Original Article

# Correlations between Placental Thickness and Neonatal Outcomes: A Detailed Analysis at 32 and 36 Weeks

**Alka Agrawal, Prachi Shukla, Vivek Yonati, Sapna Ahlawat, Rinku Meena, Deepak Ahlawat, Neelesh Patel**

Department of Radiology, M.G.M. Medical College, Indore, Madhya Pradesh, India

## Abstract

**Introduction:** The placenta helps in supporting the developing fetus by providing essential metabolic, immunological, endocrine, respiratory and nutritional functions. During pregnancy, the placenta grows in size to adequately support the needs of the developing fetus. Abnormalities in placental thickness (PT) can serve as an indicator of potential complications during pregnancy. Utilizing ultrasound technology to assess the thickness of the placenta throughout pregnancy, aiming to identify potential connections with fetal well-being, as well as other relevant factors. In addition, the objective is to establish reference charts for PT during 32 and 36 weeks of gestation. **Materials and Methods:** An observational study at a Medical College and Hospital in India, from February 2023–2024, that included 400 patients. The thickness of the placenta was measured at 32 and 36 weeks in women who were referred for antenatal scans. Out of the 400 participants, 25 gave birth before reaching 36 weeks, while the remaining 375 were monitored until they reached 36 weeks. The thickness was categorized into three groups: Normal ($10^{th}$–$90^{th}$ percentile), thin (<$10^{th}$ percentile), and thick (>$90^{th}$ percentile). The outcomes of the newborns were evaluated after delivery and statistical analysis was conducted using ANOVA to calculate descriptive measures such as the mean and standard deviation. **Results:** Among the 400 patients at 32 weeks, PT measurements had varied from 25 to 40 mm, with a PT (mean) of approximately 31 mm ± 3.13 mm. At 36 weeks, among the 375 patients, PT ranged from 27 to 44 mm and a mean PT of approximately 35.2 mm ± 3.27 mm. The correlation of PT and the fetal birth weight was noticeable, with a stronger correlation observed at 36 weeks ($r$ = 0.432) compared to 32 weeks ($r$ = 0.316). **Conclusion:** The overall thickness of the placenta at 32 and 36 weeks is closely related to the stage of pregnancy and can provide valuable insights into the overall wellness of the newborn. It is important to measure PT along with biometric parameters during ultrasound examinations for pregnant women. In addition, we observed the interaction of different factors, including body mass index and parity.

**Keywords:** Birth weight, neonatal outcome, placental thickness, pregnant women, ultrasound

## Introduction

The placenta being a remarkable organ of the fetus that plays roles in supporting the developing embryo and fetus. It serves numerous critical functions, including metabolic, immunological, endocrine, respiratory, and nutritional support.[1] Importantly, the placenta also acts as a protective barrier, shielding the fetus from infections and toxic substances.[1] Optimal placental formation and function are essential for the healthy growth also development of the fetus.

Interestingly as pregnancy progresses the placenta typically increases in thickness.[2] This change in placental morphology is influenced by the mother's metabolic state which in turn impacts the birth weight of the newborn.[2,3] Certain pregnancy conditions, such as Rh-negative status, intrauterine infections, gestational diabetes, and fetal hydrops, are associated with a thicker placenta, while preeclampsia, chorioamnionitis, and intrauterine growth restriction (IUGR) are linked to a thinner placenta.[3]

Given the critical importance of the placenta in fetal well-being and overall pregnancy outcome, the assessment of placental health has become increasingly significant in modern obstetric care.[4] However, the placental has historically been limited, often relying on indirect signs and symptoms.[4,5]

**Submitted:** 29-Jul-2024 **Revised:** 21-Aug-2024
**Accepted:** 09-Sep-2024 **Published:** 16-Dec-2024

Access this article online

Quick Response Code:

Website: http://journals.lww.com/amit

DOI: 10.4103/amit.amit_99_24

**Address for correspondence:** Dr. Sapna Ahlawat, Department of Radiology, M.G.M. Medical College, Indore, Madhya Pradesh, India.
E-mail: roll281sapnaahlawat@gmail.com



**How to cite this article:** Agrawal A, Shukla P, Yonati V, Ahlawat S, Meena R, Ahlawat D, *et al*. Correlations between placental thickness and neonatal outcomes: A detailed analysis at 32 and 36 weeks. Acta Med Int 2024;11:191-6.

