

# Ultrasound Measurement of Placental Thickness: A Reliable Estimation of Gestational Age in Normal Singleton Pregnancies in Nigerian Women

## Abstract

**Purpose:** The aim of this article is to evaluate the accuracy of placental thickness (PT) in determination of gestational age (GA) in normal singleton fetuses. **Materials and Methods:** The study was a cross-sectional descriptive study which recruited consecutively a total of 406 pregnant women with singleton pregnancies (at 15–40 weeks of gestation), referred for routine obstetric ultrasound (US) scan at the National Hospital, Abuja from October to December 2019. Biparietal diameter (BPD), femur length (FL), head circumference (HC), abdominal circumference (AC), and PT were measured using standard protocols. All measurements were calculated by taking three best measurements, and the mean of the measurements was taken and recorded for each participant. Pearson's correlation analysis was computed to determine linear relationships between variables. A significant statistical level was determined at a critical value of  $P < 0.05$ . **Results:** The mean age was  $31.8 \pm 4.8$  years. The mean PTs in the second and third trimesters were  $23.2 \pm 3.1$  and  $34.1 \pm 3.7$  mm, respectively. PT had a linear relationship and a statistically significant positive correlation ( $r=0.99$ ,  $P = 0.00$ ) with GA. There was also a statistically significant positive correlation between PT on the one hand, and BPD, AC, HC, FL, PT, and GA, on the other hand. **Conclusion:** There was a significant and strong positive correlation between PT and GA. The study shows that US measurement of PT is a reliable method of estimating GA in singleton pregnancies in Nigeria.

**Keywords:** Age, correlation, gestational, placenta, thickness, trimester

## Introduction

Quality antenatal care and successful deliveries depend on the reliable estimation of gestational age (GA). GA estimation is also important in the evaluation of intrauterine growth restriction (IUGR) and in the interpretation of biochemical tests (such as human chorionic gonadotropin and alpha-fetoprotein) for prediction of risks of congenital anomalies and pathological foetal development.<sup>[1]</sup> Furthermore, accurate knowledge of GA also determines the modality of intervention when a foetal anomaly is detected. Almost all clinical decisions in pregnancy management require an accurate knowledge of GA. These include management of preterm delivery, caesarean section, bleeding in pregnancy, complications of labour, among others.

GA often calculated from the first day of the last menstrual period (LMP) is approximately 280 days. Although estimation of GA derived from LMP is widely used in clinical settings due to its ready availability, women often fail to accurately recall their LMP. Furthermore,

pregnant women often misreport their LMP due to mid-cycle or occasional bleeding during pregnancy.<sup>[2]</sup> In addition, women who are young, primigravid, and have lower education are more likely to misreport their LMP.<sup>[3]</sup> Hence, accurate determination of the GA is a common clinical problem. Compared with the use of LMP and physical examination, ultrasound (US) dating has been cited as the most accurate method of GA determination.<sup>[4]</sup> Foetal biometric parameters used in US dating include gestational sac volume, mean gestational sac diameter, and the crown–rump length in the first trimester. In the early second trimester, biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) are used for US dating of pregnancy.<sup>[5,6]</sup> Furthermore, BPD becomes more accurate for GA determination by the end of the first trimester, whereas HC, AC, and FL in addition to BPD become the parameters of interest in GA dating in the late second trimester.

BPD, HC, AC, and FL can predict GA with a fair degree of accuracy in the second trimester, especially before the 20th week of gestation. However, they become unreliable as GA progresses due to biological variability in size

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on account of age.<sup>[7]</sup> Furthermore, BPD measurement may be misleading as in congenital malformations such as hydrocephalus or anencephaly. A need therefore exists for additional biometric parameters which can contribute towards increased accuracy in US dating of pregnancy, especially in the late second trimester or in the third trimester.

It has been shown that placental thickness (PT) is an important biometric parameter showing strong correlation to GA, especially in the second half of pregnancy. While PT measurement is relatively simple and clinically useful, its role in GA determination has not been fully explored. Furthermore, using normogram from a population with different demographics (e.g., Caucasian population) to make obstetric management decisions may pose a challenge to foetal well-being in some cases. Hence, there is a need for a study on the accuracy of PT in the determination of GA and their comparisons to established foetal biometric parameters in our local population. This study was therefore conducted to determine the accuracy of the PT in the determination of GA (using existing established biometric parameters such as BPD, HC, AC, and FL).

