illustrated in the last row of all tables.







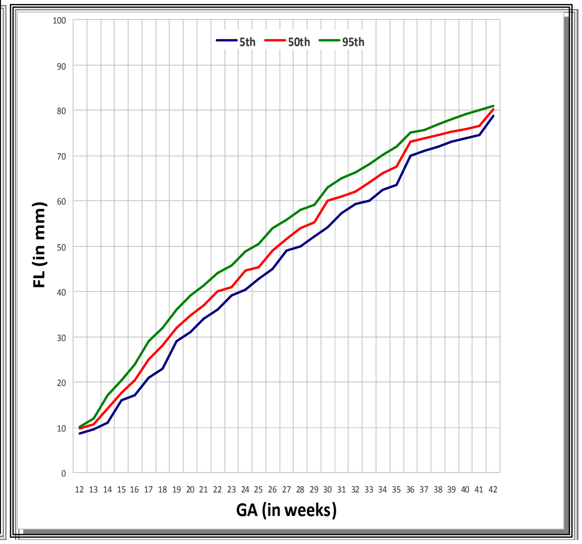


Figure (1): 5^{th}, 50^{th} and 95^{th} centile curves for BPD, HC, AC and FL.

Table (2): 5^{th}, 50^{th} and 95^{th} percentiles of BPD at 18, 28, and 38 weeks of gestation as obtained from the present study compared to published data from Western, Asian, and Arabian populations:

BPD (mm)	18 Weeks			28 Weeks			38 Weeks		
	5th	50th	95th	5th	50th	95th	5th	50th	95th
Italian[11]	39	42	45	65	72	77	87	91	95
Korean[2]	35	40	44	64	70	76	84	90	96
Saudi Arabian[12]	36	41	47	66	71	79	79	89	96
Present study	41	44	50	69	75	83	92	95	97
Range	6	2	6	5	5	7	8	6	2

The last row gives the range of variation between the maximum and minimum measurements

Table (3): 5^{th}, 50^{th} and 95^{th} percentiles of HC at 18, 28, and 38 weeks of gestation as obtained from the present study compared to published data from Western, Asian, and Arabian populations:

HC (mm)	18 Weeks			28 Weeks			38 Weeks		
	5th	50th	95th	5th	50th	95th	5th	50th	95th
Italian [11]	140	152	164	246	264	281	306	328	350
Korean[2]	131	145	160	244	260	276	309	325	342
Saudi Arabian[12]	127	149	169	248	261	278	302	321	341
Present study	151	158	175	260	268	280	330	333	339
Range	24	13	15	16	8	5	28	12	11

The last row gives the range of variation between the maximum and minimum measurements

Table (4): 5^{th}, 50^{th} and 95^{th} percentiles of AC at 18, 28, and 38 weeks of gestation as obtained from the present study compared to published data from Western, Asian, and Arabian populations:

AC (mm)	18 Weeks			28 Weeks			38 Weeks		
	5th	50th	95th	5th	50th	95th	5th	50th	95th
Italian [11]	124	137	150	212	239	266	293	321	350
Korean[2]	113	127	141	221	240	260	304	329	354
Saudi Arabian[12]	114	128	142	214	231	253	298	316	360
Present study	125	130	137	234	237	246	331	340	363
Range	12	10	13	22	9	20	38	24	13

The last row gives the range of variation between the maximum and minimum measurements

Table (5): 5th, 50th and 95th percentiles of FL at 18, 28, and 38 weeks of gestation as obtained from the present study compared to published data from Western, Asian, and Arabian populations:

FL (mm)	18 Weeks			28 Weeks			38 Weeks		
	5th	50th	95th	5th	50th	95th	5th	50th	95th
Italian [11]	23	27	30	49	53	57	64	70	76
Korean[2]	21	25	29	46	51	55	62	68	73
Saudi Arabian[12]	22	26	28	48	52	56	63	71	75
Present study	24	28	31	50	54	58	72	74	77
Range	3	3	3	4	3	3	10	6	4

The last row gives the range of variation between the maximum and minimum measurements

4. Discussion

One of risk factors for developing of IUGR, is the centiles are less than the normal centiles in a definite GA, therefore, it is fundamental to define the ranges of normal percentile. In this respect, many investigators insisted on the importance of applying adopted fetal growth charts that take care of variables, like the race and genetic influence[13]. Racial variation in newborn birth weight of different races was reported and found to be concomitant with similar differences in the fetal biometry in the uterus [12].

In cross-sectional studies, each fetal biometry was determined one time, while in longitudinal studies, fetal biometry were taken several times according to the gestational age. We selected cross-sectional scheme to avoid unfired determination via using longitudinal study in which a greatly multifarious statistical model are used. Our population samples were more frequent at certain weeks than other weeks, as the present data concerned with daily practice not depends on a prospective study.

In clinical practice, the objectives of applying of cross-sectional charts of fetal biometry are: firstly, to determine the age of fetus and, secondly, to confirm a clinically suspected abnormalities in the growth of fetus, i.e., macrosomia or IUGR. The first aim which concerned with the estimation of fetal age according to head circumference during the first half of pregnancy (<24 weeks). Thereafter, depending on the ultrasonography to determine fetal age is which may exposed to improper variety of mistakes. This is may be attributed to great biological differences in the in fetal sizes with and within the same population**.** The assessment of growth of fetus was the second purpose of the study, and usually is done after 28 weeks of gestational age (or in the 3rd trimester). However, determination of AC is significant and any deviations in AC than normal of all percentiles pointe to more progress in the pregnancy. This comment points to the probable mistakes during applying of unsuitable chart which used for valuation of fetal growth [14].

In the present study, fetal biometric measurements showed variations throughout the gestational range, with maximum and minimum changes at certain weeks. This variability may be attributed to the characteristics of our local populations, the methodology, or both.

We compared fetal biometry of our populations with Italian [11], Korean [2], and Saudi Arabian[12] populations at 18 weeks of gestation (Early 2nd trimester), 28 weeks of gestation (Early 3rd trimester), and at 38 weeks of gestational age (late 3rd trimester). This comparison showed that BPD and FL values in the present study were the highest among other populations in comparison at the three selected weeks of gestation on the 5th, 50th and 95th percentiles

Along the same lines, the values of HC in our study came ahead of other publications at all points except at 38th week, where Egyptian HC became less than the Italian one at 95thcentile. As for AC, our measurements were the highest on 5th centile at 18 and 28 weeks, then decreased gradually on 50th and 95th compared with other races. However, AC values remained on the top on the three centiles at 38 week. The cause of such differences in the results between different sources of data can be returned to many factors not only on the differences in the technique used. These differences may be also due to racial variation.

In a study done in Belgium on 524 fetuses from different races (77 Moroccan, 369 Belgian, and 78 Turkish), the results showed that fetuses of both Moroccan and Turkish women had a smaller AC, HC, and FL than those of fetuses from Belgian women[15]. Whereas, the study which done on African women found that Nigerian BPD and AC were smaller than those of the British populations[16]. The studies involving Asian populations found that fetal biometric parameters are smaller than in Caucasian populations[17].

Conclusion

We have established new fetal growth charts for normal pregnant women living in Cairo. Our data were not similar to those of other populations. The study demonstrated that genetic and racial origins are important factors that may have a significant effect on the fetal measurements. So, the present work recommends the creation and validation of national fetal growth curves that can be applied for the valuation of fetal growth in Egypt.

Conflicts of interest

There are no conflicts of interest.

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