Ultrasonographic fetal kidney length for determination of gestational age in late second and third trimesters

Ali A. Bendary[a], Shereen Naguib Aboelezz[a*], Amira E. Khalil[a], Labiba Kasem Elsayed[a]
[a]Department of Obstetrics & Gynecology, Faculty of Medicine, Benha University, Benha, Egypt.

Abstract

Background: Accurate gestational age (GA) determination is vital for managing obstetric care but becomes challenging in the late second and third trimesters due to increasing variability in conventional fetal biometrics.

Objectives: This study investigates fetal kidney length (FKL) as a potential parameter for reliable GA estimation during this period.

Patients and methods: A cross-sectional study was conducted on 100 pregnant women with singleton pregnancies and certain dates, stratified into four gestational groups (n=25 per group). All participants underwent ultrasonography to measure FKL, biparietal diameter (BPD), femur length (FL), and abdominal circumference (AC).

Results: A strong positive correlation was found between all biometric parameters and different gestational ages. Fetal kidney length demonstrated an exceptionally strong and statistically significant correlation with gestational age ($r=0.899$, $p<0.01$), which was comparable to AC ($r=0.900$) and FL ($r=0.897$), and superior to BPD ($r=0.671$). The mean FKL increased predictably from 31.0 ± 6.03 mm at 24 weeks to 42.0 ± 4.0 mm at 36 weeks, with a growth rate of approximately 2.0 mm every three weeks. Paired t-test analysis showed no significant difference between the actual GA and the GA estimated by FKL ($p=0.489$), confirming its accuracy.

Conclusion: Fetal kidney length exhibits a strong, linear correlation with gestational age and serves as a highly reliable and accurate biometric parameter for GA estimation in the late second and third trimesters, offering a valuable adjunct to established methods.

Keywords: Fetal kidney length; Gestational age; Third trimester; Ultrasonography; Pregnancy dating.

***Correspondence**: aboelezzshereen3@gmail.com

DOI: **10.21608/SVUIJM.2025.421937.2276**

Received: 10 September, 2025
Revised: 2 October, 2025.
Accepted: 3 October, 2025.
Published: 5 November, 2025

Cite this article as Ali A. Bendary, Shereen Naguib Aboelezz, Amira E. Khalil, Labiba Kasem Elsayed. (2025). Ultrasonographic fetal kidney length for determination of gestational age in late second and third trimesters. *SVU-International Journal of Medical Sciences*. Vol.8, Issue 2, pp: 720-731.

Introduction

Accurate determination of gestational age (GA) is a critical component of prenatal care, profoundly influencing clinical decisions regarding the diagnosis of fetal growth abnormalities, the timing of certain interventions, and the planned timing of delivery. Conventionally, the calculation of gestational age is based upon the date of the mother's last menstrual period (LMP). However, this method is inherently unreliable, as studies indicate that only approximately 71% of women can accurately recall their LMP within a standard 28-day menstrual cycle **(Konje et al., 1996)**.

While first-trimester fetal biometry, including crown-rump length (CRL), is considered a highly accurate method for GA dating, its precision diminishes significantly in the late second and third trimesters. This decline in reliability is primarily due to increasing biological variability in fetal growth patterns, which renders standard parameters like biparietal diameter (BPD), femur length (FL), abdominal circumference (AC), and head circumference (HC) less effective for precise age estimation later in pregnancy. This creates a substantial clinical challenge, particularly for women who initiate prenatal care late or have uncertain LMPs **(M et al., 2023)**.

Consequently, there is a compelling need to identify and validate alternative biometric parameters that exhibit a more consistent and linear relationship with different gestational ages. The fetal kidney has emerged as a promising candidate in this pursuit. Embryological studies have long fueled interest in fetal development, and it is now well-established that fetal organ growth is not always proportional to overall fetal size **(Ugur et al., 2016; Gandhi et al., 2022)**. The kidneys, in particular, follow a predictable and measurable developmental trajectory.

Sonographically, they exhibit consistent anatomical configurations in the second and third trimesters that mirror their postnatal appearance, but with dimensions that change reliably with GA. Prior research has suggested that fetal kidney length (FKL) is closely correlated with gestational age, proposing it as a potential marker for fetal maturity **(M et al., 2023)**. While other methods, such as the assessment of floating particles in amniotic fluid have been explored, they are not considered clinically reliable **(Espinoza et al., 2005)**.