The placenta is a complex and essential fetal organ that undergoes dynamic changes during pregnancy, reflecting the mother's metabolic state and influencing fetal growth and development. The assessment of placental health, particularly through noninvasive techniques like ultrasonographic (USG) evaluation, has gained considerable importance in modern obstetric practice.[4]

With easy access of advanced ultrasound technology, radiologist can now conduct detailed and accurate assessments of the placental structure, including its thickness, in a safe and noninvasive manner. This advancement has revolutionized prenatal care by providing an insight into the well-being of both the placenta and the developing fetus.

Placental thickness (PT), measured through ultrasound, has emerged as a key parameter for evaluating placental health. It serves as a direct and quantifiable indicator of the placental structure, allowing for early detection of abnormalities or potential issues that could impact fetal growth and development.[5] As a result, the correlation between PT, as determined by USG and fetal outcome has become a subject of considerable research and clinical interest.

PT is a complete parameter (morphological) for prenatal planning and changes in PT are associated with a number of abnormalities.[6] PT abnormalities can be a warning sign of prenatal complications.[6,7]

This study hence aims to evaluate the PT at 32 and 36 weeks using ultrasound and define the nomogram of PT at these points and correlate it with the fetal outcome. Understanding this correlation can enhanced antenatal care practices, more effective early intervention strategies and ultimately better outcomes for both mothers and their unborn children. Furthermore, PT was correlated with factors such as parity and body mass index (BMI).

## Materials and Methods

An observational study was conducted in a hospital setting, involving 400 pregnant women. The study received approval from the institutional ethics and scientific review committee (EC/MGM/Feb-23/39). The study took place from February 2023 to February 2024. We included a total of 400 patients who were referred to our department for antenatal scans at 32 and 36 weeks in our study.

### Inclusion criteria

The pregnant women (singleton pregnancy) between 19 and 40 years of age.

### Exclusion criteria

1. Pregnant females with any systemic illness, multiple pregnancies, placental abnormalities, fetal anomalies
2. Pregnant women who were not sure of their last menstrual period
3. Patient refused to give consent.

All the patients were subjected to the following:

Women were provided with an explanation of the procedure and their demographic information was recorded. Following the completion of the necessary formalities under the PC-PNDT act, an obstetric ultrasound was conducted. All patients underwent examination while lying down, using a low frequency transducer (3–5 MHz). We examined the fetus to determine its viability, gestational age and any major congenital defects. The placenta was found in a longitudinal section [Figure 1].

Among the entire group of 400 women who were at 32 weeks, a total of 25 gave birth before reaching 36 weeks. At 36 weeks, the progress of those remaining 375 women was monitored. We evaluated the fetal outcomes after delivery. We analyzed the PT data to determine the percentile for the participants in our study. Women who were pregnant and had a PT that fell within the average range were regarded having normal PT. They were subsequently followed up as a cohesive group. Women whose thickness fell below the 10$^{th}$ percentile or above the 90$^{th}$ percentile were categorized as having either an unusually thin or thick placenta, respectively.[3-6] These women were monitored at 36 weeks before and after giving birth as an additional group. We have created a nomogram that shows the thickness of the placenta at two specific times during pregnancy: 32 weeks and 36 weeks of gestation. PT was measured at 32 and 36 weeks of gestation using standardized ultrasound techniques by trained sonographers with each session overseen by a senior radiologist. This approach minimized inter-observer variability and measurement bias, ensuring consistency, and accuracy in the data collection process. The weight of the baby at birth, APGAR score, how developed the baby was and whether they needed to be admitted to the neonatal intensive care unit (NICU) were all recorded.

