MJMR, Vol. 35, No. 3, 2024, pages (122-131).

Open Access
ISSN: 2682-4558

Research Article

Estimation of Gestational Age by Using Fetal Kidney Length and Transcerebellar Diameter in Comparison with other Biometric Indices

Hisham Hussein Imam[1], Emad Musa Ibrahim[1], Alshymaa Mohey Eldin Fathy[1*], and Mustafa Kamal Abd elhaseeb[1]

[1] Department of Obstetrics and Gynecology, Faculty of Medicine, Minia University

DOI: 10.21608/MJMR.2024.270076.1669

Abstract

Background and aim of the work: Physicians need precise estimates of gestational age in order to plan for accurate management. Ultrasound measurements, such as Biparietal Diameter (BPD), Head Circumference (HC), Abdominal Circumference (AC), and Femur Length (FL), throughout the second and third trimesters, lack high reliability. Research on the association between gestational age and the length of the fetal kidney (FKL) and the diameter of the brain's cerebellum (TCD) has shown a strong correlation. We sought to evaluate the precision of FKL and TCD measures in estimating the GA in comparison to other fetal biometric markers. **Methods:** This study was a prospective observational study carried out at the prenatal and fetomaternal clinics of Minia Maternity University Hospital in Minia, Egypt. The study took place from March 2023 to September 2023. The study comprised a sample of 77 women who had normal, uncomplicated pregnancies with a single fetus. The women had measurements of the right and left kidneys, transcranial Doppler (TCD), and other fetal biometric indices, recorded in millimeters and weeks, and mean values were documented. GA was determined by last menstrual period (LMP). **Results:** The average age of the women included in the study was 27.13±5.31 years, with a range of 18-40 years. The median number of pregnancies and abortions were 2 and 3, respectively. The range for pregnancies was between 0 and 6 times, while the range for abortions was between 1 and 9 times. The mean gestational age was 30.22±6.00 weeks, with a range of 18-39 weeks. The majority of cases (80.5%) had a cephalic presentation. Gestational age (GA) exhibits a strong positive connection with many fetal indices, including fetal kidney length (FKL) and transcranial Doppler (TCD) measurements ($p<0.001$). Furthermore, a strong positive connection was found between GA (gestational age) and the predicted age determined by MFKL (Maternal Fetal Kidney Length) and TCD (Transcranial Doppler) in millimeters ($r= 0.885$; $p<0.001$ and $r=0.966$, $p<0.001$) respectively. **Conclusion:** Based on the current findings, it can be concluded that; MFKL and TCD can serve as reliable new indicators for estimating gestational age, particularly throughout the second and third trimesters (19 to 39 weeks) of pregnancy.

Keywords: Gestational age, Mean Fetal kidney length, Transcerebellar diameter.

Introduction

When it comes to providing good maternity care, such as identifying developmental abnormalities and choosing the most optimal delivery time, obstetricians rely on precise gestational age (GA) determinations. Increased rates of prenatal morbidity and mortality have been asso-ciated with iatrogenic preterm delivery and postmaturity, which can occur as a result of failure [(1)].

In a typical 28-day menstrual cycle, the first day of the last menstrual period (LMP) is

used to establish the pregnancy dates. But studies show that more than 30% of women either forget when their LMP was or mistakenly believe that bleeding during early pregnancy is typical menstruation [2, 3]. Hormone treatment or rare ovulation can also cause ovulation to be delayed, which would explain why gestational age calculations throughout pregnancy are inaccurate. More accurate date assessment is now within reach, thanks to advancements in diagnostic ultrasonography. Ultrasound measurements of the gestational sac's diameter, volume, and crown-rump length (CRL) can be taken during the first trimester of pregnancy to determine the gestational age (GA) [4,5]. Additionally, during various stages of pregnancy, biometric markers such as fetal biparietal diameter (BPD), femur length (FL), and head circumference (HC) are used to estimate gestational age (GA) [6].