## Materials and Methods

The study was conducted at the Radiology Department of National Hospital, Abuja (NHA). NHA is a tertiary healthcare centre and serves as a referral centre for both primary and secondary centres in Nigeria's Federal Capital Territory (FCT) as well as other parts of the country.

The study population comprised pregnant women carrying singleton pregnancy referred for routine obstetric US scan from the Obstetrics and Gynaecology Department of NHA. The subjects were recruited between 15 and 40 weeks' gestation. A selected sample of the population was studied after being ascertained free of medical and surgical conditions.

The study employed a cross-sectional descriptive study design using US scan machine to study PT in the determination of GA. The minimum sample size for this study was determined using the formula for calculating one sample mean.<sup>[8]</sup> Adjusting for anticipated 10% non-response, a sample size of 406 was used for the study.

Pregnant women who fulfil the following criteria were included in the study: (i) singleton pregnancy; (ii) GA of 15–40 weeks; (iii) history of regular menstruation; (iv) women sure of LMP, confirmed by early obstetric US scan; and (v) women who gave consent for inclusion into the study. Pregnant women with any of the following conditions were excluded from the study: (a) maternal factors (gestational diabetes, systemic hypertension and pregnancy-induced hypertension, anaemia, irregular menstrual cycles, uterine masses, absence of an early obstetric US scan, rhesus isoimmunization, and women who do not give consent); (b) foetal factors (suspected IUGR, hydrops fetalis, congenital malformations, multiple gestation, polyhydramnios, oligohydramnios, indistinct adrenal or renal borders, abnormal renal morphology, gross foetal hydronephrosis, foetal structural abnormality); and (c) placental factors (placenta previa, placental anomalies, poor visualization

of the placenta). Participants were recruited consecutively after obtaining informed consent from them.

The study instruments included a structured proforma containing sociodemographic characteristics of the participants, relevant medical and obstetric information including LMP, maternal age, weight, height, and US scan during first trimester. The proforma was used in obtaining sociodemographic and medical information of participants. US-measured foetal biometric parameters such as BPD, HC, AC, FL, and PT were recorded on the instrument.

A transabdominal sonographic examination was performed with a Phillips US scanner HD II XE (The Netherlands, 2012) with a 3–5 MHz curvilinear array probe. The transducer was placed on the skin surface after applying the coupling gel. All measurements were made on still images captured with the freeze facility of the US scanner with the on-screen electronic caliper of the US unit. Established foetal biometric parameters for GA estimation (including the BPD, FL, HC, AC) and PT were measured using standard protocols for such measurements. US estimation of GA and foetal weight through Hadlock formula-based algorithm of the scanner was recorded.

PT (in millimetres) was measured at the mid-portion of the placenta, at the level of umbilical cord insertion [Figures 1 and 2]. Tangential scan distorts PT measurement. Hence, the transducer was oriented to scan perpendicular to both the chorionic and the basal plates, and PT was calculated from the echogenic chorionic plate to placental myometrial interface. The myometrium and subplacental veins were excluded in the measurements. All placental measurements were taken during the relaxed phase of the uterus as uterine contractions often spuriously increase the PT.

GA estimation was based on reliable recollection of the first day of the LMP, and this was validated by a previous first trimester US scan. Using Naegele's rule, the GA (in weeks) was estimated from participants' LMP. US-measured GA was determined from Hadlock's chart of predicted foetal



Figure 1: US image showing a placenta that is relatively homogeneous in echotexture

measurements at specific menstrual weeks for BPD, HC, FL, and AC. All measurements were calculated by taking three best measurements, and the mean of the measurements was taken and recorded for each participant. The study was carried out over a period of 9 weeks.

The collected dataset was entered into Microsoft Excel spreadsheets, cleaned, and imported into IBM SPSS for Windows, version 20.0 (IBM, Chicago, IL, USA, 2011) and analysed. Variables were presented using frequencies tables and percentages. Student's *t*-test was used to test for significance between the means of continuous variables, whereas Pearson's correlation analysis was used to determine linear relationships between variables (BPD, AC, HC, FL, PT, and GA). A correlation matrix, a table

showing correlation coefficients between US-measured foetal parametric dimensions (including BPD, AC, HC, FL), PT, and GA, was computed using Pearson's correlation. Linear regression analysis models were used to determine appropriate best-fit model equations relating GA and PT. The level of statistical significance was determined at a *P*-value of less than 0.05.