## Results

Out of total 400 pregnant female were in majority 245 (61.2%) patients were between 19 and 25 years of age group. The mean age was 25.12 ± 3.94 years, most of the

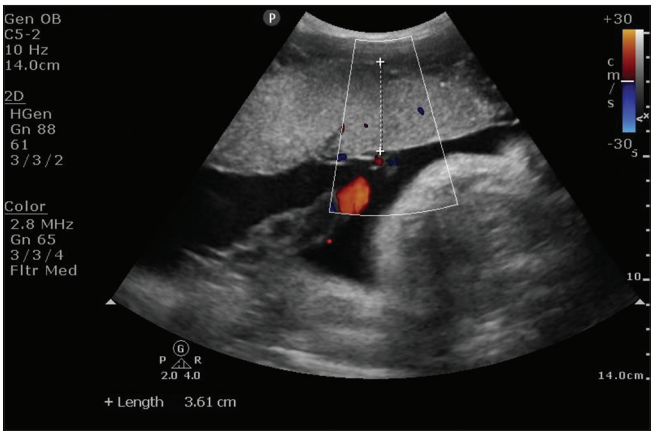


**Figure 1:** Displays the ultrasonographic measurements for placental thickness at the position of cord insertion

patients 149 cases (37.2%) had a gravida of G2 followed by G3, with 123 cases (30.7%) [Table 1].

On comparing BMI [Table 2], majority 274 (68.5%) of patients were in the normal BMI, followed by 93 (23.2%) females in the overweight group, 25 (6.2%) females in the underweight group and only 8 (2%) females in the obese group. The mean BMI for the entire group was approximately 23.1 kg/m$^2$ ± 2.5 kg/m$^2$. In our study, we found that the majority 209 (52.2%) of placenta had an anterior location followed by posterior location 115 (28.7%), fundal 48 (12%), and less frequent lateral 28 (7%) locations.

Out of 400 patient at 32 weeks, 69 (17%) had a thin placenta, 296 (74%) had a normal PT and 35 (9%) had a thick placenta. Among the 25 women, who delivered prematurely at 32 weeks of gestational age, 9 (36%) had a thin placenta, 13 (52%) had normal thickness and 3 (12%) had a thick placenta. At 36 weeks, the incidence of a thin placenta decreased to only 42 (11%) and the incidence of a thick placenta was 30 (8%), while 303 (81%) had normal PT. The mean PT of approximately 31 mm ± 3.13 mm at 32 weeks [Table 3]. At 36 weeks, among 375 patients, we observed the mean PT of approximately 35.2 mm ± 3.27 mm [Table 4].

When examining preterm deliveries at 32 weeks in a group of 25 women, researchers observed a notable difference in outcomes depending on the thickness of the placenta. Individuals with a PT of <28 mm experienced predominantly negative outcomes. Out of the nine individuals, five underwent cesarean delivery, all had babies with low birth weights (<2.5 kg), poor APGAR scores (<4) and required admission to the NICU [Table 3]. In the group of individuals with PT ranging from 28 to 35 mm, the rate of cesarean deliveries was lower, with only 2 out of 13 individuals undergoing the procedure. Nevertheless, the occurrence of low birth weight and NICU admissions continued to be noteworthy, suggesting a consistent pattern of risk linked to thinner placentas. The group with a PT >35 mm had the fewest negative outcomes, although the sample size was small, consisting of only 3 women.