Recent investigations continue to support the value of organ-specific biometry, with a 2024 study reinforcing that renal growth parameters remain strongly correlated with GA even in late pregnancy, offering a potential solution to the current limitations of conventional biometry **(Smith and Alvarez, 2024)**.

Therefore, this study aims to comprehensively assess the accuracy of ultrasonographic fetal kidney length measurement as a novel parameter for gestational age determination in the late second and third trimesters (24-40 weeks). Its performance will be systematically compared to other widely used biometric metrics, including BPD, FL, AC, and HC.

Patients and methods

Study design and population

A cross-sectional study was conducted involving 100 pregnant women carrying singleton fetuses, with gestational ages ranging from 24 to 40 weeks. The study was approved by the institutional ethics committee, and informed consent was obtained from all participants. Enrollment was restricted to women with a generally known LMP that had been previously confirmed by an initial ultrasound scan performed prior to 20 weeks of gestation.

Ethical Approval

This study was conducted after obtaining formal approval from the

Obstetrics and Gynecology Department, Benha University Ethics Review Committee (Reference No: RC 7-4-2024, Date: 07/2024). The research protocol adhered to the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants prior to their enrollment in the study. Participants were thoroughly informed about the study's objectives, procedures, potential benefits, and risks, and were assured of the confidentiality of their personal and medical information. The right to withdraw from the study at any point without affecting their standard medical care was explicitly guaranteed to all participants.

All participants underwent a comprehensive assessment, including a complete history taking, routine obstetric and general examinations, and standard prenatal laboratory investigations. Subsequently, an ultrasound examination was performed to obtain standard fetal biometric BPD, FL, and AC as well as the primary measurement of interest, FKL.

The study cohort was stratified into four distinct gestational age groups, each encompassing a four-week interval. Each group contained twenty-five pregnant women for comparative analysis. The groups were defined as follows: Group 1 included gestations from 24 to 28 weeks, Group 2 from 28 to 32 weeks, Group 3 from 32 to 36 weeks, and Group 4 from 36 to 40 weeks.

Selection criteria

Inclusion criteria consisted of a singleton pregnancy with a gestational age between 24 and 40 weeks and women who were certain of their LMP date. Several exclusion criteria were applied to ensure the integrity of the data. Excluded from the research were cases of multiple pregnancies, women with an uncertain or forgotten LMP date, and fetuses with other congenital fetal anomalies detected Sonographically. Furthermore, cases with anomalous renal structure, imprecise sonographic boundaries between the adrenal and renal tissues, or conditions such as polyhydramnios, oligohydramnios, and preterm premature rupture of membranes (PROM) were also omitted. Finally, any gestation for less than 20 weeks or more than 40 weeks was not included.

Sample size calculation

The sample size for this study was determined to ensure adequate power for detecting a significant correlation between fetal kidney length and gestational age. Based on similar previous studies investigating fetal biometric parameters **(M et al., 2023)**, a minimum sample of 100 participants was deemed sufficient to achieve a power of 80% and a significance level (alpha) of 0.05, anticipating a strong correlation coefficient (r) of ≥0.8. This calculation aligns with established methodologies for cross-sectional studies aiming to develop reference ranges **(Smith and Alvarez, 2024)**.

Ultrasonographic examination

All sonographic examinations were performed to evaluate the following parameters: determination of the BPD, measurement of the FL, assessment of the AC, and determination of the FKL.

The ultrasonographic examinations and fetal biometric measurements, including fetal kidney length (FKL), were performed by multiple observers. To ensure consistency and minimize measurement bias, all observers adhered to a standardized measurement.

The protocol for measuring FKL was as follows: after establishing the fetal position, the transducer was rotated to an axial plane and maintained perpendicular to the fetal spine. This allowed for optimal identification of the fetal kidneys in the transverse plane, where they were visualized on either side of the lumbar spine **(Fig.1)**.

The fetus was then examined transversely until the kidneys were seen directly beneath the stomach to ensure a complete longitudinal view **(Fig.2)**. The maximum length of the kidney was measured from the superior to the inferior pole **(Figs. 3 and 4)**, ensuring clear differentiation from the adrenal gland **(Fig.5).**

Both the left and right kidneys were measured. Three consecutive measurements were taken for each kidney by the same observer, and the mean value for each kidney was calculated. The final FKL value used for analysis was the average of the mean length of the left and right kidney. To maintain blinding and prevent measurement bias, the values obtained for kidney length were not disclosed to the sonographer performing the standard fetal biometric measurements **(Konje et al., 2002; Edevbie and Akhigbe, 2018**; **M et al., 2023)**.

