First trimester sonographic dating formula for the Nigerian obstetric population

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ABSTRACT

Objective: The main purpose of this study is to derive a dating formula for the Nigerian obstetric population, quantify its prediction error, and compare its performance with existing published formulae. **Materials and Methods:** The crown-rump length (CRL) of 322 fetuses without risk for fetal growth restriction were plotted against menstrual age to obtain a scatter plot from which we derived the best-fit fractional polynomial regression model for estimating gestational age (GA). The accuracy of the formula was compared with that of existing formula in another data set of 88 fetuses. **Results:** The scatter plot yielded a best-fit equation for the estimation of GA (in weeks) from CRL (in mm) as GA=−0.0008 (CRL2) + 0.168 CRL + 5.397, (R2=0.8017). The mean prediction error was 0.13 for our formula, and 0.16 and 0.20 for Nelson's, and Robinson's formulae, respectively. **Conclusion:** Our dating formula locally derived was more favorably applicable for the Nigerian population. This has implication for prenatal diagnosis in Nigeria.

Key words: Crown-rump length; dating; gestational age

Introduction

Sonographic measurement of fetal biometry using crown-rump length (CRL) has become a reliable tool for dating pregnancies in the first trimester and also for determination of the prognosis of pregnancy in the first trimester.[1] Reliable dating of pregnancy is a prerequisite for prenatal diagnosis of fetal anomalies; moreover, the correct interpretation of some structural abnormalities seen on ultrasonography, such as fetal nuchal translucency or abnormalities of the nasal bone depends on accurate dating of the pregnancy.

Our center is in the process of establishing a fetal medicine unit with prenatal diagnostic facility as an integral component for detection of fetal anomalies in our population. It has been shown that ethnicity has a significant influence on fetal biometry, the published CRL dating formulae are derived predominantly from Caucasian population and may not be applicable in our environment.[2] There is therefore the need to derive a CRL-based dating formula for our population.

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The aims of this study are therefore 3-fold:

1. To derive an ethnic-specific CRL dating formula for the Nigerian population
2. To determine the systematic prediction error of the formula, i.e., the error that could be expected in the best "point" estimate of gestational age (GA) for a given CRL
3. To compare the formula with established dating formulae.

Materials and Methods

The study was a two-stage procedure; the first stage was to develop a formula establishing a local reference for GA (in weeks) and the CRL (in mm). To achieve this we conducted a retrospective cross-sectional study at the obstetrics unit of our institution. The hospital records of 322 pregnant women who presented for early booking in the first trimester were reviewed. Inclusion criteria were regular menstrual periods (between 21 and 35 days) in the preceding months before conception, last normal menstrual period, and first trimester sonographic dating with fetal CRL measurement. Exclusion criteria were uncertain date or irregular menstrual cycle, maternal disease such as hypertension, diabetes, and renal disease likely to affect fetal size, multiple pregnancies,

pregnancies complicated by miscarriage, intra-uterine fetal death, and congenital abnormalities.

The date of last normal menstrual period, GA at delivery, and the CRL from first trimester ultrasonography were obtained from the hospital records. The ultrasound scans were performed by consultant radiologists or senior registrars in the Radiology Department of our institution with a Medison X6 and X8 machines (Medison, Seoul, South Korea). The estimated GA was calculated from the Last Menstrual Period (LMP) and corrected for cycle length for each CRL. CRL measurements were obtained transabdominally. At the point of measurement we ensured that the fetus was horizontal on the screen so that the line between crown and rump was 90° to the ultrasound beam. The long axis of the fetus in mid-sagittal position was measured from the crown of the head to the end of the trunk (rump) with the aid of the onscreen callipers.

We performed a polynomial linear regression to study the relationship between the Expected Gestatational Age (EGA) (in weeks) and CRL (in mm), and derived a mathematical formula for predicting the EGA in weeks from the CRL.

