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Ultrasound-Based Correlation between Gestational Age and Fetal Abdominal Circumference during the Third Trimester: A Cross-Sectional Study

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ABSTRACT

Background: Accurate determination of gestational age (GA) is crucial for providing effective obstetric care, monitoring fetal growth, and predicting delivery outcomes. Fetal abdominal circumference (AC), measured via ultrasonography, is a reliable parameter for estimating GA, particularly in the third trimester. This study aimed to evaluate the correlation between GA and AC during the third trimester using ultrasonography.

Methods: A cross-sectional observational study was conducted among 132 pregnant women in their third trimester who attended antenatal clinics at the Government Medical College. Only participants with a known last menstrual period (LMP) and regular menstrual cycles were included. AC was measured using standardized ultrasonographic techniques. The relationship between AC and GA was analyzed using linear regression.

Results: A strong positive correlation was observed between GA and AC ($r=0.8298$, $p<0.0001$). The regression equation derived was: GA (weeks)=8.695 + 0.924×AC (cm), indicating that AC is a significant predictor of GA.

Conclusion: Ultrasonographically measured AC in the third trimester is a reliable and non-invasive predictor of gestational age. Its inclusion in routine antenatal assessments can improve fetal monitoring and delivery planning, ultimately enhancing maternal and fetal health outcomes.

Key-words: Gestational Age, Abdominal Circumference, Ultrasonography, Third Trimester, Fetal Biometry

INTRODUCTION

Gestational age (GA) is a critical determinant in the management of pregnancy, labor, and neonatal outcomes. It serves as a cornerstone in prenatal care, influencing nearly every clinical decision from screening schedules and intervention planning to the timing of delivery and assessment of fetal maturity. Accurate estimation of GA is vital not only for optimal obstetric care but also for medicolegal purposes. [1]

Traditionally, GA has been estimated using the date of the last menstrual period (LMP), fundal height measurements, and physical examination. However, these methods are frequently limited by unreliable menstrual history, irregular cycles, or variations in uterine growth. Miscalculations may lead to

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inappropriate interventions such as unnecessary labor induction or delayed management of high-risk pregnancies. [2]

Ultrasonography has become the gold standard for GA estimation, offering a non-invasive, accessible, and highly accurate tool for fetal assessment. In the first trimester, the most accurate method is crown–rump length (CRL), with minimal variation across fetuses. However, as the pregnancy progresses beyond the first trimester, other fetal biometric parameters- including biparietal diameter (BPD), head circumference (HC), femur length (FL), and abdominal circumference (AC) are commonly used to estimate fetal age and monitor growth. [3,4]

Among these parameters, abdominal circumference is of particular importance in the third trimester, reflecting the size of the fetal liver and subcutaneous fat, which are closely linked to fetal nutrition and well-being. It is considered one of the most sensitive indicators of fetal growth abnormalities such as intrauterine growth restriction (IUGR) and macrosomia. [5,6] Studies have shown that AC not only correlates strongly with gestational age but also improves the predictive accuracy of estimated fetal weight (EFW), especially when combined with other measurements. [7]

Recent research continues to support the reliability of AC in estimating GA during late pregnancy. The Pregnancy Outcome Prediction (POP) study, a large prospective UK cohort, demonstrated that third-trimester biometry, including AC, can significantly enhance the detection of growth-restricted fetuses. [8] Similarly, a 2022 cohort study from Eastern India emphasized the utility of routine third-trimester ultrasonography in detecting adverse perinatal outcomes, even in clinically low-risk pregnancies. [9]

Population-based studies have also emphasized the importance of region-specific biometric reference values. A 2023 study conducted at AIIMS Jodhpur established normative charts for fetal parameters, including AC in the Indian population, underscoring ethnic and nutritional influences on fetal growth. [10] The researchers concluded that fetal growth patterns among Indian fetuses differ significantly from Western standards, and thus, regionally validated regression models are crucial for accurate GA estimation and growth monitoring.

