Exploring Maternal Nutrition and its Impact on Fetal Growth Patterns in Urban Communities: A study on Pregnant Women in Ojo, Lagos State, Nigeria

ABSTRACT

Accurate estimation of fetal weight is crucial for prenatal care and decision-making. This study aimed to develop a fetal anthropometric model using ultrasound measurements to estimate fetal weight between 20-40 weeks of gestation in Ojo, Lagos State. A longitudinal study of 300 pregnant women was conducted, with obstetric ultrasoundscans images. Fetal biometric parameters (biparietal diameter and head circumference) were measured and correlated to estimate fetal weight using Hadlock's formula. Regression analysis was used to develop a predictive model for estimating fetal weight. From the results,there was a negative correlation between fetal biometric parameters and estimated fetal weight (R2 = 0.113, $p < 0.001$). This study provides a reliable and accurate method for estimating fetal weight in the Nigerian population, enhancing prenatal care and obstetric decision-making.

Key words: Fetal; Anthropometry; Estimation; Ultrasound; Lagos State; Nigeria

INTRODUCTION

Anthropometry is a branch of anthropology that deals with the measurement of human individuals (1). It has been used for identification with the purpose of understanding human physical variation and in various endeavors to correlate physical with racial and physiological traits.This process entails the systematic evaluation of the physical characteristics of the human body, focusing on dimensions that describe body size and shape (2). Due to the limited effectiveness of traditional methods for assessing living standards, anthropometric history has proven to be a valuable tool for historians seeking to address pertinent inquiries.Anthropometric measurements are non-invasive quantitative body measurements that offer a valuable evaluation of nutritional status in individuals of all ages, including children and adults(3,4.5) Anthropometric measurements are utilized in pediatrics to assess the overall health, nutritional status, and growth and development of children.

Fetal biometry (also known as fetal anthropometry) is an important foundation of modern prenatal care. Biometry assessment has become a common practice since the introduction of the ultrasonic fetal measurements in the 1960s (6). It is the measurement of various parts of the fetus using ultrasonography to assess fetal growth, approximate fetal weight and wellbeing (7). Accurate estimation of gestational age is the key to further interpretations of fetal biometry. Fetal biometry gives more insights on the reasons why fetuses are big or small and if there is any abnormalities found in the fetuses(8, 9). It is very accurate and one of the most reliable ways used in determining the growth of a fetus. The fetal biometric parameters used to ascertain these abnormalities included; gestational sac, crown rump length (CRL), biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur diaphysis length (FL) (10). However, the fetal biometric parameters commonly used are BPD, HC, AC and FL. These biometric measurements can be combined into an estimated fetal weight (EFW) using a more straightforward and clinically relevant estimate of fetal weight.

Initially, the reference ranges for these four commonly used parameters for fetal biometry by ultrasound were reported by Hadlock in 1982 on the populations of developed countries.Hardlock formula for estimating fetal weight has been widely validated and is considered accurate for assessing fetal growth. The normal average ranges for fetal biometry measurements differ among populations and weeks of development. For instance, the average fetal biometry measurements in millimeters (mm) are: Head Circumference (HC) ranges between 86 and 365mm for gestational age between 14 and 41 weeks (11), Abdominal Circumference (AC) varies from 86 to 365mm for gestational age between weeks 14 and 41 weeks (11), Biparietal Diameter (BPD) between 14 and 71mm in the second trimester and 27 to 98mm for gestational age between 14 and 40 weeks (12), and Femur Length (FL) ranges from 16 to 53mm in the second trimester and 55 to 79mm in the third trimester (Beigi and ZarrinKoub, 2000) (11).

Fetal biometric parameters are important for many reasons. It provides alerts about the risk of pre-eclampsia and preterm birth which has help pregnant women take precautions to reduce the risk of being victims to high blood pressure. It also provides important information for growth restriction (13). The goal of this study was to determine the relationship and establish the correlation between fetal biometric parameters and estimated fetal weight between gestational ages 20-40 weeks in Southwestern region of Nigeria, Ojo, Lagos State.

MATERIALS AND METHODS

This study adopted a cross-sectional population based study design and consisted of 300 obstetric ultrasound scan images that belonged to pregnant women with single fetus within 20-40 weeks gestational age who visited Ceno Medical Laboratory Services, in Ojo Local Government Area, Lagos, Nigeria.The images used in this study were gotten from a system called PACS (pictures archiving and communication system).

The following parameters were assessed:

Biparietal Diameter (BPD): measurement taken from the front edge of one parietal bone to the back edge of the opposite parietal bone.

Head Circumference (HC): determined using the same plane as the Biparietal Diameter (BPD), specifically on the axial plane passing through the thalami and cavum septum pellucidum.

