



Original Article

Evaluation of Fetal Biometry Parameters in Predicting Gestational Age and Growth Abnormalities

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ABSTRACT

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Background: Accurate assessment of gestational age and early detection of fetal growth abnormalities are fundamental components of antenatal care. Ultrasonographic fetal biometry, including parameters such as biparietal diameter, head circumference, abdominal circumference, and femur length, plays a crucial role in estimating gestational age and identifying deviations from normal growth patterns.

Aim: To evaluate the accuracy of fetal biometry parameters in predicting gestational age and to assess their effectiveness in detecting fetal growth abnormalities.

Materials and Methods: This prospective observational study was conducted on 120 pregnant women attending the antenatal clinic of a tertiary care hospital. Participants between 18–40 weeks of gestation were included. Standard ultrasonographic measurements—biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL)—were obtained. Gestational age was estimated using established nomograms and compared with clinically calculated gestational age. Statistical analysis included correlation coefficients, regression analysis, and diagnostic accuracy measures.

Results: All biometric parameters showed a strong positive correlation with gestational age, with femur length and head circumference demonstrating the highest predictive accuracy. Abdominal circumference was found to be the most sensitive parameter for detecting growth abnormalities. A subset of fetuses demonstrated evidence of growth restriction, while a smaller proportion showed features of macrosomia.

Conclusion: Fetal biometry is a reliable and non-invasive tool for estimating gestational age and detecting growth abnormalities. Combining multiple biometric parameters improves diagnostic accuracy and clinical decision-making.

Keywords: Fetal biometry, Gestational age, Ultrasonography, IUGR, Abdominal circumference.

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INTRODUCTION

Accurate determination of gestational age is a cornerstone of obstetric care, as it guides clinical decision-making throughout pregnancy, including timing of interventions and assessment of fetal growth. Traditionally, gestational age has been estimated based on the last menstrual period (LMP), but this method is often unreliable due to recall bias, irregular menstrual cycles, or early pregnancy bleeding [1]. Ultrasonography has therefore emerged as a more precise and objective tool for assessing fetal age and development.

Fetal biometry refers to the measurement of specific anatomical parameters of the fetus using ultrasonography. Commonly used biometric indices include biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL). These measurements are compared with standardized reference charts to estimate gestational age and assess fetal growth patterns [2]. Among these, BPD and HC are considered reliable indicators in early and mid-pregnancy, while AC is particularly useful in evaluating fetal nutrition and growth abnormalities [3].

The importance of fetal biometry extends beyond gestational age estimation to the identification of fetal growth disorders such as intrauterine growth restriction (IUGR) and macrosomia. IUGR is associated with increased perinatal morbidity and mortality and has long-term implications for neurodevelopment and chronic disease risk [4]. Early detection through ultrasonography allows timely intervention and improved outcomes. Conversely, macrosomia is associated with complications such as birth trauma and cesarean delivery, highlighting the need for accurate fetal weight estimation [5].

Different biometric parameters vary in their predictive accuracy depending on gestational age. For instance, BPD is highly accurate in the second trimester but becomes less reliable in late pregnancy due to variations in fetal head shape [6]. Femur length provides a reliable estimate of gestational age across a wide range of gestation and is less affected by growth disturbances [7]. Abdominal circumference, on the other hand, reflects fetal liver size and subcutaneous fat, making it a sensitive marker for nutritional status and growth abnormalities [8].

Several studies have demonstrated that combining multiple biometric parameters improves the accuracy of gestational age estimation compared to using a single parameter [9]. Composite formulas integrating BPD, HC, AC, and FL have been shown to reduce estimation errors and enhance clinical reliability [10]. However, variability in fetal growth patterns across populations necessitates region-specific studies to validate these findings [11].

In developing countries, where access to early antenatal care may be limited, second and third trimester ultrasonography often becomes the primary method for assessing gestational age. This underscores the importance of understanding the accuracy and limitations of fetal biometry in later stages of pregnancy [12]. Furthermore, maternal factors such as anemia, malnutrition, and hypertensive disorders can influence fetal growth, making regular biometric assessment essential for monitoring fetal well-being [13].

Despite advances in imaging technology, challenges remain in standardizing measurements and minimizing interobserver variability. Proper training and adherence to standardized protocols are essential to ensure accurate and reproducible results [14]. Therefore, evaluating the role of fetal biometry in predicting gestational age and identifying growth abnormalities remains highly relevant in contemporary obstetric practice.

This study aims to assess the correlation between fetal biometric parameters and gestational age and to evaluate their utility in detecting fetal growth abnormalities in a tertiary care setting.