Moreover, updated guidelines from the American Institute of Ultrasound in Medicine (AIUM) and the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) stress the importance of standardizing AC measurements at the level of the fetal stomach, spine, and portal vein junction to ensure consistency and reproducibility across clinical settings. [11]

Given the clinical importance of precise GA estimation in the third trimester and the recognized value of AC as a reliable biometric parameter, this study aims to evaluate the correlation between GA and AC in a cohort of Indian pregnant women using ultrasonography. In addition, we aim to derive a regression model that may aid clinicians in estimating gestational age when LMP data is missing, uncertain, or unavailable.

MATERIALS AND METHODS

Study Design and Setting- This study was a cross-sectional observational study conducted in the Department of Radiology and Obstetrics at Government Medical College and Hospital, in Maharashtra, India. The study was carried out over a defined period from August 2023 to July 2024 and aimed at evaluating the correlation between gestational age (GA) and abdominal circumference (AC) in pregnant women during the third trimester.

Sample Population- A total of 132 pregnant women attending the antenatal care (ANC) clinic were enrolled for ultrasonographic examination in their third trimester (≥28 weeks of gestation).

Inclusion Criteria

- Singleton pregnancy
- Known and reliable date of last menstrual period (LMP).
- Regular menstrual cycles (28±2 days).
- Gestational age between 29 and 42 weeks.
- Age between 18 and 35 years.
- Uncomplicated pregnancy without any known fetal or maternal anomalies.

Exclusion Criteria

- Irregular or unknown LMP.
- Multifetal pregnancy.
- Diagnosed fetal anomalies on ultrasound
- History of gestational diabetes mellitus,

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preeclampsia, chronic hypertension, renal disease, anemia, or cardiac disorders.
- Known intrauterine growth restriction (IUGR) or polyhydramnios/oligohydramnios.
- Any systemic illness or comorbidity that could affect fetal growth.

Measurements and Tools

Ultrasound Examination Protocol- All ultrasound examinations were performed using high-resolution real-time ultrasound equipment equipped with a 3.5–5 MHz curvilinear transducer by certified radiologists.

Measurement of Abdominal Circumference (AC)- AC was measured in a transverse axial plane of the fetal abdomen at the level of the fetal stomach, portal vein (or portal sinus), and vertebral body. For each participant, only one AC measurement was recorded and used for analysis to maintain uniformity.

Gestational Age Determination- GA was initially calculated based on the first day of the last menstrual period (LMP) and confirmed with first-trimester ultrasound reports wherever available. The week of gestation was defined as a completed week.

Data Collection- Participant demographics, obstetric history, last menstrual period (LMP), and ultrasound findings were recorded in a pre-designed case proforma. All AC measurements were tabulated according to gestational age groups ranging from 29 to 42 weeks. For each gestational week, the mean AC and standard deviation (SD) were calculated.

Statistical Analysis- Statistical analysis was carried out using STATA software version 12. The following methods were employed. Descriptive Statistics: Mean and standard deviation were calculated for AC across each week of gestation. Inferential Statistics: A linear regression analysis was performed to assess the correlation between gestational age (dependent variable) and abdominal circumference (independent variable). The strength of correlation was expressed as the coefficient of determination (R^2). The reliability of the regression model was tested using the Student's t-test.

Ethical Considerations- Approval for the study was obtained from the Institutional Ethics Committee (IEC). Written informed consent was obtained from all participants after explaining the purpose and procedures of the study.

RESULTS

A total of 132 pregnant women in their third trimester (29 to 42 weeks of gestation) were included in this study. The mean age of participants was 28±5 years (range 22 to 40 years). All participants met the inclusion criteria, and no cases were excluded during data collection or analysis. The participants were recruited from both urban and rural populations attending antenatal clinics at the Government Medical College.

Table 1 presents the number of participants per gestational week, along with the mean AC (cm) and standard deviation (SD). As evident from the data, abdominal circumference shows a consistent upward trend with advancing gestational age. The lowest mean AC was observed at 29 weeks (23.65 cm), and the highest mean AC was observed around 41 weeks (31.60 cm). The increase appears linear across gestational weeks, indicating steady fetal growth.