On the other hand, these indicators start to lose some of their accuracy in estimating gestational age as the pregnancy progresses [7]. The unreliability of BPD measurements after 26 weeks of gestation is due to changes in cranial morphology caused by certain disorders, which limits these metrics. Achondroplasia patients have shorter femurs, making this an inaccurate measure of gestational age[8]. The measureements of biparietal diameter (BPD), head circumference (HC), femur length (FL), and abdominal circumference (AC) can be affected by a number of factors. These include abnormal positionning of the baby (breech presentation), low or high levels of amniotic fluid (polyhydramnios), multiple pregnancies, and intrauterine growth restriction (IUGR). Knowing the exact gestational age throughout the second and third trimesters is thus still challenging. In order to find the gestational age (GA), researchers are currently looking at a number of unconventional sonographic metrics. Transcerebellar diameter (TCD), fetal kidney length (KL), placental grading, and amniotic fluid volume are the metrics which are included in the list of parameters [9].

During the second and third trimesters, the fetal kidney can be easily spotted and measured. At this point in the pregnancy, other measuring tools including hip circumference, biparietal diameter, femur length, and abdominal circumference are no longer useful for estimating the gestational age (GA). Although fetal kidney length (FKL) is a good proxy for gestational age (GA), it has not been extensively studied as a means of predicting GA [10].

Quick and steady growth characterizes the transcerebellar diameter (TCD), which shows a robust correlation with gestational age (GA) starting in the second trimester. The reliability of TCD as an ultrasound approach for determining GA is established by the end of the second trimester [11].
The current research aims to see how well KL and TCD measure GA in healthy pregnancies that are 19–39 weeks along. We then compared the results from this method to those from the BPD, HC, AC, and FL to see how accurate it was totaly.

Patients and Methods

This is a prospective observational study that was conducted at the antenatal and fetomaternal clinics at Minia Maternity University Hospital, Minia, Egypt in the period from fist of March 2023 up to the end of September 2023. The study was approved by the regional ethics committee at Minia University (IRB No 716:4:2023). An informed written consent was obtained from all participants before enrolling in the current study.

(A) Patients:

A total of seventy-seven pregnant women with a single, simple, normal pregnancy (between 19 and 39 weeks) were included in the study. These women were either certain about their last menstrual cycle or had confirmed their gestational age with a first-trimester ultrasound, using crown-rump length measurement, they were randomly selected from the attendants of the above-mentioned hospital during the study period were asked to be enrolled in the current study.
Women with uncertain knowledge of their most recent menstrual period and significant congenital fetal abnormalities, twins or multiple pregnancies, intrauterine

fetal death, antepartum hemorrhage, those with medical disorders like hypertension and diabetes mellitus, and women who refused to participate in this study were also excluded.

All patients were subjected to:

1. **History taking:**

- Thoroughly collected patient history, specifically focusing on the menstrual history and the date of the last menstrual period (LMP) to confirm the gestational age (GA).
- The expected delivery date (EDD) was calculated using Naegle's formula: EDD = LMP + 7 days + 9 months.

2. **Measurement technique:**

Patients who met the required inclusion criteria underwent ultrasounds. Every case got regular sonographic examination. The average gestational age was calculated using Headlock's technique, which relies on fetal biometric measurements such as abdominal circumference (AC), head circumference (HC), femur length (FL), and biparietal diameter (BPD). The measurements were collected and documented.The MFKL (Maternal Fetal Kick Count) and TCD (Transcranial Doppler) were also assessed by a skilled obstetrician.

Measurement of kidney length:

The fetus was subjected to transverse imaging modalities until the kidneys became apparent in close proximity to the stomach. Afterwards, the probe was turned by 90° to clearly define the longitudinal axis of the kidneys. Markers were placed on the image of the renal capsule to measure the FKL [(12)].

The regression equation GA = 9.87 + 5.91 x MKL was developed to estimate GA based on a given MKL [(13)].