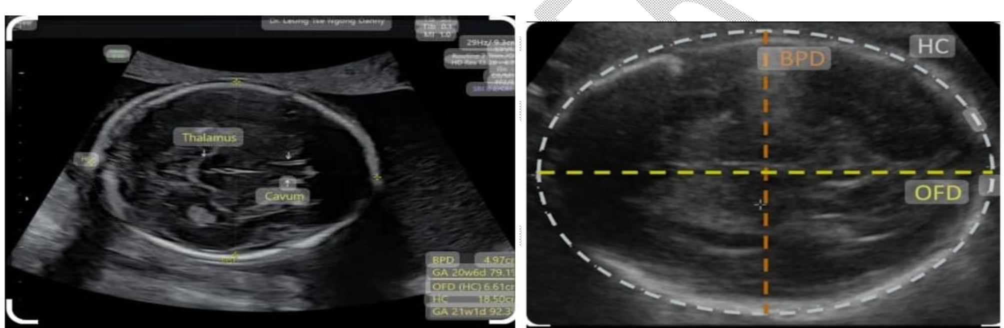

Figure 1 and 2: Measurement of the Biparietal Circumference and
Measurement of the Head Circumference [14]

The Hardlock's formula was used specifically to ensure consistency with international studies. The gathered data from the research underwent both descriptive and inferential statistical analysis. The hadlock's formula used in estimating fetal weight was outlined as follow:

Hadlock 3: Log 10 (Weight) = 1.326-0.00326*AC*FL+0.0107*HC +0.0438*AC + 0.158*FL.

RESULTS

Table 1 and 2 shows the descriptive statistics of all measured variables and correlations in the study population.This data provides an overview of the average values and variability of each variable within the dataset.

Table 3displaysP value of the linear regression equation. From the results, it shows there is a strong connection between the fetal measurements (HC, and BD) and the estimated weight of the fetus. This means we can use the fetal measurements to estimate its weight.

Table 1: Descriptive Statistics of the Biometric Parameters of Fetus

	Minimum (mm)	Maximum (mm)	Mean±SD
HC	175.90	351.90	282.36±46.82
BD	30.30	93.80	75.93±12.79

Key note:
HC-Head Circumference, BPD-Biparietal Diameter

Table 2: Correlations among Variables (HC and BPD)

	FL	HC	BPD	AC	EFW
HC	.997**	1	.940**	.994**	-.282**
BPD	.942**	.940**	1	.935**	-.280**

Correlation is significant at the 0.01 level (2-tailed)

Table 3: Correlations between EFW and Measured Variables

Variables	R	P
HC	-0.282^{*}	0.001
BPD	-0.280^{*}	0.001

HC-Head Circumference, BD-Biparietal Diameter
r- Pearson's correlation coefficient
*Correlation is significant at the 0.05 level (2-tailed)

DISCUSSION

Our study recorded an head circumference with a minimum value of 175.90mm whichis less than a study byHadlock*et al.*(7) standard value of 177mm. The mean standard deviation of 282.36±46.82 had a difference of 48.84 from that of Aggarwal and Sharma, (15)findings of 331.6±11.6. From the obtained results in this present study in comparison to previous studies there are similarities in terms of the head circumference.

The biparietal diameter with a minimum value of 30.30mm is less than the findings of Hadlock's having a value of 47.7mm and 56.00mm respectively. The minimum value is having a difference of -17.4mm and -25.7mm each. The mean difference between these studies; Aggarwal and Sharma, (15)and Hadlock *et al.*(7) is 4.30mm and -0.2mm respectively. The mean standard deviation of 75.93±12.79 is less than Aggarwal and Sharma, (15)study 91.2±03.8 mean standard deviation with a difference of 6.28. The possible différences between the measurements in thesestudiesmaybe due to nutrition intake, dietpracticesandseasonalfoodavailability.

In term of comparing the Biparietal diameter, there are similarities between this present study and previous studies.

The abdominal circumference with a minimum value of 147.10mm which is almost similar with Aggarwal and Sharma, (15) finding of 147.90mm but less than Hadlock Standard Value of 150mm Hadlock *et al.*(7). The maximum value of 368.80mm is having a difference of 34.6mm from a past study of 334.2mm and 15.8mm from Hadlock's Standard Value of 353mm. The mean standard deviation of 273.21±70 is slightly different from the findings of a study likeAggarwal and Sharma, (15)which are 321.5±16.5. There's therefore a similarity in the minimum values with other studies but difference in the maximum values and mean standard deviation of other studies.

In comparison with other studies like Demircan and Berkol,(14), Karki*et al.*(16), it shows there can be either slightly a difference or significantly a difference from the standard reference values but it can never be exact.

The Estimated Fetal Weight (EFW) with a minimum value of 0.00kg, maximum value of 0.31kg and the mean standard deviation of 0.003±0.021 all between 20-40 weeks of gestational age. It can be said that this study is likely in agreement with the study of Aggarwal and Sharma, (15).