This formula is: GA = $-0.0008\ (CRL)^2 + 0.168\ (CRL) + 5.397$ ($R^2 = 0.8017$) [Figure 1]. The second stage was to test the reliability of our formula on a new set of data. This was a prospective study on 88 new pregnancies based on our inclusion criteria and we also tested the reliability of our formula by comparing with three other established formulae. The three established formulae referenced were Korean[2] (GA = CRL × 1.08815 + 6.321988), Robinson's[3] ($GA = 8.052 \times CRL^{1/2} + 23.73$), and Nelson's[4] ($GA = 51.008 + 0.6 \times CRL$). The performance of our best-fit model and derived formula was then tested against those of the three published CRL dating formulae in the new set of patients which are as follows: The menstrual age for each fetus was compared with the GA calculated using the three established formulae and the locally derived formula, and the mean difference in estimated GA was used to quantify the systematic prediction error (the error that could be expected in the best "point" estimate of GA for a given CRL). All statistical analyses were performed using the Statistical Package for the Social Sciences Version 15.0 (SPSS Inc., Chicago, IL, USA).

Results

A total of 410 subjects were analyzed, the demographics are illustrated in Table 1. The scatter plot of the raw data for the best-fit fractional polynomial regression model showing the estimated GA by CRL expressed in days and mm, respectively, for the first group of 322 subjects is shown in Figure 1. The best-fit equation for the estimate of GA for a given CRL was $GA = -0.0008\ (CRL)^2 + 0.168\ (CRL) + 5.397$ ($R^2 = 0.8017$). Figure 1 shows the estimated GA based on this formula derived from the CRL. Figure 2 shows the comparison of our GA estimation equation with those of established formulae. The systematic prediction error (mean difference) between menstrual age and the predicted GA using our own formula in the second group of our study population was 0.13 days, compared with −0.16 for Nelson formula, 0.20 for Robinson, and 0.572 for the Korean formula (not shown in figure). Thus when our formula has the tendency to overestimate the GA by 0.13 weeks, Nelson's formula tend to underestimate by 0.16 weeks. The Korean formula has the largest systematic error, of overestimation of about 4 days (i.e., 0.572).

Discussion

In this study, we established a dating formula for use in the Nigerian population for accurate first trimester dating of naturally conceived pregnancies that had lower systematic prediction error than for established formulae. The strength of our study derived from our ability to exclude pregnancies

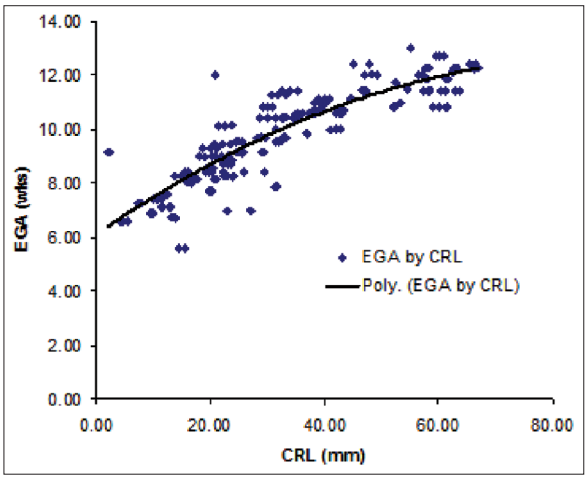

Figure 1: Best-fit fractional polynomial regression model result for mean GA (weeks) by CRL (mm). GA – Gestational age; CRL – Crump length; EGA – Expected gestatational age