Measurement of TCD

The trans-cerebellar diameter (TCD) was assessed by positioning the transducer precisely in the axial plane of the head, with emphasis on visualizing the thalamus. Subsequently, the probe was slightly tilted towards the posterior direction to observe both cerebellar hemispheres. This movement allows for visualization of the cerebellum, cistern magna, and cavum septum pellucidum. The cerebellum is bilaterally symmetrical and is located in the posterior cranial fossa, giving the impression of two lobes on either side of the midline. The trans-cerebellar diameter (TCD) is the measurement of the widest diameter of the cerebellum [(14)].

(B) Statistical analysis:

The statistical computations were performed using version 22 of SPSS (Statistical Package for the Social Sciences; SPSS Inc., Chicago, IL, USA). The data were analyzed using statistical measures such as mean ± standard deviation (±SD) or median and range. The comparison was done using a paired sample t-test, and the results were also provided as numbers and percentages. The Pearson correlation test was used to analyze the correlation between different variables. The p-value has been determined to be statistically significant at the 0.05 level.

Results

Baseline data:

The study had 77 female participants, with an average age of 27.13±5.31 years (ranging from 18 to 40 years). The median parity for pregnancies and the number of abortions were 2 and 3, respectively. The range for pregnancies was between 0 and 6 times, while the range for abortions was between 1 and 9 times. Approximately 77.9% of the participants in the study were living in rural areas, and the majority (79.2%) were primarily engaged in household duties. All participants included in the study had normal menstrual cycles and were clinically healthy, with no previous history of other medical conditions.

Regarding to the fetal presentation; 80.5% had cephalic presentation, with a mean gestational age of 30.22±6.00 weeks (range; 18 to 39 weeks), **Table 1**.

Table (1): Baseline data of enrolled women (n= 77)

Baseline data		N	(%)
Age (years)	**Mean ± SD**	27.13±5.31	
	Median (range)	26 (18 – 40)	
Parity	**Median (range)**	2 (0 – 6)	
Gravidity	**Median (range)**	3 (1 – 9)	
Residence, n (%)	**Urban**	17	(22.1%)
	Rural	60	(77.9%)
Occupation, n (%)	**Not working**	61	(79.2%)
	Working	16	(20.8%)
Fetal presentation, n (%)	**Cephalic**	62	(80.5%)
	Breech	15	(19.5%)
Gestational age (weeks)	**Mean ± SD**	30.22 6.00	
	Median (range)	31 (18 - 39)	

Correlation between gestational age and different fetal biometric indices:
A high positive connection (P< 0.001) was observed between gestational age determined by date and several fetal parameters, as shown in Table 2.

Table (2): Correlation between gestational age and different fetal biometric indices (n= 77)

Fetal indices	Gestational age (weeks)	
	r	**p**
Biparietal diameter (mm)	0.931	**<0.001***
Biparietal diameter (weeks)	0.958	**<0.001***
Head circumference (mm)	0.893	**<0.001***
Head circumference (weeks)	0.971	**<0.001***
Femur length (mm)	0.963	**<0.001***
Femur length (weeks)	0.945	**<0.001***
Abdominal circumference (mm)	0.953	**<0.001***
Abdominal circumference (weeks)	0.967	**<0.001***
Mean Fetal kidney length (mm)	0.885	**<0.001***
Mean Fetal kidney length (weeks)	0.892	**<0.001***
Trans cerebellar diameter (mm)	0.966	**<0.001***
Trans cerebellar diameter (weeks)	0.952	**<0.001***

