

IJMA



INTERNATIONAL JOURNAL OF MEDICAL ARTS

Volume 7, Issue 3 (March 2025)



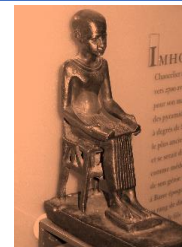
<http://ijma.journals.ekb.eg/>

P-ISSN: 2636-4174

E-ISSN: 2682-3780



Available online at Journal Website
<https://ijma.journals.ekb.eg/>
 Main Subject [Gynecology and Obstetrics]



Original Article

Evaluation of Third Trimester Gestational Age Using Fetal Maximum Transverse Cerebellar Diameter

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ABSTRACT

Article information

Received: 30-12-2024

Accepted: 07-02-2025

DOI:

[10.21608/ijma.2025.348920.2091](https://doi.org/10.21608/ijma.2025.348920.2091)

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Citation: Elashry RI, Megahed AEM, Thabet ME. Evaluation of Third Trimester Gestational Age Using Fetal Maximum Transverse Cerebellar Diameter. IJMA 2025 Mar; 7 [3]: 5468-5473. DOI: 10.21608/ijma.2025.348920.2091.

Background: Among the most crucial choices made in prenatal care is the calculation of gestational age [GA]. This is the foundation for managing difficulties and having babies at the right time.

Aim of work: Utilizing the fetal maximal transverse cerebellar diameter in contrast to biparietal diameter and femur length, gestational age may be determined during the third trimester.

Subjects & methods: 159 pregnant women carrying a singleton between the ages of twenty-eight and thirty-six weeks participated in this prospective cross-sectional research at Damietta's Al-Azhar University Hospital's Department of Obstetrics and Gynecology.

Results: In our study, the mean values were as follows: The biparietal diameter [BPD] was 81.86 ± 3.08 millimeters, the head circumference [HC] was 29.96 ± 1.95 millimeters, the abdominal circumference [AC] was 30.99 ± 1.57 centimeters, the femur length [FL] was 6.29 ± 0.57 centimeters, and the transverse cerebellar diameter [TCD] was 3.86 ± 0.23 centimeters. TCD provided the most accurate assessment of gestational age [83.6%], followed by FL [67.9%] and BPD [47.2%], while AC [37.7%] and HC [35.2%] were the least accurate. The mean estimated fetal weight was 3091.7 ± 267.2 grams. Additionally, BPD, HC, AC, FL, and TCD had sensitivities of 47.0%, 35.0%, 37.0%, 67.0%, and 83.0% and specificities of 77.5%, 85.0%, 82.5%, 75.0%, and 80.0%, respectively, all showing statistically significant predictive value for gestational age.

Conclusion: Our study demonstrated that fetal maximum TCD is a highly reliable parameter for third-trimester gestational age estimation, accurately predicting GA in 83.6% of cases—outperforming other biometric measures such as femur length [67.9%], biparietal diameter [47.2%], head circumference [35.2%], and abdominal circumference [37.7%]. The mean estimated fetal weight was 3091.7 ± 267.2 grams. Although promising, our findings are limited by a small, single-center sample and the absence of first-trimester CRL comparison; hence, larger, multicenter studies are recommended to further validate TCD's utility in prenatal care.

Keywords: Third Trimester; Gestational Age; Fetal Biometry; Maximum Transverse Cerebellar Diameter [TCD].



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INTRODUCTION

Accurate estimation of gestational age [GA] is critical for optimal prenatal care, as it aids in monitoring fetal growth, predicting developmental abnormalities, and planning appropriate obstetric interventions. Timely delivery and effective management of pregnancy-related complications largely depend on precise GA assessment^[1]. Errors in GA estimation can lead to iatrogenic preterm births or post-term pregnancies, increasing the risk of maternal and fetal morbidity and mortality^[2]. Traditionally, GA has been measured depending on the last menstrual period [LMP]. However, factors such as irregular menstrual cycles and the use of hormonal contraceptives prior to conception can affect its accuracy^[3].

In the first trimester, crown-rump length [CRL] measurement via ultrasound is considered the gold standard for GA estimation. During the 2nd and 3rd trimesters, fetal biometric parameters like femur length [FL], biparietal diameter [BPD], and abdominal circumference [AC] are commonly used^[4].