Ethical clearance for the study was obtained from the Research Ethics Committee of the National Hospital, Abuja. Informed consent was obtained from selected participants. Participants did not incur any additional cost as the investigation was part of the normal obstetric care of pregnant women presenting at the health facility.

### Results

A total of 406 eligible pregnant women participated in the study. The ages of the participants ranged from 22 to 49 years, and the mean ( $\pm$ SD) age was  $31.8 \pm 4.8$  years. The mean ( $\pm$ SD) of the participants' weight and height were  $81.7 \pm 14.7$  kg and  $1.6 \pm 0.1$  m, respectively. One hundred and eleven subjects (27.3%) were primigravida, 118 (29.1%) primiparous women, 165 (40.6%) multiparous, and 12 (3.0%) were grand multiparous.

The mean PT increased by an average of 1.1 mm in a week in the second trimester with a mean PT of  $23.2 \pm 3.1$  mm. In this trimester, the PT increased by more than 10 mm without any decrease [Table 1].



Figure 2: Ultrasound of the placenta at 35 weeks' gestational age

**Table 1: Distribution of placental thickness and gestational age in the second and third trimesters**

GA (weeks)	No.	Mean	SD	Minimum	Maximum
Second trimester					
15	8	16.20	0.83	14.80	17.40
16	9	17.70	0.71	17.20	18.20
18	12	19.60	0.14	17.50	19.70
19	14	20.18	0.22	19.90	22.40
20	21	21.00	0.42	20.70	21.80
21	23	22.05	0.21	20.90	22.20
22	22	22.94	0.34	22.50	23.40
23	18	24.08	0.38	22.80	24.60
24	13	25.34	0.18	25.10	27.60
25	12	26.30	0.28	26.10	28.50
26	16	27.17	0.20	26.90	27.40
Third trimester					
27	12	27.50	0.66	26.50	28.40
28	17	28.97	0.43	28.40	29.60
29	15	29.96	0.35	28.60	30.50
30	17	30.30	0.88	29.10	31.80
31	19	31.33	0.86	29.80	32.10
32	18	32.81	0.25	32.40	33.10
33	13	33.84	0.71	32.60	34.60
34	17	34.69	0.51	33.60	35.10
35	25	35.66	0.62	34.90	36.40
36	11	36.84	0.46	36.20	37.60
37	16	37.32	0.59	36.50	38.10
38	12	38.50	0.46	37.90	39.10
39	28	38.00	3.63	35.80	39.80
40	18	39.67	0.06	38.60	40.70