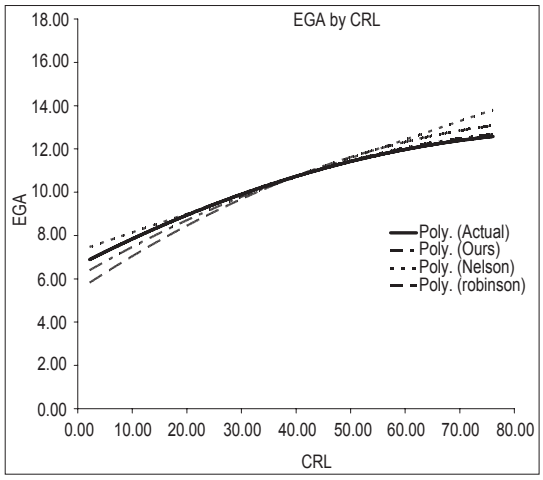

Figure 2: Comparison of our gestational age estimation equation with those of established formulae. CRL – Crump length; EGA – Expected gestational age

Table 1: Demographic characteristics of participants

	Group 1	Group 2
N	322	88
Median age (range) (years)	29 (16-41)	28 (17-39)
Median EGA by LMP (weeks)	10 (5-13)	11 (6-15)
Nulliparous (*n* [%])	132 (41)	38 (43)
EGA @ delivery (*n* [%])		
<37 weeks	19 (5.9)	5 (5.7)
37-41 weeks	295 (91.6)	81 (92.0)
>41 weeks	8 (2.4)	2 (2.3)
Mean birth weight	3188±470	3101±4684
Male	52	50

EGA – Expected gestational age; LMP – Last menstrual period

with complications that were likely to affect fetal size, such as congenital anomalies, intra-uterine growth restriction, or intra-uterine fetal death, were consistent with the criteria reported by Altman and Chitty.[3] This was made possible because data were collected retrospectively from an available clinical dataset after the pregnancies have completed their course.

A limitation of this study, however, was that CRL measurements were only reported as a single measurement by one sonologist rather than as average of repeated measurements preferably by different sonologists after inter-observer reliability has been adjudged to be more accurate.[4] Moreover, a relatively wide scatter observed in Figure 1 could reflect a lack of standardization in technique.

Overall, the pattern of our scatter plot from which we derived our best-fit formula was similar to that of other models obtained predominantly from Caucasian population.[5-8] This suggests that the growth pattern between Nigerian and non-Nigeria population are not clinically significantly different when the CRL is used in the first trimester of pregnancy. This pattern was also noted by earlier researchers in Nigeria, although most of the works were on other parameters of GA assessment, such as the biparietal diameter and the abdominal circumference.[9-12] In a publication on a population of Nigerians, the diameter of the liver was measured as an assessment of GA, and the results were similar to a large extent to results from Caucasian studies.[13]

However, when applied to our population, the CRL formulae for Caucasian population showed prediction errors that were slightly greater than the formula derived from our population. Presently, 22 different CRL based dating formulae are identified for natural and assisted-reproduction pregnancies, none of which is based on a Nigerian population.[4] No previous study has considered selection of the best formula for pregnancy dating in first trimester for the Nigerian obstetric population.

Athma and colleagues advised that systematic prediction error should be considered when selecting a dating formula.[3] The systematic error is the systematic over - or underestimation of GA using a particular formula. The systematic error of our CRL dating formula was 0.13 weeks, lower than that of the other three formulae against which comparisons were performed. First trimester aneuploidy screening using ultrasound measurement of fetal nuchal translucency (NT) and maternal biochemistry which are now a part of routine antenatal care in many countries.[14] Accurate dating of pregnancy is critical to the quality of screening programmes because of the distribution of NT and serum markers are varied according to the GA. A difference of 1 or 2 days GA can alter a Down's screening result from high risk to low risk.[15]

Thus depending on the time of incorporation of a Nigerian-specific CRL-based sonographic formula into ultrasound machines destined for use in our obstetric population, obstetricians involved in prenatal diagnosis in Nigeria should consider using our formula as an additional tool in arriving at an accurate GA.

In conclusion, we have derived a first trimester dating formula for the Nigerian obstetric population, which has a very low systematic prediction error compared with some published CRL dating formulae derived for a different population. Because Nigeria is a multi-ethnic society, ethnic-specific formulae may need to be further developed to enhance the accuracy of our derived formula.

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