While BPD is a well-established marker for GA, its accuracy can be compromised by conditions affecting cranial shape, such as dolichocephaly and brachycephaly [5]. Similarly, FL measurements may vary across different ethnic groups. Moreover, as pregnancy advances, the reliability of ultrasound measurements decreases due to increasing biological variability, making GA estimation in the third trimester particularly challenging^[5]. The transverse cerebellar diameter [TCD] has emerged as a promising biometric parameter for assessing fetal development. Located deep within the brain and protected by the bony petrous ridges, the cerebellum is less susceptible to external deformities that affect cranial shape, thus maintaining measurement consistency^[6].

Evaluating GA in the third trimester using TCD offers a robust and reliable method due to the cerebellum's steady growth pattern, which remains relatively unaffected by conditions like fetal growth restriction. This non-invasive, easily obtainable measurement enhances the practicality of routine ultrasound assessments. Additionally, integrating TCD with other biometric parameters can significantly increase the accuracy of GA estimation, making it a valuable tool in prenatal care. Overall, TCD measurement stands out as a reliable and complementary approach to third-trimester GA estimation, contributing to effective pregnancy management^[7].

By comparing the fetal maximal transverse cerebellar diameter with biparietal diameter and femur length, this study aimed to maintain gestational age at the third trimester.

PATIENTS AND METHODS

Study design: An exploratory cross-sectional investigation was conducted.

Study setting: The study was conducted at the Department of Obstetrics and Gynecology at Al-Azhar University Hospital, Damietta, on 159 singleton pregnant women at their 28-36 weeks of gestation from November 2023 to November 2024. All participants were required to complete an informed consent form and have the research approved by an ethics committee before they could take part.

Sample size calculation: The sample size is calculated according to the equation: $N = 4\sigma^2 [Z_{crit} + Z_{power}]^2 / D^2$. N = Total sample size, which is the sum of the sizes of both comparison groups. σ = the standard deviation of each group, assumed to be equal in both groups = 1. Z_{crit} = the desired significance criterion = 0.05. Z_{power} = Desired static power.

= 80.0%. D = the minimum expected difference. The calculation showed that we should include at least 159 women to achieve a study power of 80.0%.

The inclusion criteria for this study require mothers aged 18 to 40 years with a singleton pregnancy among 28 and 36 weeks of gestation. Participants must have had regular menstrual cycles with predictable start dates [LMP] for at least six months prior to pregnancy. Gestational age must be confirmed through a first-trimester ultrasound using the crown-rump length [CRL] measurement.

The exclusion criteria for this study include women who have had more than one previous birth, those with fetal growth impairment [IUGR], unintended fetal death [IUFD], or birth defects. Additionally, women with maternal obesity, those who have used hormonal birth control or hormone treatments in the six months prior to conception, and those with pregnancy-related medical conditions like diabetes or hypertension are also excluded from participation.

Method: Each participant underwent a thorough evaluation, which included a complete history taking and physical examination. The general examination involved assessing vital signs such as heart rate, temperature, blood pressure, and respiratory rate, as well as checking for signs of lymph node enlargement, pallor, cyanosis, and jaundice. Body mass index [BMI] has been measured utilizing the formula: weight in kilograms separated by squared height in meters. Blood pressure was measured using a sphygmomanometer. The local examination included an abdominal inspection to assess for any abnormalities or concerns related to the pregnancy.

Abdominal palpation: Light palpation of the abdomen: In order to look for symptoms that might indicate gastrointestinal disease, we gently palpated each of the nine areas of the abdomen. These areas include guarding, tenderness, rebound tenderness, Rovsing's sign, and masses.

Deep palpation of the abdomen: The nine areas of the abdomen were palpated once again, but this time with more force in order to detect any deeper lumps. Notify the patient that they may have discomfort and inquire as to whether they would want to discontinue. In addition, keep a close eye on the patient's face in case they show any signs of discomfort—something they may not say.

Abdominal percussion: The liver, spleen, and bladder were percussed.