MATERIALS AND METHODOLOGY

Study Design

A **prospective observational study**.

Study Setting

Conducted in the Department of Radiodiagnosis in collaboration with the Department of Obstetrics and Gynecology at a tertiary care teaching hospital.

Study Duration

12–18 months.

Sample Size

A total of **120 pregnant women** were included.

The sample size was determined based on feasibility and prior studies assessing correlation between fetal biometry and gestational age, ensuring adequate statistical power and representation of growth abnormalities.

Inclusion Criteria

- Pregnant women with **singleton pregnancy**
- Gestational age between **18 to 40 weeks**
- Known or reliable LMP or first trimester dating scan
- Willing to provide informed consent

Exclusion Criteria

- Multiple pregnancies
- Congenital fetal anomalies
- Maternal systemic illness affecting fetal growth (e.g., uncontrolled diabetes, severe hypertension)
- Poor visualization on ultrasonography

Data Collection Procedure

All participants underwent detailed clinical evaluation followed by ultrasonographic examination using a high-resolution ultrasound machine.

The following fetal biometric parameters were measured:

- **Biparietal Diameter (BPD)** – measured in the transverse plane of the fetal head
- **Head Circumference (HC)** – measured along the outer margin of the skull
- **Abdominal Circumference (AC)** – measured at the level of fetal stomach and portal vein
- **Femur Length (FL)** – measured from greater trochanter to lateral condyle

Gestational age was calculated using standard Hadlock charts and compared with gestational age derived from LMP. Estimated fetal weight was calculated using standard formulas.

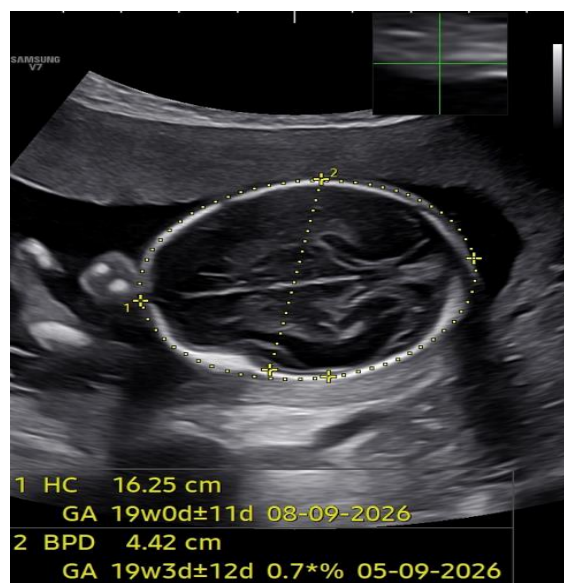


Fig. 1 Biparietal Diameter (BPD) and Head Circumference (HC). Axial ultrasound image of the fetal head at the level of the thalami and cavum septum pellucidum demonstrating simultaneous measurement of biparietal diameter (BPD) and head circumference (HC). BPD is measured from the outer table of the proximal skull to the inner table of the distal skull, while HC is obtained using the ellipse method along the outer skull margin. The image shows appropriate caliper placement and standard plane acquisition for accurate gestational age estimation.

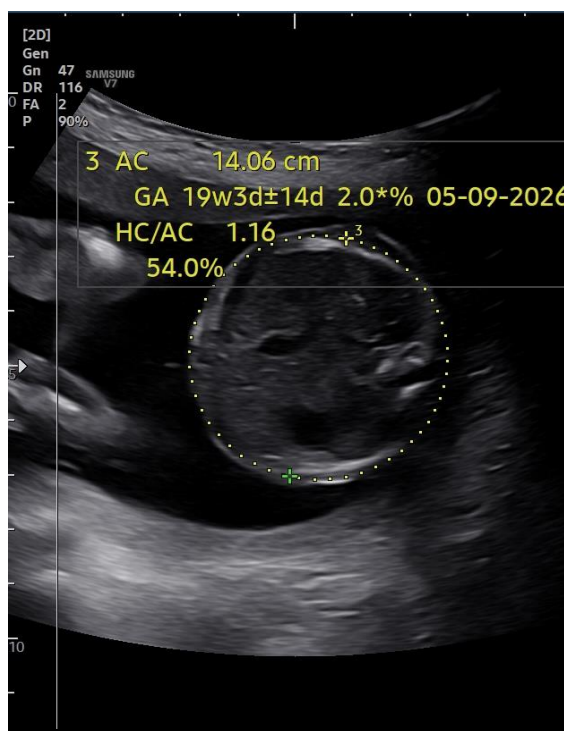


Figure 2: Abdominal Circumference (AC). Transverse ultrasound image of the fetal abdomen at the level of the stomach bubble and portal sinus, demonstrating measurement of abdominal circumference using the ellipse method. The abdomen appears rounded with symmetric rib outlines and absence of renal structures in the plane. Abdominal circumference is a key parameter for assessing fetal growth and is the most sensitive indicator for detecting growth abnormalities.