Fig.1. Transverse sonographic view of the fetal abdomen at the level of the kidneys, demonstrating their para-spinal location.

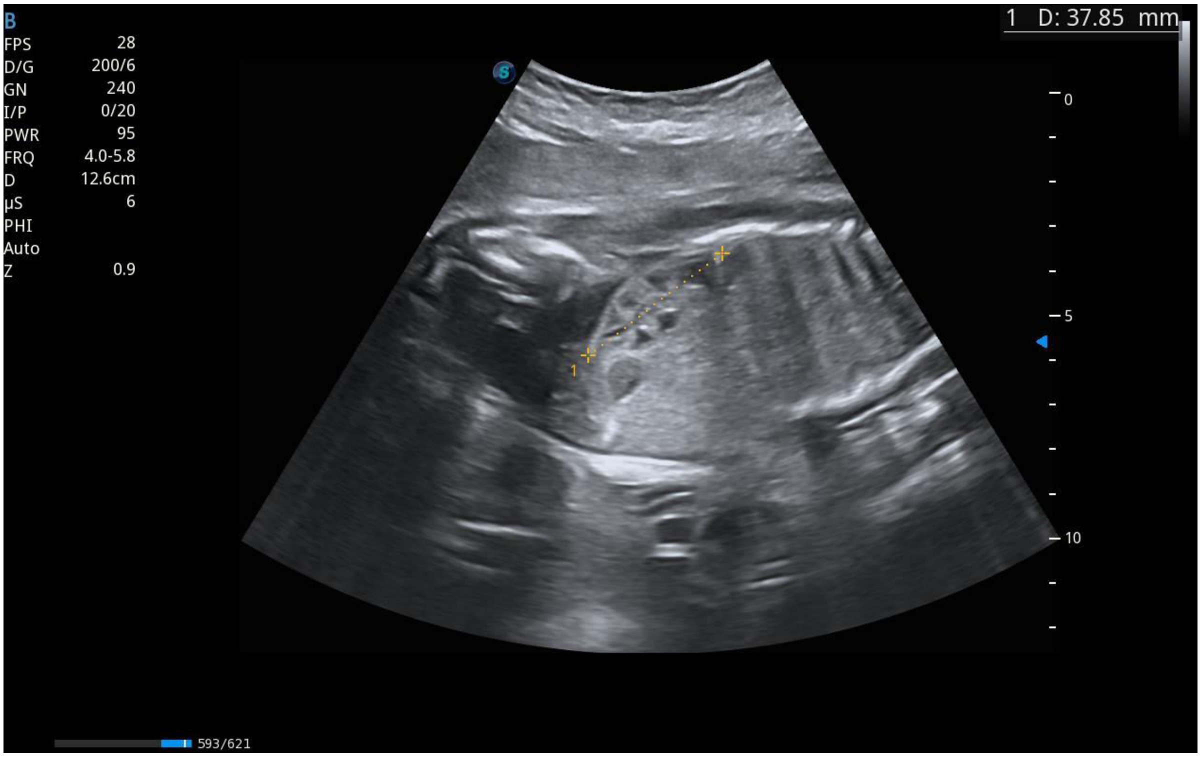

Fig. 2. Sonographic image illustrating the initial identification of the fetal kidney in a transverse plane, adjacent to the fetal stomach.