The P value for the derived linear regression equation implies that a significant relationship exists between the predictors (HC and BD) and estimated fetal weight which means the fetal biometric parameters can be used to estimate fetal weight.

CONCLUSION

Based on this study, fetal biometric measurements are connected. When one goes up, the other goes down. This means that there is a relationship between fetal biometric measurements (HC and BD) and Estimated Fetal Weight (EFW). So, the size of a fetus can help us estimate how much it weighs. This shows that fetal measurements are helpful in predicting fetal weight.

It is therefore recommended that Toimprove the accuracy of fetalweightpredictionmodelsbased on biometricmeasurements for the Nigerian population, future researchcould focus on collecting a large, diverse dataset of biometricmeasurementsfromNigerianwomen to ensure the model reflects the specificphysical and geneticcharacteristics of this population. This couldinvolve sampling acrossdifferentregions and ethnic groups in Nigeria to account for variations.

Ethicalapproval

Approval for the studywassoughtfrom the Research and EthicsCommittee at the Faculty of Basic Medical Sciences, Delta State University, Abraka (RBC/FBMC/DELSU/24/353). In addition, clearance wasgottenfrom the ethicalcommittee at CenoMedicalLaboratory Services, located on Shibiri Road, Arola Bus Stop, Ojo, Lagos State.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

REFERENCES

1. Baten J, and Komlos J. Looking backward and looking forward: anthropometric research and the development of social science history. *Social Science History*,2004;28(2):191-210.

2. Kinare AS, Chinchwadkar MC, Natekar AS, Coyaji KJ, Wills AK, Joglekar CV. Patterns of fetal growth in a rural Indian cohort and comparison with a Western European population: Data from the Pune maternal nutrition study. *J Ultrasound Med*,2010; 29(2):215-223.

3. Fryar CD, Gu Q, Ogden CL, Flegal KM. Anthropometric reference data for children and adults: United States, 2011-2014. *Vital Health Statistics 3 Anal Study*,2016; 39:1-46.

4. Mamerhi ET, Godswill OO. Anthropometric study of the frontal sinus on plain radiographs in Delta State University Teaching Hospital. *J Exp Clin Anat*, 2018;17(2):49-52.

5. Udi, OA, Godswill OO, Mamerhi ET, Boma D. Nutritional knowledge and body mass index among students at Novena University, Ogume, Nigeria. Folia Medical Indonesiana, 2023; 59:20-25.

6. Willocks J, Donald I, Duggan TC. Foetal Cephalometry by Ultrasound. *BJOG International Journal Obstetetric Gynaecology*.1964;71(1):11-20.

7. Hadlock FP, Deter RL, Harrist RB, Park SK. Estimating fetal age: Computer-assisted analysis of multiple fetal growth parameters. *Radiology*, 1984;152(2):497-501.

8. Omogbiya A, Moke EG, Ojieh AE, Enaohwo MT, Umukoro EK, Anachuna KK, Omilo CU. Evaluation of perception, attitude, and impact of club-house noise pollution on mental health of individuals living within proximity of club-houses in Abraka, Delta State, Nigeria. *Journal of Applied Sciences and Environmental Management*, 2020;24(6):1009-1013.

9. Moke EG, Ekuerhare B, Enaohwo MT, Asiwe JN, Ofulue OO, Umukoro EK, Isibor NP. Resistant Hypertension. *Journal of Drug Delivery and Therapeutics,* 2020; 12(3):230-235.

10. Degani S. 'Fetal biometry: clinical, pathological, and technical considerations'. *Obstetric Gynecology Survey,*2001; 56(3):159-167.

11. Beigi A. andZarrinkoub F. 'Ultrasound assessment of fetal biparietal diameter and femur length during normal pregnancy in Iranian women'. *International Journal GynaecologyObstetetrics,* 2000;69:237-242.

12. Kovac CM, Brown JA, Apodaca CC, Napolitano PG, Pierce B, PatienceT. Maternal ethnicity and variation of fetal femur length calculations when screening for Down syndrome. *Journal of Ultrasound Medicine,* 2002; 21:719-722.

13. Murao F, Takamiya O, Yamamoto K, andIwanari O. Detection of intrauterine growth retardation based on measurements of size of the liver. *Gynecologic and Obstetric Investigation,* 1990; 29(1):26-31.

14. Demircan A and Berkol Y. Growth curves derived from ultrasonographic fetal parameters in a Turkish population. *Marmara Med J,*1988; 1:6-16.

15. Aggarwal N and Sharma GL. Fetal ultrasound parameters: Reference values for a local perspective. *Indian J Radiol Imaging,* 2020; 30:149-55.

16. Karki DB, Sharma UK, &Rauniyar RK. Study of accuracy of commonly used fetal parameters for estimation of gestational age. *Journal of Nepal Medical Association,* 2006;45(162):233-237.