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Ultrasound Biometry of Nigerian Fetuses: 1. Estimated Fetal Weight

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Abstract: Fetal weight studies are few in Nigeria and the population used for these studies are too small to provide a meaningful statistical significant data for the relationship between it and age. In the developed countries, fetal weight reference values have been produced but there are no such in our environment. This study was designed to establish chart of fetal weight in Jos. A total of 12,080 pregnant women were scanned in a cross-sectional study at the Centre for Reproductive Health Research, Jos over a period of five years. The mean estimated weights and percentiles of 12,080 fetuses from 17-42 weeks are presented in a tabular form. Mathematical modeling of data demonstrated that the best-fitted regression model to describe the relationship between estimated fetal weight and gestational age was the power regression equation $y = 0.038x^{3.1347}$ where y is the fetal weight in grams and x is the fetal age in weeks with a correlation of determination $R^2 = 0.9951$ ($p < 0.001$). When fetal weight was plotted against symphysio-fundal height, it was found out that there is a positive correlation between fetal weight and symphysio-fundal height with a correlation of determination $R^2 = 0.9951$ ($p < 0.001$). The relationship is best described by the power regression equation $y = 0.0409x^{3.1217}$ where y is the fetal weight in grams and x is the symphysio-fundal height in centimeters. It is concluded that the estimated weight of fetuses in Jos correlated well with gestational age and symphysio-fundal height.

Key words: Correlation and regression equation, fetal weight, gestational age, reference values, symphysio-fundal height

INTRODUCTION

Accurate prediction of fetal weight has been of great importance in obstetrics. Since fetal weight cannot be measured directly, it must be estimated from fetal and maternal anatomical characteristics. Many workers have used different methods to achieve this. Of the various methods such as tactile evaluation of fetal size (Dare *et al*., 1990), maternal self-estimation (Chauhan *et al*., 1992; Baum *et al*., 2002), birth-weight prediction equations (Dare *et al*., 1990) and using algorithm derived from maternal and pregnancy-specific characteristics (Nahum, 2007), the most-commonly used are the clinical and ultrasonographic methods. Akinola *et al*. (2009) in their study of clinical versus sonographic estimation of fetal weight in Southwest Nigeria reported that clinical estimation of birth-weight may be as accurate as routine ultrasonographic estimation, except in low-birth-weight babies. They futher reported that when the clinical method suggests weight smaller than 2,500 g, subsequent sonographic estimation is recommended to yield a better prediction and to further evaluate the fetal well-being. From the few fetal weight studies (Fasubaa *et al*., 1991; Airede, 1995) conducted in Nigeria, the population used for these studies are have been too small to provide a meaningful statistical significant data for the relationship between estimated fetal weight and age that is why the present study was carried out using a large sample size in order to examine the relationship between gestational age and ultrasound estimated fetal weight and symphysio-fundal height and ultrasound estimated fetal weight in normal Nigerian women.

MATERIALS AND METHODS

This was a prospective cross-sectional study carried out at the centre for reproductive health research Jos between January 1998 and June 2002. The study was approved by the Ethics Committee of Jos University Teaching Hospital and before inclusion of the patients, informed consent was obtained.

A total of 12,080 pregnant women with only singleton pregnancies were included. Pregnant women with concomitant disease possibly affecting fetal growth (e.g., diabetes mellitus, asthma, hypertension, renal disease, thyroid disease) were not included as were those

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with complications of pregnancy known at the moment of the ultrasound scan (e.g., bleeding, pre-eclampsia). If a fetal malformation was detected during the examination the patient was excluded. Patients with a history of obstetric complications, intrauterine growth retardation or macrosomia were also excluded. The investigators did not take in to account complications or diagnosis that occurred later in the pregnancy, after the ultrasound measurements were performed. Every fetus was measured and included only once so that a pure cross-sectional set of data was constructed. For each patient the gestational age was recorded, as were last menstrual period, maternal age and parity. Maternal age was calculated in completed years at the moment of the ultrasound. Symphysio-fundal height measurements were taken using a non-stretch tape measure in centimeter. Obstetric ultrasonography was carried out on the patients using Philips Real time ultrasound machine equipped with 3.5 MHz transducer and an electronic caliper system set at a velocity of 1540 m/s. Head circumference measurement was made at the fetal plane described by Campbell and Thomas (1977). Biparietal diameter measurement was made on the same frozen image for head circumference from outer to outer table of the skull (Campbell and Thomas, 1977). Abdominal circumference was made on the fetal plane described by Campbell and Wilkin (1975). Femur length measurements were made using the method described by O'Brien *et al*. (1981). Estimated fetal weight was calculated in grams by the formulae described by Shepard and by Hadlock, as these are included in the software of most commercially available ultrasound scanners (Shepard *et al*., 1982).