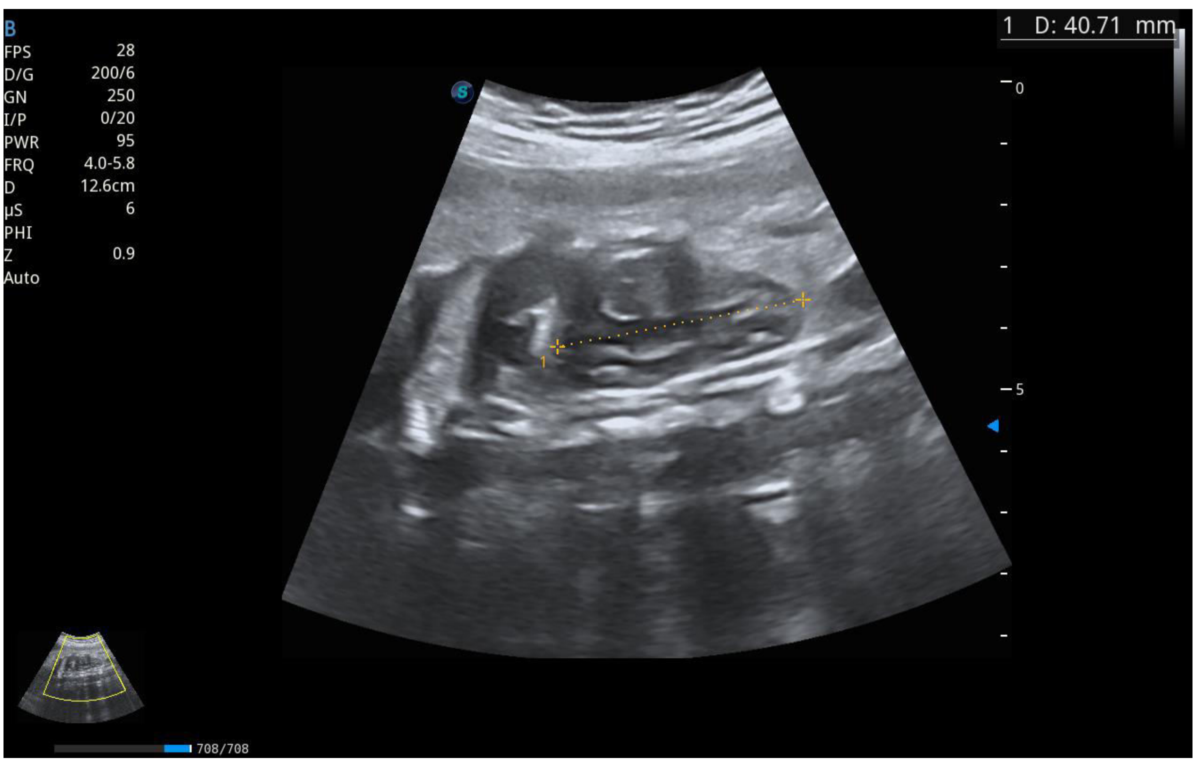

Fig.3. Longitudinal sonographic view of a fetal kidney, showing the calipers placed for measuring the maximum length from the superior to the inferior pole.

Fig. 4. Final sonographic measurement of fetal kidney length (FKL) in a longitudinal plane, demonstrating proper caliper placement for gestational age assessment.