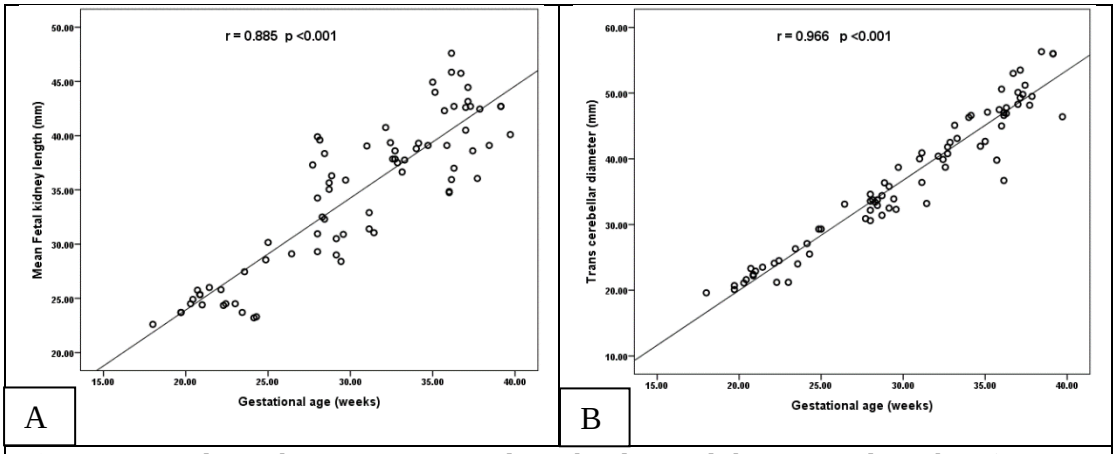

Figure 1 Correlation between gestational age by date and the expected age by A) MFKL (mm), B) TCD (mm).

Correlation between the TCD and different fetal biometric indices:
A high positive and statistically significant connection was seen between MFKL and TCD, and several fetal indicators (P< 0.001). **(Table 3)**.

Table (3): Correlation coefficient of TCD with BPD, HC, FL, and AC

Fetal indices	MFKL (mm)		TCD (mm)	
	r	p	r	p
Biparietal diameter (mm)	0.887	**<0.001***	0.905	**<0.001***
Head circumference (mm)	0.830	**<0.001***	0.879	**<0.001***
Femur length (mm)	0.883	**<0.001***	0.948	**<0.001***
Abdominal circumference (mm)	0.907	**<0.001***	0.937	**<0.001***

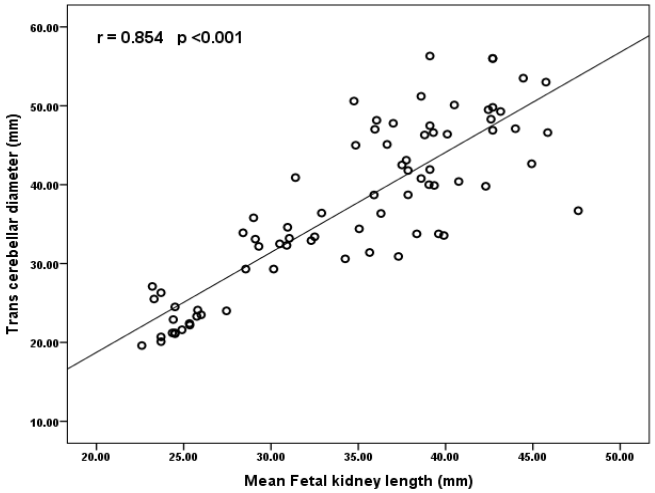

Figure 2: Correlation between the mean fetal KL (mm) and the TCD (mm) among the studied neonates.

Discussion

The cornerstone of pregnancy management is an accurate assessment of the gestational period. Preterm or postterm delivery, both of which can be caused by inaccurate gestational age (GA) estimation, can result in significant perinatal morbidity and death. To avoid complications for the mother, it is particularly important to precisely determine the gestational age (GA) in high-risk pregnancies when termination is being considered [(15)].