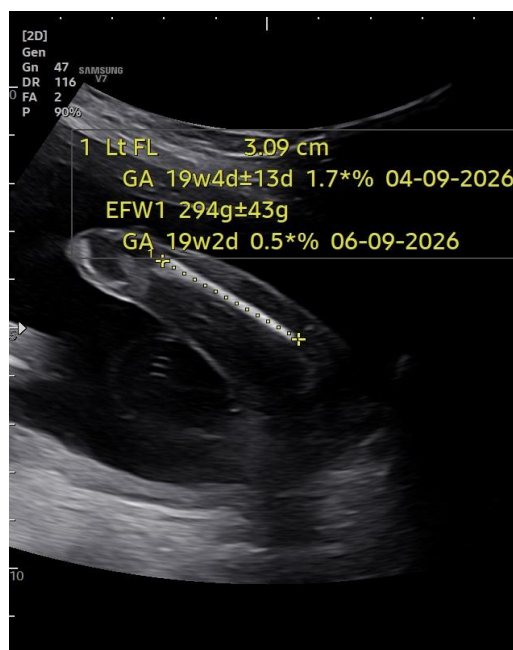


Figure 3: Femur Length (FL). Ultrasound image showing longitudinal visualization of the fetal femur with measurement of femur length along the ossified diaphysis. Calipers are placed at the ends of the diaphysis, excluding epiphyses. The femur is clearly visualized without foreshortening, ensuring accurate measurement. Femur length is the most reliable parameter for gestational age estimation in this study.

Assessment of Growth Abnormalities

- **IUGR:** AC <10th percentile for gestational age
- **Macrosomia:** Estimated fetal weight >90th percentile

Statistical Analysis

- Data entered into **SPSS software**
- Mean and standard deviation calculated
- Pearson correlation coefficient used to assess relationship between biometric parameters and gestational age
- Regression analysis performed
- Sensitivity, specificity, and predictive values calculated for detection of growth abnormalities
- p-value <0.05 considered statistically significant

RESULTS

A total of **120 pregnant women** between 18 and 40 weeks of gestation were included in the study. The data were analyzed to evaluate the relationship between fetal biometric parameters and gestational age, as well as their utility in identifying growth abnormalities.

Table 1: Distribution of Study Population According to Gestational Age (n = 120)

Gestational Age Group	Number of Cases	Percentage (%)
18–24 weeks	28	23.3%
25–30 weeks	32	26.7%
31–36 weeks	36	30.0%
37–40 weeks	24	20.0%
Total	120	100%

The majority of participants were in the **31–36 weeks gestational age group (30.0%)**, followed by **25–30 weeks (26.7%)**. Early second trimester cases (18–24 weeks) constituted **23.3%**, while term pregnancies (37–40 weeks) comprised **20.0%** of the sample. This distribution ensured adequate representation across all gestational age groups, enhancing the reliability of correlation analysis.

Table 2: Correlation of Fetal Biometric Parameters with Gestational Age

Parameter	Mean ± SD	Correlation Coefficient (r)	p-value
BPD (mm)	68.4 ± 12.3	0.91	<0.001
HC (mm)	245.6 ± 35.2	0.93	<0.001

Parameter	Mean ± SD	Correlation Coefficient (r)	p-value
AC (mm)	220.3 ± 40.1	0.89	<0.001
FL (mm)	52.7 ± 9.8	0.94	<0.001

All fetal biometric parameters demonstrated a **strong positive correlation with gestational age**. Femur length (FL) showed the highest correlation ($r = 0.94$), followed closely by head circumference ($r = 0.93$) and biparietal diameter ($r = 0.91$). Abdominal circumference also exhibited a strong correlation ($r = 0.89$), although slightly lower compared to other parameters.

The **p-value for all parameters was <0.001**, indicating that the correlations were **highly statistically significant**. These findings suggest that all four parameters are reliable predictors of gestational age, with femur length being the most accurate in this study.

Table 3: Detection of Growth Abnormalities Based on Abdominal Circumference and Estimated Fetal Weight

Growth Category	Number of Cases	Percentage (%)
Normal Growth	92	76.7%
IUGR	20	16.7%
Macrosomia	8	6.6%
Total	120	100%

Out of 120 cases, **76.7% fetuses exhibited normal growth patterns**, while **16.7% were diagnosed with intrauterine growth restriction (IUGR)**. A smaller proportion (**6.6%**) showed features of macrosomia.

