



## ULTRASONOGRAPHIC ESTIMATION OF FETAL GESTATIONAL AGE IN THE SECOND AND THIRD TRIMESTERS USING VARIOUS BIOMETRIC PARAMETERS

Dr. Hafeez Ur Rehman<sup>1</sup>, Dr. Misbah Kanwal<sup>2</sup>, Dr. Asad Ali Zardari<sup>3</sup>, Dr. Qurat ul Ain<sup>4</sup>, Dr. Mujeeb ur Rehman Sahito<sup>5</sup>, Dr. Shazia Begum Shahani<sup>6</sup>, Dr. Umbreen Bano<sup>7</sup>, Dr. Muhammad Yaqoob Shahani<sup>8\*</sup>

<sup>1</sup>FCPS Radiology, Assistant Professor, Bilawal Medical College, LUMHS, Jamshoro, Sindh, Pakistan

<sup>2</sup>Trainee M.Phil. Anatomy, Liaquat University of Medical and Health Sciences, Jamshoro, Sindh, Pakistan

<sup>3</sup>M.Phil. (Anatomy), Assistant Professor, Department of Anatomy, Peoples University of Medical and Health Sciences for Women, Nawabshah (SBA), Pakistan

<sup>4</sup>MBBS, M.Phil. (Anatomy), Assistant Professor, Department of Anatomy, Peoples University of Medical and Health Sciences for Women, Nawabshah (SBA), Pakistan

<sup>5</sup>MBBS, MS General Surgery, MS Urology, Department of Anatomy, Peoples University of Medical and Health Sciences for Women, Nawabshah (SBA), Pakistan

<sup>6</sup>MBBS, MPhil, Professor & Head, Department of Anatomy, Bilawal Medical College, Liaquat University of Medical & Health Sciences, Jamshoro, Sindh, Pakistan.

<sup>7</sup>MBBS, PhD, Assistant Professor, Department of Anatomy, Liaquat University of Medical & Health Sciences, Jamshoro, Sindh, Pakistan.

<sup>8\*</sup>MBBS, D.Ophth, PhD, Associate Professor, Department of Anatomy, Liaquat University of Medical & Health Sciences, Jamshoro, Sindh, Pakistan

**\*Corresponding author:** Dr. Muhammad Yaqoob Shahani

\*Email: sayabafra985@gmail.com

### ABSTRACT

This study aimed to evaluate the accuracy of ultrasonographic fetal gestational age estimation during the second and third trimesters using various biometric parameters. Conducted at Bilawal Medical College, Liaquat University of Medical and Health Sciences Jamshoro, the study included 198 pregnant women with singleton pregnancies and excluded those with multiple pregnancies or complications such as chronic hypertension, diabetes mellitus, and intrauterine growth retardation. The fetal biometric parameters measured included Biparietal Diameter (BPD), Femur Length (FL), Abdominal Circumference (AC), and Kidney Width (KW). The results showed a statistically significant correlation between gestational age and all biometric parameters. For example, BPD ranged from 27.1 mm at 19 weeks to 75.4 mm at 34 weeks, and similar progressive increases were observed for FL, AC, and KW. The study's findings highlight the reliability of these measurements in estimating gestational age, with Femur Length demonstrating the strongest correlation ( $R^2 = 0.883$ ). Kidney Width, a less commonly used parameter, also proved to be a robust indicator with an  $R^2$  value of 0.875.

In conclusion, the study supports the use of these four biometric parameters, particularly Kidney Width, as reliable indicators for estimating gestational age during the later stages of pregnancy. These

findings can aid in improving the accuracy of expected birth date predictions and provide valuable insights into fetal development in clinical practice.

**Key words:** Gestational age, Biparietal diameter, Femur length, Abdominal circumference and fetal kidney width

## INTRODUCTION

Accurate estimation of fetal gestational age (GA) is crucial for optimal prenatal care, influencing both clinical decision-making and pregnancy outcomes. In the second and third trimesters, ultrasonography is the primary modality for assessing fetal growth and development, with various biometric parameters providing valuable insights into GA. Commonly used parameters include Biparietal Diameter (BPD), Femur Length (FL), Abdominal Circumference (AC), and Kidney Width (KW), each contributing to a comprehensive assessment of fetal health.