Abdominal auscultation: Auscultating over at least two positions on the abdomen for assessing bowel sounds.

Radiological investigation: Ultrasound was performed to assess several key parameters of fetal development, including fetal viability, ensuring the presence of a live pregnancy. Measurements taken included the biparietal diameter [BPD], femur length [FL], head circumference [HC], and abdominal circumference [AC], all of which are crucial for monitoring fetal growth. Additionally, the TCD was calculated to evaluate the development of the cerebellum, providing further insights into the overall fetal health and development.

With the accurate date of the last menstrual period [LMP] serving as the gold standard for gestational age estimation.

Technique of ultrasound: Every patient had transabdominal ultrasonography using a 50/60 Hz transabdominal probe. The ladies were asked to lie slightly inclined with their heads lifted at thirty degrees and a small cushion placed under their right loin for the examination.

Biparietal Diameter: At the lowest point of the paired thalami and cavum septum pellucidum, the fetal head was measured using trans-axial ultrasonography. To find the Biparietal Diameter [BPD], we calculated the distance from the transducers outside edge to the inner margin of the cranium, which was the farthest point from the transducer.

Abdominal Circumference: The transverse scan measured the umbilical vein's intrahepatic section and the stomach level.

Head Circumference: Tracing around the outside border of the skull using the ellipse approach allowed us to measure in the identical plane as the Biparietal Diameter [BPD].

Femur Length: The area between the greater trochanter and the lateral condyle was measured. Once you have obtained the trans-thalamic picture of the BPD, angle the probe slightly lower toward the fetal neck. This will allow you to measure the trans cerebellar diameter more accurately. The posterior horns of the lateral ventricles have been replaced by the cerebellum, as you will see in the following statement. The measurement of the TCD was taken across the widest point of the cerebellum using the outer-to-outer method. This measurement was taken at a right angle to the cerebellum's long axis. The cerebellum is often seen to be composed of two lobules, one on each side of the midline, when it is located in the posterior cranial fossa. A measurement was taken of the greatest diameter of the cerebellum [17].

Ethical Consideration: All participant information is treated with the utmost confidentiality. No publication or paper pertaining to this research ever mentioned the subjects by name. All participants have been informed of the study's goals, methodology, and risk-benefit analysis prior to their enrollment. A waiver of bias was acquired.

Statistical Analysis: SPSS for Windows and Microsoft Excel version 7 were used for the statistical analyses. For parametric data, descriptive statistics [mean, standard deviation, and range] were applied, while non-

parametric data were summarized using frequencies, percentages, and median with IQR. Multiple regression analysis assessed the relationship between gestational age [GA] estimated by ultrasound parameters [BPD, HC, AC, FL, and TCD] and GA measured by the last menstrual period, with TCD showing the strongest correlation. Additionally, ROC analysis demonstrated that TCD was the most accurate parameter for predicting GA.

RESULTS

Table [1] showed that, the mean age was 29.9 ± 4.57 , and mean BMI was 28.41 ± 2.1 , 5 females [3.1%] had no gravidity, 25 females [15.7%] had one gravidity, 81 females [50.9%] had two gravidities, 47 females [29.6%] had three gravidities, and only female had four gravidities. Table [2] showed that, mean BPD of the studied group was 81.86 ± 3.08 mm, mean HC was 29.96 ± 1.95 mm, mean AC was 30.99 ± 1.57 cm, mean FL was 6.29 ± 0.57 cm, mean TCD was 3.86 ± 0.23 cm.

Table [3] showed that, the TCD gave the most correct evaluation of gestational age [83.6%], followed by the FL [67.9%], The BPD correctly assessed [47.2%] of gestational age and the least accurate was the AC and HC that correctly assessed [37.7% and 35.2%, respectively] of gestational age. Table [4] showed that the mean of Estimated fetal weight was 3091.7 ± 267.2 g.

Table [5] showed that, there was significant association among GA estimated by ultrasound parameters and GA calculated by LMP, illustrated that GA measured by TCD gave the most correct assessment of gestational age. Table [6] showed that, BPD had sensitivity of 47.0% and specificity of 77.5% with significance in prediction of GA, HC had sensitivity of 35.0% and specificity of 85% with significance in prediction of GA AC had sensitivity of 37.0% and specificity of 82.5% with significance in prediction of GA FL had sensitivity of 67% and specificity of 75.0% with significance in prediction of GA TCD had sensitivity of 83.0% and specificity of 80.0% with significance in prediction of GA.