Data were analyzed using Number Cruncher Statistical System (NCSS/PASS 2006 Dawson Edition, USA). Values of estimated fetal weight at various gestational ages were expressed as mean, standard deviation, standard error of mean together with percentiles. Statistical significance was considered at 0.001. Person's correlation and regression analysis was used to establish the relationship between estimated fetal weight and gestational age and estimated fetal weight and symphysio-fundal height.

RESULTS

Mean estimated fetal weight at various gestational ages are shown in Table 1 together with their corresponding standard deviations, standard error of mean and percentiles. Figure 1 is a graph showing mean fetal weight ± SD from 17-42 weeks. Mathematical modeling of data demonstrated that the best-fitted regression model

Table 1: Estimate fetal weight mean values, standard deviation, standard error of mean and percentiles from 12 – 42 weeks gestation.

Gestational ages (weeks, days)	Number of fetuses	Estimated fetal weight (g)	Fetal weight centiles						
			SD	SEM	5th	10th	50th	90th	95th
17 to 17+6	427	319.0	40.2	8.8	300	300	300	400	400
18 to 18+6	446	731.9	650.8	94.9	300	300	400	1900	2400
19 to 19+6	282	413.3	101.8	11.8	300	400	400	400	500
20 to 20+6	553	437.6	81.0	4.4	400	400	400	500	600
21 to 21+6	400	496.3	73.2	3.9	400	400	500	600	600
22 to 22+6	398	567.4	124.5	6.5	500	500	600	600	700
23 to 23+6	478	668.4	180.9	8.5	500	600	600	800	800
24 to 24+6	520	781.9	161.7	7.2	600	700	800	900	900
25 to 25+6	388	925.0	177.6	9.1	700	800	900	1100	1100
26 to 26+6	511	1077.6	217.9	9.7	900	900	1100	1300	1400
27 to 27+6	432	1206.8	226.8	11.0	900	1000	1200	1400	1600
28 to 28+6	548	1370.2	227.7	9.8	1100	1200	1400	1500	1690
29 to 29+6	484	1498.1	204.2	9.4	1200	1300	1500	1800	1800
30 to 30+6	625	1733.8	297.7	12.0	1300	1500	1700	2000	2100
31 to 31+6	523	1865.1	295.3	13.0	1300	1600	1900	2100	2200
32 to 32+6	583	2086.1	276.3	11.5	1700	1800	2100	2400	2500
33 to 33+6	516	2279.6	298.8	13.2	1800	1900	2300	2600	2700
34 to 34+6	744	2516.0	333.0	12.4	2100	2200	2500	2900	3065
35 to 35+6	739	2675.0	352.8	13.0	2180	2300	2700	3100	3300
36 to 36+6	599	2837.0	341.3	14.1	2300	2500	2900	3200	3400
37 to 37+6	532	3079.8	392.0	17.2	2600	2700	3100	3400	3600
38 to 38+6	481	3276.7	351.3	16.2	2700	2900	3300	3700	3800
39 to 39+6	525	3490.8	360.3	15.8	3000	3000	3500	4000	4100
40 to 40+6	252	3634.9	419.8	26.4	3100	3200	3600	4200	4435
41 to 41+6	72	3752.9	350.9	41.9	3155	3210	3800	4190	4545
42 to 42+6	22	3868.2	599.5	127.8	2900	2960	3900	4600	4600
Total	12,080								

Table 2: Mean values, Standard deviation, standard error of mean and percentile of symphysio-fundal height of Nigerian women in Jos from 14 – 40 weeks gestation