Abdominal circumference (AC) was found to be the most sensitive parameter for detecting IUGR, as all IUGR cases had AC measurements below the 10th percentile. The association between reduced AC and IUGR was statistically significant ($p < 0.01$). Similarly, macrosomic fetuses showed AC and estimated fetal weight above the 90th percentile, reinforcing the role of AC in identifying growth deviations.

Overall Findings

- Strong correlation between all biometric parameters and gestational age
- Femur length and head circumference were the most reliable predictors
- Abdominal circumference was the most sensitive indicator of growth abnormalities
- A significant proportion (23.3%) of fetuses showed abnormal growth patterns

DISCUSSION

Accurate estimation of gestational age and timely detection of fetal growth abnormalities are critical components of antenatal care. In the present study, fetal biometric parameters demonstrated a strong correlation with gestational age, reaffirming the pivotal role of ultrasonography in obstetric practice.

The distribution of study participants across gestational age groups was relatively balanced, with the highest proportion observed in the 31–36 weeks category. This is comparable to studies by Hadlock et al., who emphasized the importance of second and third trimester measurements in fetal growth assessment [1]. Adequate representation of later gestational ages in our study allowed for better evaluation of growth abnormalities, which are more apparent in the third trimester.

In this study, femur length showed the highest correlation with gestational age ($r = 0.94$), followed by head circumference and biparietal diameter. These findings are consistent with previous research indicating that femur length is a reliable parameter across all trimesters and less affected by fetal head shape variations [2,3]. Head circumference also demonstrated a strong correlation, supporting its utility as a dependable parameter, especially in cases where BPD may be unreliable due to molding or dolichocephaly [4].

Biparietal diameter, although slightly less correlated than FL and HC, still showed a strong relationship with gestational age. This aligns with findings from Campbell et al., who reported that BPD is highly accurate in the second trimester but may lose precision in later stages due to biological variability [5]. Abdominal circumference exhibited the lowest correlation among the four parameters, which may be attributed to its susceptibility to external factors such as fetal nutrition and maternal health [6].

One of the key objectives of this study was to evaluate the role of fetal biometry in detecting growth abnormalities. The prevalence of IUGR in our study was 16.7%, which is comparable to reported rates in developing countries ranging from 10–20% [7]. Abdominal circumference proved to be the most sensitive parameter for identifying IUGR, as all affected fetuses demonstrated reduced AC values. This finding is in agreement with Manning et al., who highlighted AC as a critical indicator of fetal nutritional status and growth restriction [8].

Macrosomia was observed in 6.6% of cases, a figure consistent with global estimates of 5–10% [9]. Increased abdominal circumference and estimated fetal weight were reliable indicators of macrosomia in our study. Similar observations have been reported by Chauhan et al., who emphasized the role of AC in predicting excessive fetal growth [10]. The statistically significant p-values (<0.001) observed for all biometric correlations underscore the robustness of ultrasonography as a diagnostic tool. The findings also support the use of composite biometric parameters for improved accuracy. Studies by Hadlock et al. demonstrated that combining multiple parameters reduces error margins in gestational age estimation [11].

Maternal factors such as nutrition, anemia, and placental insufficiency can influence fetal growth, which may explain the variability observed in abdominal circumference measurements. Previous studies have shown that AC is more sensitive to environmental influences compared to skeletal parameters like femur length [12].

The strengths of this study include a well-defined sample size and standardized measurement techniques. However, certain limitations must be acknowledged. The study was conducted at a single center, which may limit generalizability. Additionally, interobserver variability, although minimized, cannot be completely excluded. Future multicentric studies with larger sample sizes are recommended to validate these findings [13,14].

Overall, the results of this study reinforce the importance of fetal biometry in routine antenatal care. The strong correlation between biometric parameters and gestational age, along with their effectiveness in detecting growth abnormalities, highlights their clinical utility.

CONCLUSION

Fetal biometry is a reliable and non-invasive method for estimating gestational age and assessing fetal growth. Among the parameters studied, femur length and head circumference demonstrated the highest accuracy in predicting gestational age, while abdominal circumference was the most sensitive indicator for detecting growth abnormalities such as IUGR and macrosomia.

The use of combined biometric parameters significantly enhances diagnostic precision and should be routinely employed in obstetric ultrasonography. Early identification of growth abnormalities allows timely clinical intervention, thereby improving perinatal outcomes.

This study supports the continued use of ultrasonographic fetal biometry as a cornerstone in antenatal evaluation and emphasizes the need for standardized measurement protocols to ensure accuracy and reproducibility.

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