Table 1: Week-wise Mean along with standard deviation of Abdominal Circumference (AC)

Menstrual age (weeks)	No of Cases	Mean AC (cm)	Standard deviation
29	10	23.65	0.97
30	9	24.12	1.17
31	11	25.28	1.17
32	12	27.07	1.88
33	14	27.41	1.99
34	13	28.38	2.33
35	8	29.25	1.03
36	13	30.06	1.58
37	10	30.39	1.68
38	14	31.26	1.84
39	8	31.56	1.29
40	6	31.57	1.18
41	2	31.60	0.84
42	2	31.45	0.91
Total	132		

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To assess the relationship between AC and gestational age, a linear regression analysis was conducted. The regression model demonstrated a strong positive correlation. Regression Statistics: Sample size (n): 132, Coefficient of determination (R^2): 0.82, Correlation coefficient (r): 0.91, Standard error of Y (residuals): 1.53, x-coefficient (slope): 0.92, Constant (intercept): 8.69, Degrees of freedom: 130, t-test for regression coefficient: t=189.97, p<0.0001 (Fig. 1). The R^2 value of 0.82 indicates that approximately 83% of the variability in gestational age can be explained by changes in abdominal circumference, which is considered a statistically significant and clinically strong correlation. This high R^2 value confirms the reliability of AC as a predictive marker for gestational age in the third trimester.

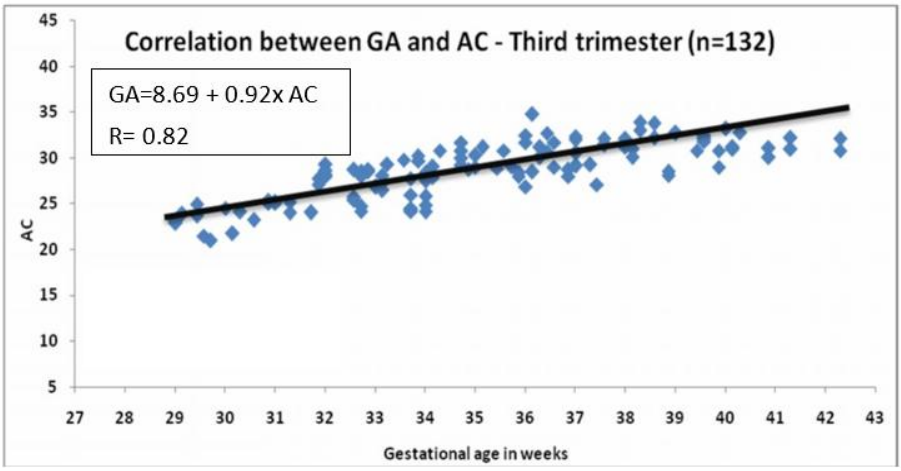

Fig. 1: Scatter Plot Showing Correlation Between Gestational Age and Abdominal Circumference

A scatter plot was constructed using AC values (x-axis) and corresponding gestational ages (y-axis). A regression line was superimposed to demonstrate the linear relationship. The plot confirmed that most data points lie close to the regression line, supporting the model's predictive strength. The derived regression equation allows for practical clinical application: For every 1 cm increase in abdominal circumference, gestational age increases by approximately 0.92 weeks. For example, an abdominal circumference of 30 cm would correspond to: GA= 8.69 + (0.924×30)= 36.41 weeks. This calculation method can assist clinicians in estimating GA during ultrasound assessments when LMP data is unavailable or unreliable.

DISCUSSION

This study aimed to evaluate the relationship between abdominal circumference (AC) and gestational age (GA) during the third trimester using ultrasonography. The results demonstrated a strong, statistically significant positive correlation between the two variables (r=0.91, p<0.0001), and the regression model derived (GA=8.695 + 0.924×AC) offers a reliable method for estimating fetal age when other clinical data may be unavailable or unreliable.

The correlation found in our study aligns closely with previous research that has emphasized the utility of ultrasound biometry particularly AC in estimating fetal age and monitoring growth. DeVore *et al*. [7] were among the first to establish a percentile rank for AC. They concluded that AC is a strong predictor of fetal size and gestational age, particularly in the third trimester. Similarly, Shawky SA [3] demonstrated that AC, when combined with other parameters like biparietal diameter (BPD) and femur length (FL), significantly enhances the predictive value for GA estimation. Our findings are also in agreement with the work of Jain and Zargar [12], who found a direct association between GA and AC in the second and third trimesters, and recommended AC as a reliable surrogate when LMP is uncertain.