Gestational age (weeks)	Sample size (n)	Mean SFH (cm)	SD	standard error of mean	Percentiles		
					10th	50th	90th
14	2	14.5	0.07	0.50	14.0	14.5	15.0
15	10	14.4	0.83	0.30	13.0	14.5	15.3
16	4	15.1	0.38	0.20	14.7	15.1	15.6
17	11	16.8	0.67	0.20	16.0	16.7	18.0
18	5	16.5	1.49	0.01	14.2	16.3	17.8
19	4	18.7	0.96	0.48	17.3	19.0	19.5
20	5	18.9	0.27	0.12	18.5	19.1	19.1
21	8	20.9	0.74	0.20	19.8	20.9	22.0
22	8	22.5	1.54	0.50	20.5	23.0	24.3
23	14	23.3	1.10	0.30	21.3	24.0	24.4
24	6	23.9	1.50	0.60	22.0	24.4	25.1
25	13	24.4	0.40	0.10	23.8	24.4	24.9
26	11	25.6	0.95	0.30	24.3	25.6	27.1
27	13	26.8	1.40	0.40	23.8	27.0	28.1
28	10	28.2	0.63	0.20	27.3	28.3	28.9
29	17	29.1	1.00	0.30	28.2	28.8	31.5
30	22	29.8	1.40	0.30	28.7	29.5	32.0
31	17	30.8	0.90	0.20	29.9	30.4	32.4
32	23	31.9	1.70	0.30	30.6	32.0	32.3
33	35	32.8	1.50	0.30	31.0	32.9	33.9
34	27	33.4	1.70	0.32	32.0	33.2	36.0
35	30	33.9	1.60	0.30	31.7	34.2	35.9
36	28	35.7	1.90	0.40	33.3	35.8	37.4
37	30	36.7	2.20	0.40	34.5	36.1	39.5
38	35	38.3	1.60	0.30	36.3	38.1	40.7
39	14	38.1	2.80	0.80	31.8	39.0	40.2
40	3	39.1	2.10	1.20	37.0	39.3	41.1
Total	405						

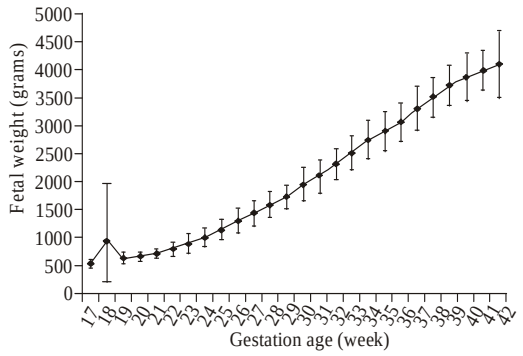

Fig. 1: Graph of estimated fetal weight mean values in 12,080 fetuses of women at different gestational ages between 12-42 weeks. The vertical bars show the values of ± SD

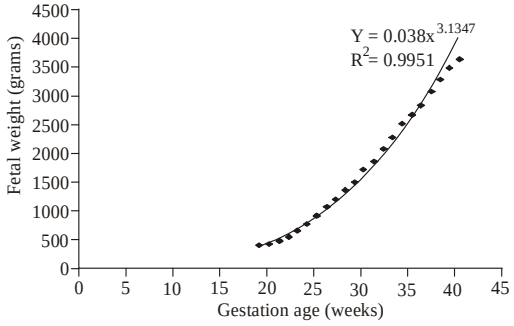

Fig. 2: Correlation and regression equation of estimated fetal weight mean values in 12,080 Nigerian fetuses in Jos plotted against gestational age

(Fig. 2) to describe the relationship between estimated fetal weight and gestational age was the power regression equation $y = 0.038x^{3.1347}$ where y is the fetal weight in grams and x is the fetal age in weeks with a correlation of determination of $r^2 = 0.9951$ ($p < 0.001$). Mean symphysio-fundal height from 14-40 weeks gestation together with standard deviation, standard error of mean and percentiles are as shown in Table 2. When fetal weight was plotted against symphysio-fundal height, it was found out that there is a positive correlation between fetal weight and symphysio-fundal height with a correlation of determination of $r^2 = 0.9951$ ($p < 0.001$).