Table [1]: Distribution of demographic data in studied group.

Variable		Studied group N=159
Age: Mean \pmSD		29.9 \pm 4.57
BMI: Mean \pmSD		28.41 \pm 2.1
Gravidity	0	5 [3.1%]
	1	25 [15.7%]
	2	81 [50.9%]
	3	47 [29.6%]
	4	1 [0.6%]

Table [2]: Distribution of ultrasound measures of studied group.

Variable	Studied group N=159
BPD [mm]: Mean \pmSD	81.86 \pm 3.08
HC [mm]: Mean \pmSD	29.96 \pm 1.95
AC [cm]: Mean \pmSD	30.99 \pm 1.57
FL [cm]: Mean \pmSD	6.29 \pm 0.57
TCD [cm]: Mean \pmSD	3.86 \pm 0.23

Table [3]: Distribution of correct assessment of [GA]estimated by ultrasound parameters compared to [GA] measured by [LMP] of studied group.

Variable	Studied group N=159
GA by BPD	75 [47.2%]
GA by HC	56 [35.2%]
GA by AC	60 [37.7%]
GA by FL	108 [67.9%]
GA by TCD	133 [83.6%]

Table [4]: Distribution of outcome of studied group.

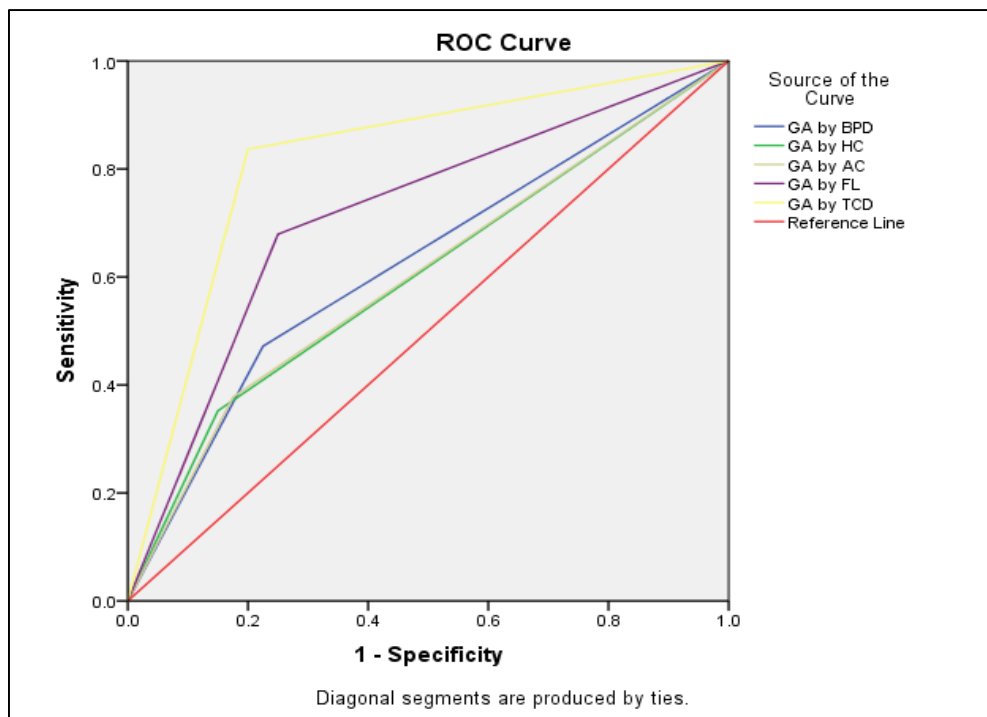
Variable	Studied group N=159
Estimated fetal weight [g]: Mean \pm SD	3091.7 \pm 267.2

Table [5]: Multiple regression analysis for GA estimated by ultrasound parameters and GA measured by LMP

Variable	B	SE	t	P value
GA by BPD	0.073	0.051	2.141	0.039
GA by HC	0.259	0.039	4.042	0.030
GA by AC	0.206	0.043	5.103	0.001
GA by FL	0.392	0.047	8.311	<0.001
GA by TCD	0.514	0.054	11.06	<0.001

Table [6]: ROC analysis for GA estimated by ultrasound parameters and GA measured by LMP.