There might be a few problems with the traditional method of estimating the due date (EDD) using the last menstrual period (LMP). The likelihood of these complications increases in situations where the LMP is unclear, menstrual cycles are irregular, or first trimester hemorrhage has occurred [(16)]. In the last twenty years, sonography has made tremendous strides in accurately determining gestational age. Several biometric markers, including head circumference (HC), femur length (FL), crown rump length (CRL), abdominal circumference (AC), and biparietal diameter (BPD), are analyzed to estimate the sonographic gestational age. Multiple pregnancies, aberrant amounts of amniotic fluid, insufficient or excessive fetal growth, and a fetus positioned with its buttocks or feet first are some of the conditions that can impact the accuracy of these gestational age measurements [(17, 18)]. Additionally, these measurements do not consistently show the gestational age throughout the second and third trimesters due to the non-uniformity of size changes produced by biological variables in the latter stages of pregnancy. This becomes even more important when women are referred for maternal-fetal care later in the pregnancy or when they have questions about their LMP. Developing trustworthy sonographic gestational markers is of the utmost importance in such cases [(19)].

No matter what stage of pregnancy you are in, determining the gestational age should be a simple and basic process. To guarantee the best possible pregnancy care, it is crucial to have reliable sonographic fetal biometric data for gestational age dating in a clinical setting. Deciding when to undertake various prenatal tests, gauging the sufficiency of growth, and planning the delivery for the best possible obstetric outcome are all of the utmost importance [(12)].

Babies with intrauterine growth retardation tend to have wider and more irregularly shaped kidneys than those without the condition. Still, there is no correlation between its duration and any preexisting medical issue (Kansaria and Parulekar, 2010). Independent of preexi-sting growth disorders, a study by Ahmadi et al., (2015) found that foetal growth increased at a rate of 1.1mm per gesta-tional week throughout pregnancy.

There were statistically significant positive connections between gestational age and average fetal kidney length in this study of seventy-seven healthy women experiencing normal pregnancies. The average length of the fetal kidney was positively correlated with various fetal indices, including AC, BPD, HC, and FL.

Consistent with the current research, Peter et al., discovered a strong relationship between the GA estimated from conventional biometric data and the GA predicted using FKL: 9). This study's conclusions were in perfect agreement with those of Abonyi et al., who found a statistically significant relationship between FKL and GA [(20)]. Also, Dash et al., verified that there is a direct relationship between the fetal kidney length (FKL) and the gestational age (GA) advancement[(21)]. Overlooking other biometric parameters, Munthaian et al., found a strong connection (0.926) between the FKL and the prediction of GA [(22)]. The measurements of BPD, AC, CRL, HC, and FL in pregnant women were found to have a substantial bilateral connection with FKL in a recent prospective research by Dahmarde and Noori [(23)]. This idea is supported by the results of the present investigation, which also show that the comparison between TCD and FL had the most significant correlation coefficient, whereas the highest correlation coefficient

was obtained between FKL and AC. When Dahmarde and Noori compared FKL with FL, they discovered a high correlation coefficient.

The present study is in agreement with that of Shivalingaiash et al., who examined 60 pregnant women between the ages of 24 and 36 weeks to determine the effect of kidney length on gestational age. Thanks to an early dating scan, these women's pregnancies were precisely pinpointed. In the later trimesters of pregnancy in particular, the researchers discovered a robust association (r = 0.85) between the length of the fetal kidneys and the gestational age. Fetuses with intrauterine growth restriction (IUGR) and other biometric data showed this association [(18)].

Notably, the capacity to see many fetal organs, particularly the kidneys, using in utero imaging has been substantially improved by developments in sonographic resolution. Fetal kidneys can now be more easily identified with the use of real-time high-resolution sonography. There was a substantial correlation between FKL and GA in the study that used inaccurate and out-of-date ultrasonography equipment, similar to the one by Cohen and Lemann Jr. In addition, the results showed that the gestational age estimated by FKL and other physiological markers were quite consistent with one another (24). This finding provides more evidence that FKL is useful for assessing the GA.

The results of the present study were consistent with those of Akram et al., and Meenakshi et al., which found no significant differences in kidney size between the right and left sides of the body [(25, 26)].