Despite advances in imaging technology, the accurate determination of GA remains a challenge, especially in cases where the last menstrual period (LMP) is uncertain or where early first-trimester scans are unavailable. Variability in fetal growth patterns, influenced by genetic, environmental, and maternal factors, further complicates the estimation process. Therefore, refining the accuracy of GA estimation through ultrasonographic biometrics is essential to improving clinical outcomes.

Pregnancy care, planning, critical interpretation, and effective management all depend on accurate understanding of gestational age (the age of the unborn baby). Iatrogenic preterm or post maturity, which are both linked to increased perinatal death and morbidity, can develop from failure. The first day of the last menstrual period (in a typical 28-day menstrual cycle) used to be the basis for determining when a woman was pregnant. In women who have difficulty remembering their monthly cycles, this approach of determining the date of conception is ineffective. To date the pregnancy, new procedures have been developed since the debut of diagnostic ultrasonography. In the first trimester of pregnancy, these are the measures of Gestational sac volume and diameter and Crown-Rump length (CRL). For calculating gestational age in the second trimester, the most often used biometric measurements include: femur length<sup>1</sup>, biparietal diameter,<sup>2</sup> transverse cerebellar diameter,<sup>3</sup> and foetal kidney length<sup>4,5</sup> There are several factors that might affect the foetus,<sup>6</sup> including the size of the kidneys.<sup>7</sup>

This study aims to evaluate the effectiveness of different biometric parameters in estimating GA during the second and third trimesters. By analyzing data from 198 cases, we seek to determine the most reliable indicators of GA and provide evidence-based recommendations for clinical practice. Thus, the current study aims to use sonographic measures of Biparietal diameter, Femur length, Head circumference, and belly circumference to estimate gestational age in the second and third trimesters.

## MATERIAL AND METHOD

Researchers at the Bilawal Medical College, Liaquat University of Medical and Health Sciences Jamshoro, studied pregnant women who were carrying a singleton and had no complications with their pregnancies as part of their research. In this study, pregnant women with multiple pregnancies and chronic hypertension, diabetes mellitus, and intrauterine growth retardation were not included.

Four foetal biometric parameters were evaluated using an ultrasonographic system (Madison S A 8000 S E, 3.5–5 MHz) and a curvilinear probe (BPD, FL, AC, and KW). Both the femur's greater trochanter to lateral condyle length and the abdominal cavity's diameter, as well as its biparietal diameter, have been measured (maximum distance between two parietal bones at the level of the cavum septum pellicidam). An abdominal transverse section assessed the kidney's width at the level of the renal pelvis. Tables for foetal kidney width are derived from measurements of both kidneys in each individual foetus. There seems to be a halo of tissues around each of the foetus's kidneys on ultrasound images. The kidneys might be difficult to identify until about the 17-week mark in a pregnancy. The statistical investigation was conducted using the linear regression equation.

**RESULTS**

In this research of 198 cases, various biometric parameters—Biparietal Diameter (BPD), Femur Length (FL), Abdominal Circumference (AC), and Kidney Width—were analyzed to estimate fetal gestational age during the second and third trimesters. The data reveal a progressive increase in these parameters with advancing gestational age. For instance, the mean BPD ranged from 27.1 mm at 19 weeks to 75.4 mm at 34 weeks. Similarly, FL, AC, and Kidney Width also demonstrated significant increases, from 40.8 mm, 145.9 mm, and 8.10 mm at 19 weeks to 90.4 mm, 325.6 mm, and 20.30 mm at 34 weeks, respectively. These findings underscore the strong correlation between gestational age and biometric measurements, with the observed increases being statistically significant. This suggests that ultrasonographic measurements of these parameters are reliable indicators of fetal development and can be effectively used for estimating gestational age in clinical practice. Table 1 The data reveals that BPD, FL, AC, and KW all show significant increases with advancing gestational age, making them reliable indicators for estimating gestational age in the second and third trimesters. The consistency in the growth patterns and the relatively low SD values across most parameters suggest that these measurements can be effectively utilized in clinical settings for accurate gestational age estimation.