Test Result Variable[s]	Area	Sensitivity	Specificity	Std. Error ^a	Asymptotic Sig. ^b	Asymptotic 95.0% Confidence Interval	
						Lower Bound	Upper Bound
GA by BPD	0.623	47.0%	77.5%	0.047	0.016	0.531	0.716
GA by HC	0.601	35.0%	85.0%	0.046	0.048	0.509	0.693
GA by AC	0.601	37.0%	82.5%	0.047	0.048	0.509	0.694
GA by FL	0.715	67.0%	75.0%	0.045	0.000	0.626	0.803
GA by TCD	0.818	83.0%	80.0%	0.040	0.000	0.739	0.897

**Figure [1]:** ROC analysis for GA estimated by ultrasound parameters and GA measured by LMP.

DISCUSSION

In the current study, the mean age was 29.9 ± 4.57 , and the mean BMI was 28.41 ± 2.1 . Five females [3.1%] had no gravidity, 25 females [15.7%] had one gravidity, 81 females [50.9%] had two gravidities, 47 females [29.6%] had three gravidities, and only one female had four gravidities. Consistent with our findings, *Elbarbary et al.* [8] assessed whether gestational age [GA] in singleton gestations during the third trimester could be predicted by transverse cerebellar diameter [TCD]. Among 31 and 36 weeks of gestation, 103 pregnant women receiving regular prenatal care underwent their prospective observational research. Pregnant women's mean age was 30.22 ± 4.49 years; the lowest age of presentation was 19 years and the highest was 40 years. Of 59.2% of women, the most

often occurring group was the age range of 31–40 years. With a mean of 28.67 ± 1.93 kg/m², the Body Mass Index [BMI] ran from 25 kg/m² to 31 kg/m². With 7.8% being primigravida and 92.2% being multigravida, the mean parity was 2.44 ± 1.19 .

Likewise, our findings matched *Rauf et al.* [9], who found the mean transverse cerebellar diameter and mean gestational age link in the third trimester of pregnancy. According to their report, their investigation comprised the ultrasonic data of 150 singleton gestations among women. The ladies in the study's mean age were recorded to be 26.53 ± 4.14 years. Within their research sample, the average gestational age was 31.95 ± 3.97 weeks. Furthermore, our results matched those of *Bavini et al.* [10], who assessed third-trimester singleton pregnancy known gestational ages using trans-cerebellar diameter [TCD], therefore determining the accuracy of the

gestational age estimate. There were 100 women in their prospective research, most of them between the ages of 21 and 30.

Our results showed that according to ultrasound measures, the mean [BPD] of the studied group was 81.86 ± 3.08 mm, mean [HC] was 29.96 ± 1.95 mm, mean [AC] was 30.99 ± 1.57 cm, mean [FL] was 6.29 ± 0.57 cm, and mean [TCD] was 3.86 ± 0.23 cm.

Our findings were inconsistent with those of **Elbarbary et al.**^[8], who found that the mean bi-parietal diameter was 83.055 ± 3.688 mm while the mean femur length was 65.041 ± 3.46 mm. The abdominal circumference was 286.078 ± 15.738 mm. The mean trans-cerebellar diameter of studied cases was 40.669 ± 2.349 mm. Similarly, our findings were aligned with **Rauf et al.**^[9], who reported that the mean value of transverse cerebellar diameter was recorded as 29.49 ± 5.90 mm in their study.