As a standard against which to compare deviations in other measurements, the transcerebellar diameter is a useful tool for gestational age (GA) estimation [(27)]. The subject's growth accelerates significantly in the second trimester and continues in a steady linear pattern that is directly related to the gestational age [(28)]. The present study found a strong and statistically significant correlation between GA and transcranial Doppler (r = 0.966, p value <0.001) in normal, uncomplicated pregnancies. Relationships between TCD and BPD (r = 0.905, p < 0.001), HC (r = 0.879, p < 0.001), FL (r = 0.948, p < 0.001), and AC (r = 0.937, p < 0.001) were substantial and statistically significant. Results were similar in a study by Bansal et al., that included 650 cases with GA ranging from 14 to 40 weeks. Researchers discovered a correlation between the gestational age of a fetus and the TCD (Transcranial Doppler) measurement. A correlation coefficient (r) of 0.9723 and a p-value less than 0.001 [(29)] demonstrated a highly significant and substantial connection between gestational age and TCD.

Prssad and Likhitha conducted their own investigation, which corroborated the results of the current probe. Measurements of intrauterine growth retardation (IUGR) and transcranial Doppler (TCD) in the third trimester were found to be significantly correlated in this study (30). In their third trimester study, Naseem et al., looked at 327 pregnant patients. The research found the gestational age by comparing the results of transcranial Doppler (TCD) and femur length (FL) tests. The findings demonstrated that TCD is an improved technique for third-trimester gestational age determination [(31)]. The accuracy of Transcranial Doppler (TCD) in estimating the gestational age (GA) of third-trimester pregnant women was the subject of an Egyptian study by Akl et al., At this point in the pregnancy, the researchers found that TCD is a valid way to measure GA [(32)].

This study's results are in agreement with those of Reddy et al., who compared Fetal TCD to other well-established methods for estimating GA from the fifteenth to the forty-first week of pregnancy and assessed its accuracy in predicting GA. Using transcranial Doppler (TCD), they proved that it is a reliable indication of gestational age during the second and third trimesters. Reason being, at the time of the last menstrual period (LMP), there is a substantial correlation between TCD levels and gestational age. Additionally, as shown

by Fattah et al.,[33], the transcere-bellar diameter is a more reliable marker of gestational age in the third trimester when compared to other fetal measurements.

Additionally, in healthy pregnancies, Singh et al., (2021) found a strong association (r = 0.975, p value <0.001) between GA and transcranial Doppler (TCD) readings. Additionally, there was a meaningful association between TCD and both BPD (r = 0.950, p < 0.001) and HC (r = 0.966, p < 0.001) [12]. This leads us to believe that standard measurements of the cerebellum taken during pregnancy can accurately determine the gestational age (GA), regardless of the shape of the baby's head [12]. In addition, there was a strong and substantial positive association (r=0.854, p<0.001) between FKL and TCD. This result is also in line with that of Singh et al., who found a strong correlation between the two approaches [12].

The results of this experiment showed that the FKL and TCD were significantly related to the GA that was allocated. In addition, the dimensions of the femur and knee, as well as the diameter of the tibial condyle, were positively correlated with that of the patient's Borderline Personality Disorder (BPD), head circumference, abdominal circumference, and lumbar region. Accordingly, when coupled with other biometric indications, FKL and TCD may prove to be valuable predictors, particularly in the second and third trimesters.

In addition, this is very helpful when measuring the infant's head circumference or biparietal diameter becomes challen-ging because the baby is engaged in head movement during pregnancy or because the abdomen circumference is modest because of intrauterine growth restriction (IUGR). In this case, you can use FKL and TCD independently to predict GA. The current research supports the idea that foetal kidney length (FKL) and transchordal diameter (TCD) can be used as reliable sonographic parameters to determine the fetus's gestational age, particularly in the second and third trimesters when other measure-ment indices are not as reliable.

A small sample size, a single center, and the unusual use of transcranial Doppler (TCD) and fetal kidney length measurements in fetal biometry are major limitations of this study.

Conclusion

The current study's findings indicate that fetal kidney length and TCD both increase as GA increases. Furthermore, there is a strong correlation coefficient, suggesting a high level of agreement and reproduce-bility in the measurements. Importantly, this correlation is not affected by any discrepancies in the late trimester. Therefore, we suggest that both the FKL and TCD approaches can be utilized as appropriate sonographic parameters to precisely determine fetal gestational age, particularly during the second and third trimesters, and when other measurement indices are not as reliable.