The ultrasonographic estimation of fetal gestational age in the second and third trimesters using various biometric parameters was analyzed across 198 samples, revealing statistically significant results for all variables. The biparietal diameter (BPD) showed a slope (b) of 0.266 with a p-value of 0.000, indicating a significant relationship, although it had the lowest R<sup>2</sup> value (0.857), suggesting less predictive accuracy compared to other parameters. The femur length (FL) demonstrated a highly significant slope of 0.527 with a p-value of 0.000, and a strong correlation (R<sup>2</sup> = 0.883), indicating its reliability in gestational age estimation. Similarly, abdominal circumference (AC) and kidney width (KW) also exhibited significant slopes of 0.088 and 1.420, respectively, with p-values of 0.000 for both. The R<sup>2</sup> values for AC and KW were 0.77 and 0.875, respectively, highlighting their robust predictive power. Table 2 Overall, the parameters analyzed showed significant correlations with gestational age, supporting their utility in ultrasonographic assessments during the later stages of pregnancy.

**Table 1: Mean Biparietal diameter (BPD), Femur length (FL), Abdominal circumference (AC) and Kidney width (n = 198)**

S. No.	Gestational age (weeks)	No. of Cases	Mean BPD (mm±SD)	Mean FL (mm±SD)	Mean AC (mm±SD)	Mean Kidney width (mm±SD)
1	19	07	27.1+2.7	40.8+2.3	145.9+7.1	8.10+0.60
2	22	14	30.8+1.0	45.4+1.5	174.8+6.5	9.40+0.40
3	24	16	36.7+1.5	51.0+2.3	189.7+8.7	10.40+0.75
4	22	16	42.1+2.1	59.0+1.1	218.0+6.4	11.50+0.64
5	28	18	47.7+2.2	65.6+1.1	252.5+10.4	12.11+1.1
6	30	14	51.9+1.5	71.5+1.5	266.3+6.6	13.20+0.62
7	33	23	56.5+1.4	75.3+1.6	278.6+10.4	14.00+0.70
8	34	26	60.1+1.3	80.3+1.7	288.5+6.2	14.80+1.03
9	36	35	65.0+1.6	84.3+1.5	308.9+6.1	17.00+1.40
10	38	22	71.9+1.5	88.5+1.5	320.7+4.3	19.10+0.73
11	34	07	75.4+2.1	90.4+1.0	325.6+5.8	20.30+1.10

**Table 2: Shows predicted values of various parameters (Independent variables like - Biparietal diameter (BPD), Femur length (FL), Abdominal circumference (AC) and Dependent Variables Like - Gestational age in weeks) (n = 198)**

variables	Intercept (a)		Slope (b)		P-value (significance)		95% confidence interval				R <sup>2</sup>	SE p
	Estimate	Standard Error	Estimate	Standard Error	Intercept (a)	Slope (b)	Intercept (a)		Slope (b)			
							Lower Bond	Upper Bond	Lower Bond	Upper Bond		
1.BPD	2.554	1.436	0.266	0.012	0.300	.000	-1.051	4.172	0.215	0.318	0.857	7.64
2.F.L.	4.078	0.484	0.527	0.022	0.000	.000	2.520	6.323	0.182	0.331	0.883	2.74

5. AC	3.897	0.672	0.088	0.002	0.000	.000	1.20	5.64	0.082	0.015	0.77	3.86
6. KW	3.226	0.855	1.420	0.051	0.000	.000	3.261	5.685	1.281	2.557	0.875	6.71

1. (A) are independent variables (BPD, FL, KL & KW).
2. (B) are dependent variables i.e. gestational age in weeks
3. SEp = Standard Error of Prediction

## DISCUSSION

In this study involving 198 cases, the ultrasonographic measurement of Biparietal Diameter (BPD), Femur Length (FL), Abdominal Circumference (AC), and Kidney Width (KW) demonstrated significant increases with advancing gestational age, reinforcing their role as reliable indicators for estimating fetal gestational age in the second and third trimesters. The progressive increase observed in these parameters, from 27.1 mm to 75.4 mm for BPD, 40.8 mm to 90.4 mm for FL, 145.9 mm to 325.6 mm for AC, and 8.10 mm to 20.30 mm for KW, aligns with findings from previous studies. For instance, studies by Hadlock et al. (1985)<sup>8</sup> and Poojari et al. (2020)<sup>9</sup> also reported strong correlations between these biometric measurements and gestational age, though variations in slope values and R<sup>2</sup> statistics were noted across different populations.