The relationship is best described by the power regression equation $y = 0.0409x^{3.1217}$ where y is the fetal weight in grams and x is the symphysio-fundal height in centimeters (Fig. 3). From Table 1, it can be seen that the

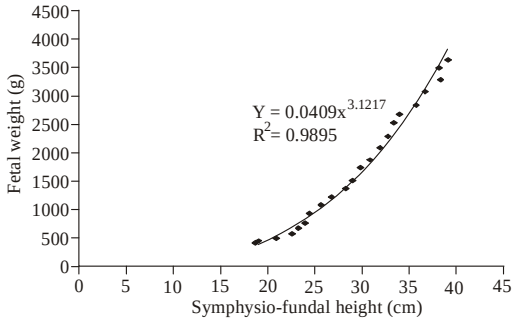

Fig. 3: Correlation and regression equation of estimated fetal weight mean values in 12,080 Nigerian fetuses in Jos plotted against symphysio-fundal height

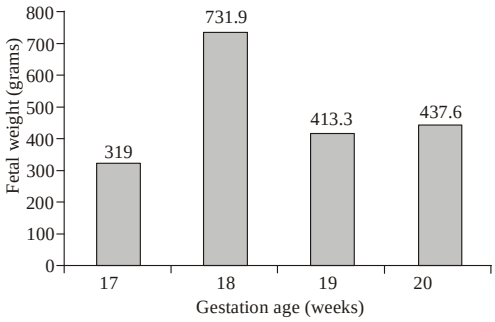

Fig. 4: Estimated fetal weight mean values at 5 months

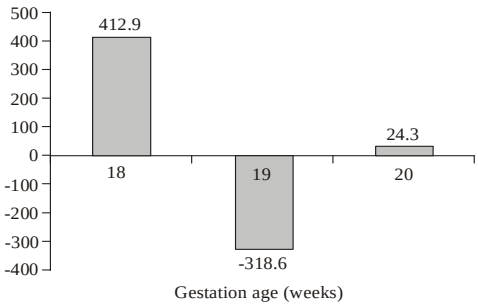

Fig. 5: Mean fetal weight gain at 5 months

human fetus gains the highest weight at 18 weeks but loses much by 19 weeks before it starts gaining weight again as from 20 weeks.

DISCUSSION

Mean values of estimated weight of fetuses of Nigerian women in Jos have been established. The findings of this study agree with those of Abu *et al*., 2009 and Akinola *et al*., 2009. Unlike the study of Akinola *et al*. (2009) which used small sample size, the strength of the present study is the very large sample size used. The mean values of the estimated fetal weight have relatively small standard error of mean signifying that the mean values obtained for the estimated fetal weight from the sample are a reflection of the population mean in Jos, Nigeria. This will enable the benefiting specialist (obstetricians, perinatologist, embryologist and forensic pathologist) to use the mean values with confidence since they were obtained form a very large sample size. When the estimated fetal weight mean values obtained from this study were compared with those of Abu *et al*. (2009), a statistically significant difference ($p<0.05$) was found with mean values from the study being higher than those of Abu *et al*. (2009) except at 38 weeks where the mean values are almost equal. The reason for this difference is probably due to the small sample size used in Abu's study. Figure 4 shows estimated fetal weight mean values at 5 month (from 17-20 weeks). It can be seen in Fig. 5 that the human fetus gains the highest weight at 18 weeks (412.9 g) but loses 318.6 g by 19 weeks before it starts gaining weight again as from 20 weeks. The cause of weight loss at 19 weeks is not known yet but is likely to be due to placentation phenomenon.

In conclusion, this study has identified a 19th week gestation problem which has to be investigated further and it has also demonstrates that the estimated weight of a fetus could be predicted using symphysis-fundal height. Symphysis-fundal height could explain the prediction of a fetus's weight by 99.51% ($r^2 = 0.9951$) in the 12,080 fetuses scanned during this study. Again, the estimated weight of a fetus could be predicted using fetal gestational age. Gestational age could explain the prediction of a fetus's weight by 99.51 percent ($r^2 = 0.9951$) in the 12,080 fetuses scanned during this study. However, the accuracy of a given formula decreases as the mathematical model deviates from the population from which it is derived, therefore, population specific measurements should be done since anthropological variations may change the various coefficients.

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