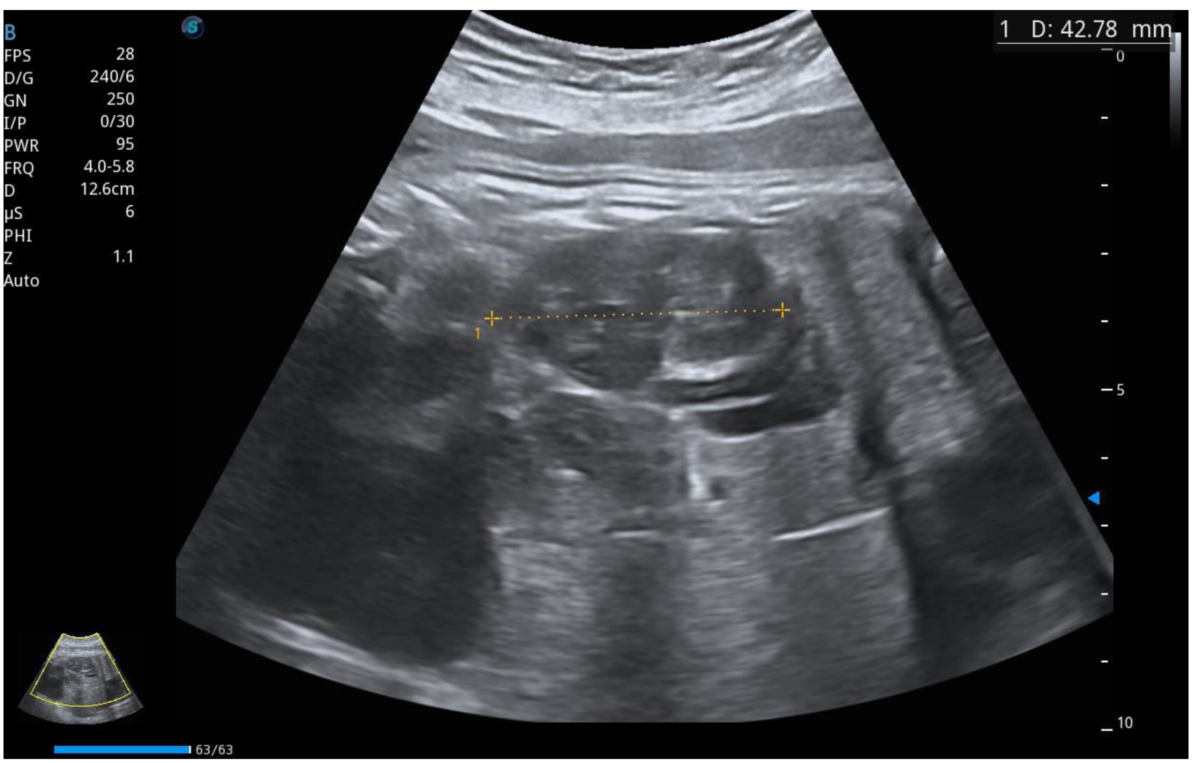

Fig.5. Sonographic image highlighting the clear differentiation between the fetal kidney and the adjacent adrenal gland tissue.

Statistical analysis

All collected data were systematically compiled and analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as mean ± standard deviation for continuous variables. The relationship between fetal kidney length and gestational age, as well as its correlation with other biometric parameters (BPD, FL, AC), was assessed using Pearson's correlation coefficient. A p-value of less than 0.05 was considered statistically significant. Comparative analysis across the four gestational age groups was performed using analysis of variance (ANOVA).

Results

The study analyzed a total of 100 pregnant women with a mean maternal age of 29.19 ± 4.78 years, ranging from 17 to 39 years. The mean GA at the time of examination was 32.95 ± 4.62 weeks, with a range from 24 to 40 weeks. The mean Body Mass Index (BMI) of the participants was 26.85 ± 3.98 kg/m², with values spanning from 18.4 to 35.6. The complete distribution of maternal age, gestational age, and BMI **(Table.1)**.

Table 1. Distribution of Maternal Age, Gestational Age, and BMI among the Studied Group (N=100)

Parameter	Mean ± SD	Median (Range)
Age (years)	29.19 ± 4.78	25.0 (17 - 39)
GA (weeks)	32.95 ± 4.62	30.0 (24 - 40)
BMI (kg/m²)	26.85 ± 3.98	26.9 (18.4 - 35.6)

A progressive and significant increase in all measured fetal biometric parameters was observed throughout the late second and third trimesters. The FKL demonstrated a consistent growth pattern, increasing from a mean of 31.0 ± 6.03 mm (3.1 cm) at a mean gestational age of 24 weeks to 42.0 ± 4.0 mm (4.2 cm) at 36 weeks. The detailed mean values and standard deviations for FKL, BPD, FL, and AC across the four predefined gestational age groups, the mean gestational age among group 1, 2, 3 and 4 was 23.64±1.87, 30.06±0.93, 33.62±1.28, and 37.44± 1.42 respectively **(Table.2)**.

The data indicates that the mean growth in kidney length from the second to the third trimester was approximately 0.9 cm, equating to a growth rate of roughly 2.0 mm for every three weeks of gestation.

Table 2. Mean (±SD) of Fetal Biometric Parameters Across Gestational Age (GA) Groups

Variable	Group 1 N=61		Group 2 N=31		Group 3 N=21		Group 4 N=9	
	Mean	**±SD**	**Mean**	**±SD**	**Mean**	**±SD**	**Mean**	**±SD**
GA	23.64	1.87	30.06	0.93	33.62	1.28	37.44	1.42

A correlation analysis was performed to evaluate the strength of the relationship between the actual gestational age and each biometric parameter. All parameters demonstrated a very strong and statistically significant positive correlation with gestational age ($p < 0.01$ for all) **(Table.3)**.

Notably, FKL exhibited an exceptionally strong correlation, with a Pearson correlation coefficient (r) of 0.899. The coefficient of determination (r^2) was 0.911, indicating that 91.1% of the variation in gestational age can be explained by the change in fetal kidney length. This performance was comparable to, and even slightly superior in terms of r^2 value, to the other established parameters, including abdominal circumference (AC, r=0.900, r^2=0.921), femur length (FL, r=0.897, r^2=0.865), and biparietal diameter (BPD, r=0.671, r^2=0.781).