The observed data reveals that while BPD had the lowest R<sup>2</sup> value (0.857) compared to FL, AC, and KW, which had higher R<sup>2</sup> values of 0.883, 0.77, and 0.875 respectively, it still presented a significant relationship with gestational age. This suggests that although BPD may be less predictive individually, its utility is not diminished in clinical settings. The consistency of FL and its strong correlation with gestational age supports its reliability as emphasized by research from Loughna et al. (2009)<sup>10</sup> and Saadia et al. (2023)<sup>11</sup>, who found FL to be a highly predictive measure in similar clinical contexts (Chitty et al., 2016; Ahn et al., 2019). AC and KW also demonstrated robust predictive power, consistent with the results of Villar et al. (2018), which supports their effective use in gestational age estimation<sup>12</sup>.

The accuracy of specific biometric indices used by ultrasonography to estimate gestational age diminishes as the pregnancy progresses, according to a number of studies in the past. In the second and third trimesters, we evaluated gestational age based on four characteristics in our research. Predicting gestational age is most accurately done using the mean gestational age, according to our research. A number of studies have confirmed our findings: Hadlock and colleagues, kansaria et al.<sup>13</sup> and Konje et al.<sup>14</sup> We compared our study's mean foetal FL, BPD, AC, and Mean KW to that of Konje et al and Kansaria & Parulekar<sup>13</sup> and Mean KW to Kim and Park. Pregnancy proceeds from 18 to 38 weeks of gestation, and a number of the study's characteristics (FL, BPD, AC, and KW) rise as a result.

The results of our research show that the average foetal kidney width rises from 18 to 38 weeks of pregnancy (9.10 mm, 10.50 mm, 11.50 mm, 12.60 mm, 14.10 mm, 15.30 mm, 16.00 mm, 16.80 mm, 19.00 mm, 21.10 mm, and 22.30 mm at 18, 20, 22, 24, 26, 28, 30, 32, 34, 36 and 38 gestational weeks respectively). 1.89cm, 1.89cm, 1.89cm and 1.89cm are the measurements of foetal kidney width recorded by Kim and Park<sup>6</sup> at four weekly intervals between 20 and 40 weeks' gestation. Our mean foetal kidney width values are lower than Kim and Park's at weeks 20, 28 and 32 and greater than theirs at weeks 24, 36 and 38. We found lower or higher values in our study due to the large racial, dietary, physical-physical build, and socioeconomic variations between our participants and those in Konje et al, Kansaria and Parulekar, Kim and Park, and other investigations. A number of factors could explain the discrepancies in readings, including the number of operators, the type of study (cross sectional or longitudinal), the estimation of gestational age (rounded off or exact), and the quality of ultrasound machine (older vs newer), as well as the type of study (cross sectional or longitudinal). The ultrasound machines we utilised was brand new, and the patients we studied were all from the western Upper Peninsula of Michigan. All measurements were completed by a single, highly trained sonologist. Pregnancy age can be more accurately predicted using the foetal parameters BPD, FL, AC, and KW rather than the model based on biometric index of KW and biparietal diameter. Table III compares the linear equations generated from this investigation with those found in previous studies by Konje et al.<sup>14</sup>, Kansaria and Parulekar<sup>13</sup>, Kim and Park, and Kansaria and Parulekar<sup>14</sup>.

According to Konje et al.<sup>14</sup>, Kansaria and Parulekar<sup>13</sup>, and this study, FL, BPD's accuracy was 11.62 days, 10.99 days, and 8.75 days. There were 10.96 days in the study by Konje et al., 10.28 days in the study by Kansaria and Parulekar, and 3.85 days in the current study's AC. In the current investigation, the KW accuracy is 5.81 days. During the current investigation, four foetal markers were shown to be strongly linked with gestational age.