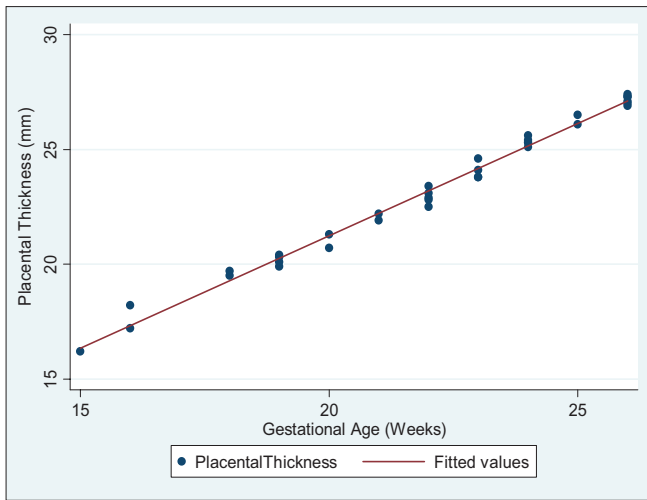


Figure 3: Graph showing correlation between PT and GA in the second trimester

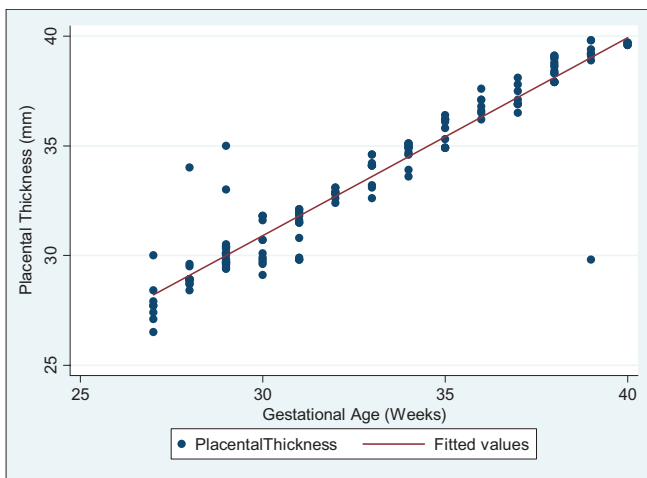


Figure 4: Graph showing correlation between PT and GA in the third trimester

In the third trimester (27–40 weeks), PT increased by an average of 1.2 mm in a week, with a mean PT of  $34.1 \pm 3.7$  mm. The PT increased by a total of about 11 mm from the 27th week to the 38th week without any significant decrescendo. PT thereafter decreased by about 0.5 mm at the 39th week and then increased by almost 2 mm at 40 weeks [Table 1]. The mean PT in the combined trimesters was  $31.3 \pm 7.4$  mm. The maximum PT of 40.7 mm was recorded at 40 weeks' gestation, whereas the minimum PT of 14 mm was recorded at 15 weeks.

An independent samples *t*-test was conducted to compare PT among primigravida and multiparous women. There was no statistically significant difference in PT for primigravida ( $M=31.0$ ,  $SD=6.3$ ) and multiparous ( $M=31.7$ ,  $SD=8.6$ ) women;  $t(404)=0.61$ ,  $P=0.27$ . Furthermore, there was no correlation between PT and maternal age ( $r=-0.057$ ,  $P=0.48$ ).

A linear increase in PT was observed as GA increases in the second and third trimesters [Figures 3–5]. The correlation matrix

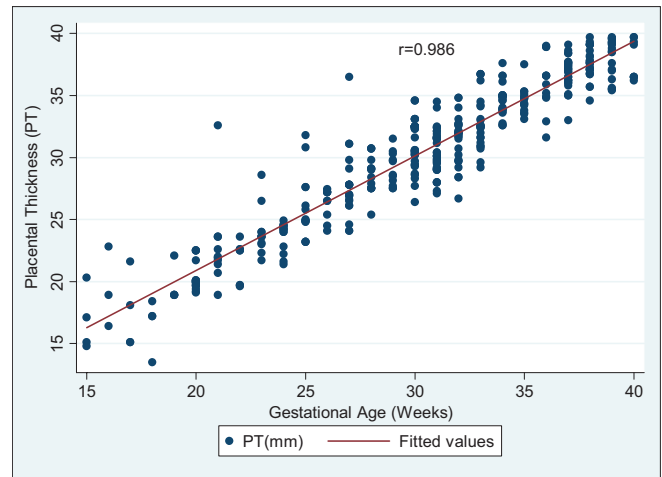


Figure 5: Correlation between PT and GA in the combined second and third trimesters

[Table 2] showed that there were strong positive correlations between PT and GA in the second ( $r=0.995$ ,  $P=0.00$ ) and third ( $r=0.958$ ,  $P=0.00$ ) trimesters. A similar relationship was also observed between PT and other parameters (i.e., BPD, HC, FL, AC). The linear regression model showed that the relationship between GA and PT can be represented by  $GA=1.011(PT)-1.442$  in the second trimester and  $GA=0.981(PT)+0.077$  in the third trimester.

## Discussion

Accurate determination of GA is necessary to ensure optimal obstetric care. Currently, US measurement of foetal growth parameters including BPD, HC, AC, and FL is the most reliable way of dating pregnancy.<sup>[8]</sup> Normograms of various foetal/obstetric parameters are therefore useful tools for GA determination. This study aimed at determining the accuracy of the PT in the estimation of GA using existing established biometric parameters including BPD, HC, AC, and FL.

More than three-quarters of the 406 participants in the study were aged 22–39 years. This is similar to the findings of the study by Azagidi *et al.*,<sup>[9]</sup> which showed that more than 80% of the participants were aged 18–37 years. Young age of participants found in this study was expected, as this period marks the peak of women's reproductive age.