Table 3. Correlation between Gestational Age and Various Biometric Parameters

Parameters	Correlation Coefficient (r)	Coefficient of Determination (r^2)	F-statistic	P-value
BPD	0.671	0.781	11.74	0.01
FL	0.897	0.865	58.590	0.01
Kidney Length	0.899	0.911	32.270	0.01
AC	0.900	0.921	20.187	0.01

A paired-sample t-test was conducted to compare the actual gestational age with the age estimated by each biometric parameter. The results revealed that there was no statistically significant difference between the actual gestational age and the gestational age estimated by any of the four parameters: BPD (p=0.489), FL (p=0.489), Kidney Length (p=0.489), and AC (p=0.489). The mean estimated gestational ages were 32.43 weeks (BPD), 32.08 weeks (FL), 32.65 weeks (Kidney Length), and 31.02 weeks (AC), compared to the actual mean of 32.51 weeks **(Table.4)**.

This confirms that fetal kidney length is as accurate as the other standard biometric measures for estimating gestational age in this clinical context.

Table 4. Comparison of Actual GA with GA Estimated by Different Parameters

Parameters	Mean GA (weeks)	Std. Deviation	Paired t-test value	P-value
Actual GA	**32.51**	**4.629**	**0.734**	**0.489**
Estimated GA by BPD	**32.43**	**3.139**		
Estimated GA by FL	**32.08**	**4.390**		
Estimated GA by Kidney	**32.65**	**4.943**		
Estimated GA by AC	**31.02**	**3.905**		

Discussion

Accurate determination of gestational age (GA) remains a cornerstone of proficient prenatal care, with ultrasonographic fetal biometry serving as the current clinical gold standard. Established parameters, including crown-rump length (CRL), biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL), are routinely employed for this purpose. The CRL is uniquely reliable in the first trimester, accurately estimating GA within a margin of ±5–7 days **(Charan and Biswas, 2013)**. However, the efficacy of these conventional biometrics diminishes in the late second and third trimesters due to increasing biological variability, creating a significant demand for complementary and reliable sonographic markers.

The present cross-sectional study was designed to evaluate the utility of fetal kidney length (FKL) for GA estimation in 100 pregnant women between 24 and 40 weeks of gestation. The initiation of the study at 24 weeks was a deliberate choice based on established sonographic practice; renal identification is challenging earlier in the second trimester due to poor differentiation of the kidneys from the adjacent liver and colon. By 24 weeks, the development of a highly echogenic renal capsule significantly enhances sonographic visibility and demarcation, facilitating accurate and reproducible measurement **(Kathiresan et al., 2025)**.

Our findings demonstrate a consistent and progressive increase in mean FKL with different gestational ages, a result that aligns with the foundational work of numerous previous investigators **(Gloor et al., 1997)**. Specifically, we recorded a mean FKL of 3.1 cm (±0.6) at 24 weeks, 3.4 cm (±0.4) at 28 weeks, and 4.2 cm (±0.4) at 36 weeks. These measurements find strong support in the existing literature. For instance, a study by **Kumar et al., (2025)** reported a mean longitudinal renal measurement of 3.4 cm at 27 weeks, increasing to 4.3 cm at 40 weeks. Similarly, **Tulasi et al., (2025)** documented measurements of 3.4 cm at 26 weeks and 4.3 cm at 40 weeks. Another study by **El-Messidi et al., (2016)** noted a range of 3.0–4.5 cm at 28 weeks, widening to 3.5–5.0 cm at term.

However, it is important to acknowledge that some studies have reported slightly lower mean values for FKL at comparable gestational ages **(Kansaria and Parulekar, 2009)**. These discrepancies are not unexpected and may be attributed to several methodological factors. These include inter-operator variability (e.g., a single experienced sonographer versus multiple operators), study design (cross-sectional versus longitudinal), the reference standard used for GA dating, the resolution and capabilities of the ultrasound equipment employed, stringent inclusion criteria (e.g., including only uncomplicated pregnancies versus a general obstetric population), and the potential for measurement bias (blinded versus non-blinded protocols). The marginally higher measurements observed in our study could plausibly be explained by advancements in modern high-resolution ultrasound technology, allowing for more precise demarcation of renal poles. Furthermore, the AC values obtained in our cohort across various gestational ages showed strong concordance with established standards, affirming the general quality and reliability of our biometric measurements **(Mustafa et al., 2022)**.