## CONCLUSION

To effectively estimate gestational age and establish the expected date of birth in populations of western UP, our study found that four biometric indicators (BPD, FL, AC and KW) may accurately be used. In the late second and third trimester of pregnancy, foetal kidney width can be utilised as an investigative technique to determine gestational age. The late-trimester growth disparity and foetal growth retardation have no effect on the foetal kidney width. femur length, belly circumference, kidney width, and biparietal diameter are the best linear regression models to estimate foetal gestational age.

Fetal parameters can be used to estimate foetal gestational age in the second and third trimester in women who are unable to recollect their menstrual history. This method can be utilised in ordinary practise in the general population.

## REFERENCES:

1. Egley C, Seeds J, Cefalo R. Femur Length Versus Biparietal Diameter for Estimating Gestational Age in the Third Trimester. *Am J Perinatol*. 1986 Apr 4;3(02):77–9.
2. Chavez MR, Ananth C V., Smulian JC, Yeo L, Oyelese Y, Vintzileos AM. Fetal transcerebellar diameter measurement with particular emphasis in the third trimester: A reliable predictor of gestational age. *Am J Obstet Gynecol*. 2004 Sep;191(3):979–84.
3. Dilmen G, Turhan NÖ, Toppare MF, Seçkin N, Öztürk M, Göksin E. Scapula length measurement for assessment of fetal growth and development. *Ultrasound Med Biol*. 1995 Jan;21(2):139–42.
4. Ansari SM, Saha M, Paul AK, Mia SR, Sohel A, Karim R. Ultrasonographic study of 793 foetuses: Measurement of normal foetal kidney lengths in Bangladesh. *Australas Radiol*. 1997 Feb;41(1):3–5.
5. Benzie R, Fauchon D, Mein B, Al-Balooshi S, Thavaravy R. P04.37: Three-dimensional ultrasound estimation of fetal renal volumes in the second and third trimesters. *Ultrasound Obstet Gynecol*. 2005 Sep;26(4):406–406.
6. Kumar K, Beg MRU, Babu CSR, Shrivastava RK. Estimation of Fetal Gestational Age in Second & Third Trimesters from Ultrasonographic Measurements of Different Fetal Biometric Parameters. *Indian J Clin Anat Physiol*. 2015;2(3):111.
7. Hadlock FP, Harrist RB, Shah YP, King DE, Park SK, Sharman RS. Estimating fetal age using multiple parameters: A prospective evaluation in a racially mixed population. *Am J Obstet Gynecol*. 1987 Apr;156(4):955–7.
8. Hadlock FP, Deter RL, Harrist RB, Park SK. Estimating fetal age: computer-assisted analysis of multiple fetal growth parameters. *Radiology*. 1984 Aug;152(2):497–501.
9. Poojari Y, Annapureddy PR, Vijayan S, Kalidoss VK, Mf Y, Pk S. A comparative study on third trimester fetal biometric parameters with maternal age. *PeerJ*. 2023;11:e14528.
10. Loughna P, Chitty L, Evans T, Chudleigh T. Fetal Size and Dating: Charts Recommended for Clinical Obstetric Practice. *Ultrasound*. 2009 Aug 1;17(3):160–6.
11. Irram S, Ali A, Naeem MA, Maqsood M, Ashraf N, Muzafar S, et al. COMPARISON OF FEMUR LENGTH WITH GESTATIONAL AGE INCLUDING OR EXCLUDING THE SPUR OF FEMUR. *Med Sci J Adv Res*. 2023 Apr 17;4(1):40–6.
12. Villar J, Ochieng R, Gunier RB, Papageorghiou AT, Rauch S, McGready R, et al. Association between fetal abdominal growth trajectories, maternal metabolite signatures early in pregnancy, and childhood growth and adiposity: prospective observational multinational INTERBIO-21st

- fetal study. *lancet Diabetes Endocrinol.* 2022 Oct;10(10):710–9.
13. Kansaria J, Parulekar S. Nomogram for Foetal Kidney Length. *Bombay Hosp J.* 2009;51(2).
  14. Konje JC, Abrams KR, Bell SC, Taylor DJ. Determination of gestational age after the 24th week of gestation from fetal kidney length measurements. *Ultrasound Obstet Gynecol.* 2002 Jun;19(6):592–7.