The mean PT values in the second and third trimesters in the present study were  $23.2 \pm 3.1$  and  $34.1 \pm 3.7$  mm, respectively, comparable to the findings of a previous study, which reported the mean PT values of  $23.2 \pm 2.9$  and  $36.4 \pm 3.7$  mm in the second and third trimesters, respectively.<sup>[10]</sup> Furthermore, the present study recorded a mean PT of  $39.7 \pm 0.1$  mm at 40 weeks of gestation. This is in keeping with the findings of a similar study,<sup>[11]</sup> showing a mean PT of  $41.3 \pm 4.6$  mm at 40 weeks of gestation. The finding is also in tandem with a previous study in Benin City, Nigeria, which reported that the mean PT at 40 weeks' gestation reported was  $39.3 \pm 5.7$  mm.<sup>[11]</sup> A similar finding was also seen in studies conducted by Hoddick *et al.*<sup>[12]</sup>



**Table 2: Correlation matrix showing relationship among PT, GA, and foetal parameters in the second and third trimesters**

	PT	GA	BPD	HC	AC	FL
Second trimester						
PT ( <i>r</i> )	1	0.9946	0.9157	0.9758	0.8754	0.9651
GA ( <i>r</i> )	0.9946	1	0.9315	0.9837	0.8956	0.9631
BPD ( <i>r</i> )	0.9157	0.9315	1	0.905	0.8891	0.8636
HC ( <i>r</i> )	0.9758	0.9837	0.905	1	0.8912	0.9675
AC ( <i>r</i> )	0.8754	0.8956	0.8891	0.8912	1	0.8252
FL ( <i>r</i> )	0.9651	0.9631	0.8636	0.9675	0.8252	1
Third trimester						
PT ( <i>r</i> )	1	0.9575	0.8293	0.7893	0.6857	0.8315
GA ( <i>r</i> )	0.9575	1	0.8656	0.8228	0.698	0.8661
BPD ( <i>r</i> )	0.8293	0.8656	1	0.9259	0.6893	0.9268
HC ( <i>r</i> )	0.7893	0.8228	0.9259	1	0.6942	0.8815
AC ( <i>r</i> )	0.6857	0.698	0.6893	0.6942	1	0.7026
FL ( <i>r</i> )	0.8315	0.8661	0.9268	0.8815	0.7026	1

and Weerakkody,<sup>[13]</sup> in which they reported that the normal placenta was not greater than 40 mm in thickness at any stage of pregnancy in their studies. It may, therefore, be said that PT is not significantly influenced by race. However, a maximum mean PT of  $45.1 \pm 6.4$  mm (at 39 weeks' gestation) reported by a previous study<sup>[14]</sup> contrasts with the findings of this study. This may be related to the short insertion site included in PT measurement in that study, as Hoddick *et al.*<sup>[13]</sup> suggested that short placental insertion sites often spuriously increase the thickness of a normal placenta. In this study, measurement of PT was carried out perpendicular to the uterine wall and through the placenta at the site of umbilical cord insertion. This may have accounted for the difference in the findings of this study and those of a previous study.<sup>[14]</sup>

This study showed that there was no significant difference in mean PT between primigravid and multiparous pregnant women. Furthermore, there was no correlation between PT and maternal age in the study, and this is consistent with the findings of similar studies.<sup>[15,16]</sup> This indicates that PT is independent of parity and maternal age.

PT strongly correlates to GA in this study, implying that PT measurement is relevant to accurate determination of GA. PT had a linear relationship with the GA from 15 to 40 weeks of gestation and increased with advancing GA, a finding consistent with previous studies.<sup>[17-19]</sup> A strongly positive correlation between PT and GA throughout gestation (combined second and third trimesters) observed in this study is similar to findings of a study in Enugu, Nigeria.<sup>[11]</sup> Other studies also showed strongly positive correlation between PT and GA, confirming that GA and PT are linearly related.<sup>[16-19]</sup>

Although a repeated measure of PT might have been more accurate, this study used a cross-sectional study design in which authors measured PT only once in each participant during the study. Hence, this was the major limitation of the study. A larger study on PT and GA determination conducted in multiple study sites may be helpful in constructing a nomogram for GA determination using PT.

## Conclusion

US measurement of PT in GA determination is relatively simple and clinically useful. This study showed that PT can be used as a predictor of the GA, in pregnant women who are unsure of their LMP and including women whose LMPs are unreliable. PT and GA are linearly related. Hence, PT measurement is an important additional parameter for estimating GA along with other biometric parameters.

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## Ethical statement

This study was performed in keeping with the principles of the Declaration of Helsinki. Approval was granted by the Research Ethics Committee of the National Hospital, Abuja (NHA/EC/050/2019). Informed consent was obtained from all individual patients who participated in the study. The authors affirm that research participants provided informed consent for publication of the images in the manuscript.

## Authors' contribution

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by OAO, OOO, JOK, and AOO. The first draft of the manuscript was written by OAO, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Nil.

## Conflicts of interest

The authors have no relevant financial or non-financial interests to disclose.

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