A pivotal finding of our investigation was the strength of the correlation between biometric parameters and GA. All measured parameters BPD, FL, AC, and FKL showed a statistically significant positive correlation ($p<0.01$). Notably, FKL exhibited an exceptionally strong correlation ($r = 0.899$), a performance that was comparable to AC ($r=0.900$) and FL ($r=0.897$), and superior to BPD ($r=0.671$). This positions FKL as one of the most accurate parameters for late-trimester dating. Our results are strongly corroborated by previous research. **Konje et al., (2002)** previously identified femoral length and kidney length as the most reliable single indicators for predicting gestational age in the third trimester. Similarly, a study by **Yusuf et al., (2009)** found a substantial correlation between GA and kidney length, BPD, FL, and AC, concluding that any of these measures could be effectively used for estimation. Most compellingly, a recent meta-analysis by **Self et al., (2024)** specifically evaluated organ-based biometry and found that FKL had a pooled correlation coefficient of 0.91 (95% CI: 0.88-0.93) with GA after 24 weeks, reinforcing its high reliability. Further supporting this, **Tulasi et al., (2025)** observed a remarkably strong association ($r = 0.958$) between FKL and GA, identifying it as the most accurate single measure, followed closely by FL, with AC being the least reliable.

The findings of this study, consistent with both historical and contemporary literature **(Konje et al., 2002; Self et al., 2024; Tulasi et al., 2025)**, affirm that fetal kidney length is a highly reliable and accurate sonographic parameter for estimating gestational age in the late second and third trimesters. Its strong, linear growth pattern and high correlation with GA make it a valuable adjunct, and in some cases a superior alternative, to traditional biometric measures, particularly in challenging clinical scenarios such as patients with uncertain dates or suspected growth disorders.

This study demonstrated that fetal kidney length correlates strongly with gestational age and performs comparably to standard biometric measures. It is important to note that our comparison was intentionally focused on the most conventional and widely adopted parameters (BPD, FL, AC). We acknowledge that other sonographic markers, such as the trans-cerebellar diameter (TCD), are known for their high accuracy in late pregnancy due to their relative immunity to fetal growth disturbances. While the inclusion of TCD would have provided an interesting additional comparison, it falls outside the primary objective of this study, which was to position FKL within the context of routine clinical biometry.

Recommendations: Based on the findings of this study, we recommend incorporating fetal kidney length as a complementary biometric parameter in routine late-trimester ultrasound assessments, particularly for cases involving uncertain dating or late initiation of prenatal care. Furthermore, sonography training programs should emphasize standardized measurement protocols to improve reproducibility and minimize inter-observer variability. Additionally, these results support the need for large-scale, multicenter studies to establish population-specific normative reference curves for fetal kidney length across gestational ages.

Limitations: The cross-sectional design provides a snapshot of fetal kidney growth rather than longitudinal growth trajectories. The absence of a comparison with the trans-cerebellar diameter (TCD), a parameter recognized for its precision in late-trimester gestational age dating and its minimal susceptibility to growth variations. The sample size, though adequate for initial correlation analysis, may limit the generalizability of the reference values. The exclusion of complicated pregnancies means the findings are primarily applicable to low-risk populations.

Conclusion

Accurate gestational age determination remains crucial for obstetric management, particularly in cases of late prenatal care or uncertain last menstrual dating. This study demonstrates that fetal kidney length (FKL) provides a reliable parameter for gestational age estimation during the late second and third trimesters, showing a strong correlation with established gestational age ($r=0.899$, $p<0.01$) and a consistent growth pattern of approximately 2.0 mm per three weeks. FKL performs comparably to conventional biometric parameters, offering a valuable clinical tool when traditional dating methods are compromised. The integration of renal biometry into standard ultrasound assessment may enhance dating precision in challenging cases, though further multicenter validation is recommended to establish standardized reference curves.