As the gestational age [GA] increased throughout the third trimester, fetal biometric measures also increased, which is consistent with our findings **Baviani et al.**^[10]. At 28-32 weeks, the mean transvaginal diameter [TCD] was measured to be 35 ± 0.98 mm; at 32-36 weeks, 40 ± 1.04 mm; and at 36-40 weeks, 43 ± 0.88 mm. Furthermore, their research showed that TCD had better accuracy in estimating GA than other common biometric markers, especially as the pregnancy went on. Estimates derived from third-trimester biometric parameters differed from those derived from first-trimester ultrasonography on average in the following ways: The duration of BPD is around 2 days from 28 to 32 weeks, 4 to 36 weeks, and 2 to 9 days beyond 36 weeks, with a notable variation after 32 weeks. The HC duration is around 2 days from 28 to 32 weeks, 4 to 36 weeks, and 9 days beyond 36 weeks, with notable variations occurring after 36 weeks. The average duration of the third trimester varies significantly, with $\pm 2-7$ days from 28-32 weeks, $\pm 7-11$ days from 32-36 weeks, and $\pm 11-15$ days beyond 36 weeks. [FL]: between 28 and 32 weeks, $\pm 1-4$ days; between 32 and 36 weeks, $\pm 2-7$ days; and beyond 36 weeks, $\pm 4-10$ days, with notable variations in the third trimester. [TCD]: about one day between weeks 28 and 32, one to two days between weeks 32 and 36, and no later than thirty-six weeks, within six days after the period of gestation [POG], by the last menstrual period [LMP].

In contrast to other biometric measurements, which exhibit comparatively larger variability, our results highlight the dependability of TCD as a precise parameter for calculating GA, particularly in the latter stages of pregnancy. The TCD was the most accurate in determining gestational age [83.6%], while the [FL] came in second with 67.9%. The BPD had the highest percentage of accurate gestational age assessments at 47.2%, while the AC and HC had the lowest rates at 37.7% and 35.2%, respectively.

Consistent with these findings, **Elbarbary et al.**^[8] showed that, out of 103 patients, the TCD provided the most accurate estimate of gestational age in 91 cases [88.35%] and 73 cases [70.87%] within one week. In contrast, 81 patients [78.64%] and 50 patients [48.54%] had accurate gestational age assessments within one week and three days, respectively, from the [FL]. by 3 days, the [BPD] accurately assessed the gestational age of 35 patients [33.98%], and by 1 week, it was accurate for 60 patients [58.25%]. Although it correctly assessed gestational age in 47 patients [45.63 percent] and 30 patients [29.13 percent] within one week, the [AC] was the least accurate. Furthermore, our results were corroborated by **George et al.**^[3], who found that TCD is a more accurate measure of growth throughout the second and third trimesters of pregnancy than other commonly used ultrasonography measures and has a stronger correlation with gestational age.

El-Ebeisy et al.^[11] also discovered that the transverse cerebellar diameter [TCD] was a reliable predictor of gestational age [GA] in fetuses

between 14- and 40-weeks' gestation, which is in line with our findings. They divided the subjects into two groups, one for 14-27 weeks and the other for 28-42 weeks.

The study found that [TCD] is a reliable measure for gestational age estimation because its values are quite similar to those of [GA] as calculated by [LMP]. There are a number of ways to determine gestational age, but TCD is clearly the most accurate. A separate study also examined the accuracy of the TCD in estimating gestational age; it included 150 third-trimester pregnant Egyptian women. The TCD is a dependable way to find out how far along you are in pregnancy during the third trimester, according to **Akl et al.**^[12].

We utilized the same fetal trans cerebellar diameter [TCD] as **Reddy et al.**^[13], who examined the accuracy of GA predictions from 15 to 40 weeks of gestation and compared TCD to other metrics for measuring GA. The high connection between TCD levels and GA via LMP shows that it is a valid approach for estimating gestational age throughout the second and third trimesters. In the third trimester in particular, it outperforms other metrics as a predictor of gestational age.

These findings provide credence to the positive correlation between fetal Transverse Cerebellar Diameter [TCD] and gestational age that **Rauf et al.**^[9] discovered for the whole sample. At 0.945, the calculated Pearson correlation coefficient [r] was statistically significant [P < 0.001]. Lastly, a good and accurate way to estimate gestational age is by measuring the transverse cerebellar diameter. During the second and third trimesters of pregnancy, it may be used as a reliable and standalone indicator of gestational age. When compared to the real gestational age as calculated by LMP, its findings are well correlated. Additionally, it fares better as a predictor of GA than other third-trimester traits. Prenatal sonography may be more accurate if a variety of parameters are used, one of which is transverse cerebellar diameter.