References

1. Konje J, Abrams K, Bell S, Taylor D. Determination of gestational age after the 24th week of gestation from fetal kidney length measurements. Ultra-sound in obstetrics and gynecology: the official journal of the interna-tional society of ultrasound in obstetrics and gynecology. 2002;19 (6):592-7.
2. Wegienka G, Baird DD. A comparison of recalled date of last menstrual period with prospectively recorded dates. Journal of Women's Health. 2005;14 (3):248-52.
3. Waller DK, Spears W, Gu Y, Cunningham GC. Assessing number-specific error in the recall of onset of last menstrual period. Paediatric and Perinatal Epide-miology. 2000;14(3): 263-7.
4. Bailey C, Carnell J, Vahidnia F, Shah S, Stone M, Adams M, et al., Accuracy of emergency physicians using ultrasound measurement of crown-rump length to estimate gestational age in pregnant females. The American journal of emergency medicine. 2012;30(8):1627-9.

5. Sahota D, Leung T, Leung T, Chan O, Lau T. Fetal crown–rump length and estimation of gestational age in an ethnic Chinese population. Ultra-sound in Obstetrics and Gynecology. 2009; 33(2):157-60.
6. Karki D, Sharmqa U, Rauniyar R. Study of accuracy of commonly used fetal parameters for estimation of gestational age. JNMA; Journal of the Nepal Medical Association. 2006;45 (162):233-7.
7. Kaul I, Menia V, Anand AK, Gupta R. Role of Fetal Kidney Length in Estimation of Gestational Age. JK science. 2012;14(2).
8. Reddy RH, Prashanth K, Ajit M. Significance of foetal transcerebellar diameter in foetal biometry: a pilot study. Journal of clinical and diag-nostic research: JCDR. 2017;11(6): TC01.
9. Peter M, Nayak AK, Giri PP, Jain MK. Fetal kidney length as a parameter for determination of gestational age from 20th week to term in healthy women with uncomplicated pregnancy. Int J Res Med Sci. 2017;5(5):1869-73.
10. Kumar K, Lalwani R, Babu R, Aneja S, Malik A. Ultrasonographic estim-ation of fetal gestational age by fetal kidney length. Journal of the Anatomical society of India. 2013;62 (1):33-6.
11. Sharma R, Gupta N. Comparative accuracy of transcerebellar diameter and crown rump length for estimation of gestational age. Parity. 2017;35 (16):8.
12. Singh A, Singh G, Gupta K. Estimation of gestational age by using fetal kidney length and transcerebellar diameter in compa-rison with other biometric indices. Donald School J Ultrasound Obstet Gynecol. 2021;15(1):4-9.
13. Kiridi EK, Oriji PC, Briggs DC, Ugwoegbu JU, Okechukwu C, Adesina AD, et al., Ultrasound measurement of foetal kidney length during healthy pregnancy: relationship with gesta-tional age. Ethiopian Journal of Health Sciences.2023; 33(1.
14. George R, Amirthalingam U, Hussain MRK, Aditiya V, Anand A, Padmanaban E, et al., Can trans-cerebellar diameter supersede other fetal biometry in measuring gestati-onal age? A prospective study. Egyptian Journal of Radiology and Nuclear Medicine. 2021;52:1-6.
15. Brandão P, Sousa-Faria B, Marinho C, Vieira-Enes P, Melo A, Mota L. Polymorphic eruption of pregnancy: Review of literature. Journal of Obstetrics and Gynaecology. 2017;37 (2):137-40.
16. Fitzpatrick M, Pulver T, Klein M, Murugan P, Khalifa M, Amin K. Perivascular epithelioid cell tumor of the uterus with ovarian involvement: a case report and review of the literature. The American Journal of Case Reports. 2016;17:309.
17. Wu P, Haththotuwa R, Kwok CS, Babu A, Kotronias RA, Rushton C, et al., Preeclampsia and future cardio-vascular health: a systematic review and meta-analysis. Circulation: Car-diovascular Quality and Outcomes. 2017;10(2):e003497.
18. Shivalingaiah N, Sowmya K, Ananya R, Kanmani T, Marimuthu P. Fetal kidney length as a parameter for determination of gestational age in pregnancy. Int J Reprod Contracep Obstet Gynecol. 2014;3:424-7.
19. Edevbie J, Akhigbe A. Ultrasound measurement of fetal kidney length in normal pregnancy and correlation with gestational age. Nigerian journal of clinical practice.2018;21(8):960-6.
20. Abonyi EO, Eze CU, Agwuna KK, Onwuzu WS. Sonographic estimation of gestational age from 20 to 40 weeks by fetal kidney lengths' meas-urements among pregnant women in Porthar-court, Nigeria. BMC Medical Imaging. 2019;19(1): 1-7.
21. Dash RN, Satpathy G, Shankar G, Kumar BA. Determination of gesta-tional age by fetal kidney measure-ments in pregnancy. Indian Journal of Public Health Research & Develop-ment. 2020;11(8):116-21.
22. Muthaian E, Selvaraj K. Accuracy of the fetal kidney length measurement by ultrasonography in the determi-nation of the gestational age in pregnancy.