In the Indian context, Bhusari *et al*. [13] conducted a radiological study on aborted fetuses and established a significant correlation between AC and GA. Their work validated the reliability of ultrasonographic fetal measurements, even post-mortem, and endorsed AC as a standard in fetal growth assessments.

The third trimester represents a phase of rapid fetal weight gain, during which the abdominal circumference expands considerably, reflecting liver size, fat deposition, and gastrointestinal development.

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Therefore, AC becomes particularly sensitive to nutritional and growth disturbances, such as intrauterine growth restriction (IUGR) and macrosomia. [6] As shown in our study, the mean AC progressively increased with gestational age, from 23.65 cm at 29 weeks to 31.60 cm at 41 weeks. This growth pattern correlates with fetal maturation and supports the assertion that AC can serve as a dynamic marker of fetal wellbeing and chronological age. Moreover, the regression equation derived from our data enables clinicians to estimate GA even in the absence of LMP, which is especially relevant in low-resource or rural settings where early ultrasound or accurate menstrual history is often unavailable.

Recent Advances and Global Context: Recent large-scale studies continue to support the findings of our research. The Pregnancy Outcome Prediction (POP) study in the UK showed that incorporating AC and other biometry in the third trimester significantly improved detection rates of small-for-gestational-age (SGA) neonates. [8] In another study by Kalafat *et al*. [14], the authors emphasized that fetal abdominal growth velocity during late gestation is an independent predictor of perinatal outcomes, even in fetuses that are appropriate-for-gestational-age (AGA) by size. These studies underline the value of AC not just as a static measurement but also as a dynamic indicator of fetal well-being. Further, Gordijn *et al*. [15] highlighted that abnormal AC measurements should prompt close surveillance and delivery planning, as deviations from expected centiles are often early indicators of placental insufficiency or metabolic imbalance. In the Indian scenario, Bhattacharjee *et al*. [9] and Sharma *et al*. [10] reinforced the role of routine third-trimester sonography, particularly AC measurement, in predicting adverse perinatal outcomes and aiding in the decision-making process for timely interventions.

From a practical standpoint, the findings of this study have several important implications. The AC can be used as a standalone parameter to estimate GA, particularly in the third trimester. The regression model developed is easy to apply in clinical settings and can be used in electronic fetal monitoring systems. In regions with limited access to early ultrasound, AC becomes a crucial metric for antenatal assessment. Its high correlation with GA (R^2=0.83) makes AC a robust tool for dating pregnancies, improving the accuracy of expected date of delivery (EDD) estimations.

STRENGTHS

A relatively homogeneous cohort with confirmed LMP and uncomplicated pregnancies. Strict adherence to ultrasound measurement guidelines (AIUM and ISUOG standards). Use of a single ultrasound system to reduce inter-machine variability.

LIMITATIONS

The sample size, though adequate, could be expanded for better generalizability. The study did not include other biometric parameters like HC, FL, or EFW to compare composite models. Longitudinal follow-up to track fetal outcomes was not performed. Future studies could incorporate multivariable regression using multiple fetal biometric parameters and assess how well such models predict perinatal outcomes, birth weight, and gestational complications.

CONCLUSIONS

This study demonstrated a strong, statistically significant positive correlation between fetal abdominal circumference and gestational age during the third trimester. The derived regression equation (GA = 8.695 + 0.924 × AC) provides a reliable, non-invasive method for estimating gestational age using ultrasonography, particularly when the last menstrual period is unknown or uncertain. Abdominal circumference increases progressively with advancing gestation and serves not only as a proxy for fetal age but also as an indicator of fetal growth and nutritional status. Given its ease of measurement, reproducibility, and high predictive value, AC should be routinely incorporated into third-trimester fetal assessments in both urban and rural healthcare settings.

The findings of this study support the clinical utility of AC in gestational age estimation and reinforce its role in enhancing antenatal care, especially in resource-limited environments. Future research with larger, multi-centric cohorts and inclusion of additional biometric parameters may further validate and refine the model for broader clinical application.

CONTRIBUTION OF AUTHORS

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