Consistent with our results, **Ali et al.**^[2] assessed the validity of biparietal and trans-cerebellar diameters as indicators of gestational age throughout the third trimester. Their prospective observational study included 275 pregnant women with gestational ages ranging from 32 to 37 weeks. The biparietal diameter had a stronger positive correlation with gestational age [r = 0.87, p < 0.001] than the trans-cerebellar diameter [r = 0.98, p < 0.001], while both were positively connected with gestational age. Compared to biparietal diameter, trans-cerebellar diameter was a more reliable indicator of gestational age [93.6% vs. 79.9%].

Additional research **Eze et al.**^[14] showed in their research that TCD is a reliable method for determining GA. A total of 257 healthy pregnant women whose first trimester was characterized by gas between weeks 16 and 45 made up the sample. The day of the last menstrual period's commencement [LMP] was the primary criterion for determining GA; however, other measures including the biparietal diameter [BPD], head circumference [HC], abdominal circumference [AC], and femur length [FL] were also used. We used the quantifiable data to build regression models that would allow us to evaluate GA. The sono-graphically measured transvaginal diameter [TCD] was the most reliable variable for estimating gestational age [GA] in a group of healthy pregnant women during the last trimester of their pregnancies.

The findings showed that the average estimated fetal weight of the group studied in this study was 3091.7 ± 267.2 grams. We discovered that macrosomia and low birth weight are linked with gestational age ambiguity, which is consistent with **El-Barbary et al.**^[8]

If you're having trouble with biparietal diameter calculations or if the stated head mold prevents you from using them, transverse cerebellar

diameter might be a good substitute [9]. The cerebellum's size is proportional to the gestational age and biparietal diameter, and it does not alter form throughout pregnancy [15].

Under normal conditions, the fetal cerebellar diameter correlates strongly with other fetal growth indices, including biparietal diameter, belly circumference, femur length, and estimated fetal weight [16].

In the current study, there was a significant association between GA estimated by ultrasound parameters and GA measured by LMP, illustrating that GA measured by TCD gave the most correct assessment of gestational age. Our study was aligned with **El-barbary et al.** [8], who reported that there was a significant association between GA measured by LMP and GA estimated by ultrasound parameters, and the TCD was the most important predictor for GA, also in agreement with **George et al.** [3], who revealed that TCD shows better regression values. As well, **El-Sayed et al.** [18], who evaluated the accuracy of transcerebellar diameter [TCD] in the detection of gestational age in pregnancies with intrauterine growth restriction IUGR, they found that in the normal group, all parameters were highly significantly positively correlated with GA, but the highest was TCD.

Limitation: Our study has several limitations, including a relatively small sample size and its single-center design, which may limit the generalizability of the findings. The narrow gestational age range [28–36 weeks] and cross-sectional nature restricted the assessment of TCD growth trends over time. Additionally, the absence of comparison with a gold standard like first-trimester CRL, potential measurement bias due to limited operator variability, and lack of correlation with neonatal outcomes may affect the robustness of the conclusions. It is recommended that future studies be conducted using well-designed randomized controlled trials or large, comparative observational studies.

Conclusion: Our study evaluated the reliability of fetal maximum TCD for assessing third-trimester GA compared to other biometric parameters. TCD was the most accurate measure, correctly estimating GA in 83.6% of cases, surpassing femur length [67.9%], biparietal diameter [47.2%], head circumference [35.2%], and abdominal circumference [37.7%]. The mean estimated fetal weight was 3091.7±267.2 grams. While TCD shows promise as a precise tool for GA assessment, our study's limitations include a small sample size, a single-center design, and a lack of comparison with first-trimester crown-rump length [CRL]. Future research should address these limitations through larger, multicenter studies. Overall, TCD is a reliable measure for third-trimester GA estimation and can enhance prenatal care.

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IJMA



INTERNATIONAL JOURNAL OF MEDICAL ARTS

Volume 7, Issue 3 (March 2025)



<http://ijma.journals.ekb.eg/>

P-ISSN: 2636-4174

E-ISSN: 2682-3780