National Journal of Clinical Anatomy. 2019;8(01):018-21.
23. Dahmarde H, Noori J. The Sonographic Evaluation of Gestational Age: A Comparative Study Utilizing Different Biometric Measurement Indices and Fetal Kidney Length. Journal of Diagnostic Medical Sonography. 2022;38(4): 303-7.
24. Cohen EP, Lemann Jr J. The role of the laboratory in evaluation of kidney function. Clinical chemistry. 1991;37 (6):785-96.
25. Meenakshi S, Suganthi M, Suresh Kumar P. An approach for automatic detection of fetal gestational age at the third trimester using kidney length and biparietal diameter. Soft Computing. 2019;23(8):2839-48.
26. Akram MS, Yousaf M, Farooqi U, Arif N, Riaz A, Khalid M, et al., Estimation of gestational age from fetal kidney length in the second and third trimester of pregnancy by ultrasonography. Saudi J Med Pharm Sci. 2019;5(3): 222-9.
27. Swaminathan M, Davies M, Davis P, Betheras F. Transverse cerebellar diameter on cranial ultrasound scan in preterm neonates in an Australian population. Journal of paediatrics and child health. 1999;35(4):346-9.
28. Scott JA, Hamzelou KS, Rajagopalan V, Habas PA, Kim K, Barkovich AJ, et al., 3D morphometric analysis of human fetal cerebellar development. The Cerebellum. 2012;11:761-70.
29. Bansal M, Bansal A, Jain S, Khare S, Ghai R. A study of correlation of transverse cerebellar diameter with gestational age in the normal & growth restricted fetuses in Western Uttar Pradesh. PJSR.2014;7(2):16-21.
30. Prasad S, Likhitha S. Cerebellar measurements with ultrasonography in the evaluation of fetal age. IOSR-JDMS. 2014;13(9):49-56.
31. Naseem F, Ali S, Basit U, Fatima N. Assessment of gestational age: Comparison between transcerebellar diameter versus femur length on ultrasound in third trimester of pregnancy. The Professional Medical Journal. 2014;21 (02):412-7.
32. Akl S, Mohammed M, Bahaa El-din A, Mohammed A. Accuracy of transcerebellar diameter at the third trimester in estimating the gestational age in singleton pregnancy. Med J Cairo Univ. 2014;82(1):879-84.
33. Zakaria AM, Mohamed AH, Eldarder AKM. Comparison between transcerebellar diameter, biparietal diameter and femur length for gestational age measurement accu-racy in third trimester of pregnancy. The Egyptian Journal of Hospital Medicine.2019;74 (1):17-22.