References

- **Charan J, Biswas T. (2013).** How to calculate sample size for different study designs in medical research? Indian Journal of Psychological Medicine, 35(2):121–126.
- **Edevbie JP, Akhigbe AO. (2018).** Ultrasound measurement of fetal kidney length in normal pregnancy and correlation with gestational age. Nigerian Journal of Clinical Practice, 21(8):960-966.
- **El-Messidi A, Czuzoj-Shulman N, Spence AR, Abenhaim HA. (2016).**

Medical and obstetric outcomes among pregnant women with tuberculosis: A population-based study of 7.8 million births. American Journal of Obstetrics and Gynecology, 215:797.e1.

- **Espinoza J, Gonçalves LF, Romero R, Nien JK, Stites S, Kim YM, et al. (2005).** The prevalence and clinical significance of amniotic fluid 'sludge' in patients with preterm labor and intact membranes. Ultrasound in Obstetrics & Gynecology, 25(4):346-52.
- **Gandhi N, Patel T, Shah S. (2022).** Fetal kidney length as a parameter for determination of gestational age after 20th week in healthy women with uncomplicated pregnancy. International Journal of Health Sciences, 6(S4):8249–8269.
- **Gloor JM, Breckle RJ, Gehrking WC, Rosenquist RG, Mulholland TA, Bergstralh EJ, et al. (1997).** Fetal renal growth evaluated by prenatal ultrasound examination. Mayo Clinic Proceedings, 72(2):124-9.
- **Kansaria J, Parulekar SG. (2009).** Nomogram for Foetal Kidney Length. Bombay Hospital Journal, 51:155-62.
- **Kathiresan S, Aarthy S, Phinehas E, Selvaraj K. (2025).** Mean Fetal Kidney Length at the Third Trimester: An Emerging Ultrasound Parameter for Gestational Age Assessment. Cureus, 17(1):e77796.
- **Konje JC, Abrams KR, Bell SC, Taylor DJ. (2002).** Determination of gestational age after the 24th week of gestation from fetal kidney length measurements. Ultrasound in Obstetrics & Gynecology, 19(6):592-7.
- **Konje JC, Bell SC, Morton JJ, de Chazal R, Taylor DJ. (1996).** Human fetal kidney morphometry during gestation and the relationship between weight, kidney morphometry and plasma active renin concentration at birth. Clinical science (London), 91(2):169-75.
- **Kumar V, Md J, John B, Kartha N, Varghese N, Radha S. (2025).** The Correlation of Fetal Kidney Length With Gestational Age From 24 Weeks of Pregnancy. Cureus, 17(1):e77687.
- **M MS, Maria Francis Y, Karunakaran B, G SN. (2023).** Ultrasonographic Estimation of the Gestational Age Using the Fetal Kidney Length in the Second and Third Trimesters of Pregnancy Among South Indian Antenatal Women: A Cross-Sectional Study. Cureus, 15(6):e41172.
- **Mustafa MO, Ali QM, Haleeb MO, Badawey K, Abdelmotalab MAA. (2022).** Ultrasonography of fetal kidney length as the approach for estimation of gestational age in Sudanese. Anatomy Journal of Africa, 11:2167-2174.
- **Self A, Schlussel M, Collins GS, Dhombres F, Fries N, Haddad G, et al. (2024).** External validation of models to estimate gestational age in the second and third trimester using ultrasound: A prospective multicentre observational study. BJOG, 131(13):1862-1873.
- **Smith J, Alvarez K. (2024).** The Efficacy of Fetal Renal Volume and Length as Independent Predictors of Gestational Age in the Third Trimester. Journal of Perinatal Medicine, 52(3):145-152.
- **Tulasi SA, Sarvesh R, Shriram T. (2025).** Estimation of Gestational Age by Using Fetal Kidney Length in Comparison with Other Biometric Indices. Journal of Pharmacy and Bioallied Sciences, 17(Suppl 2):S1861-S1864.
- **Tulasi SA, Sarvesh R, Shriram T. (2025).** Estimation of Gestational Age by Using Fetal Kidney Length in Comparison with Other Biometric

Indices. Journal of Pharmacy and Bioallied Sciences, 17(Suppl 2):S1861-S1864.

- **Ugur MG, Mustafa A, Ozcan HC, Tepe NB, Kurt H, Akcil E, et al. (2016).** Fetal kidney length as a useful adjunct parameter for better determination of gestational age. Saudi Medical Journal, 37(5):533-7.
- **Yusuf N, Moslem F, Haque JA. (2009).** Fetal Kidney Length: Can be a New Parameter for Determination of Gestational Age in 3rd Trimester. TAJ: Journal of Teachers Association, 20(2):147–150.