Out of the 375 term deliveries observed at 36 weeks, 43 women had a PT of <31 mm. Among these women, 15 had cesarean deliveries. Out of their newborns, 35 had low birth weight, 27 had poor APGAR scores at 5 min and 22 needed to be admitted to the NICU. Among the group of 303 women with a PT between 31 and 39 mm, there were 20 cesarean deliveries, 90 babies with low birth weights, 45 with poor APGAR scores and 38 who required NICU admission. Among the group of 29 women with a PT >39 mm, 5 had cesarean deliveries, 10 babies were born with low birth weight, 6 had poor APGAR scores, and 5 required admission to the NICU [Table 4].

**Table 1: Distribution of females according to age**

| Age group (years) | Frequency, n (%) |
|---|---|
| 19–25 | 245 (61.2) |
| 26–30 | 115 (28.7) |
| 31–35 | 34 (8.5) |
| >35 | 6 (1.5) |
| Total | 400 (100.0) |

Table 5 presents a detailed statistical analysis examining the relationships between PT at 32 and 36 weeks of gestation and various clinical and demographic factors. At 32 weeks, there was a notable correlation between PT and birth weight, indicated with a coefficient of 0.316 and $P < 0.001$. The association between PT and the APGAR score, although weaker is statistically significant ($r = 0.140$, $P < 0.005$). The strongest correlation observed is between BMI and PT, with an $r = 0.684$ and a $P < 0.001$. In addition, a slight inverse relationship exists between PT and the number of previous births, with a correlation coefficient of −0.103 and a $P = 0.041$ suggesting statistical significance.

By the 36$^{th}$ week, these relationships evolve slightly. The correlation between PT and birth weight strengthens ($r = 0.432$, $P < 0.001$). The link between PT and APGAR scores also increases ($r = 0.214$, $P < 0.000$). While the association between BMI and PT slightly weakens, it remains significant ($r = 0.630$, $P < 0.001$). The negative correlation between PT and maternal parity persists, indicated by a similar $r$-value (−0.102) and a significant $P$ value (0.039). These findings highlight the evolving nature of these relationships as pregnancy progresses.

## Discussion

Among 400 patients at 32 weeks, PT measurements ranged from 25 to 40 mm, with a mean PT of approximately 31 ± 3.13 mm [Figure 2]. Below 28 mm (10$^{th}$ percentile), the placenta was labeled as thin and above 36 mm (90$^{th}$ percentile), it was considered thick. At 36 weeks, among 375 patients, we observed that PT ranged from 27 to 44 mm, with a mean PT of approximately 35.2 ± 3.27 mm. Below 31 mm (10$^{th}$ percentile), the placenta was labeled as thin and above 39 mm (90$^{th}$ percentile), it was labeled as thick [Figure 3].

The data in Table 1 show that 61.2% of pregnant women were aged 19–25, with a mean age of 25.12 ± 3.94 years. This pattern is consistent with findings from studies, which reported that younger women, particularly those in their early twenties, form

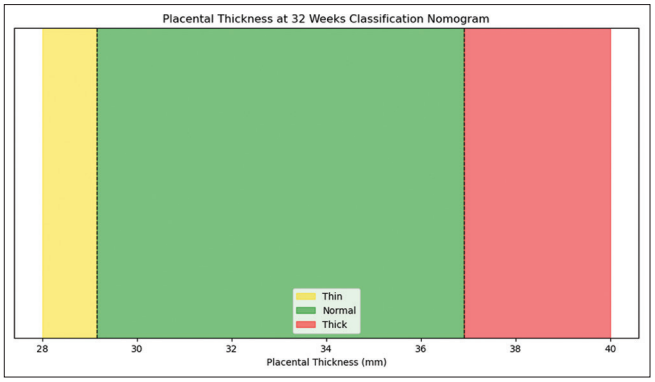


**Figure 2:** Nomogram illustrating placental thickness measurements at 32 weeks

a significant portion of the pregnant population.[8,9] This age distribution underscores the importance of tailored prenatal care programs for younger mothers, who generally face lower risks of complications but higher rates of preterm births.[10,11] Such findings highlight the need for targeted educational initiatives focusing on prenatal health and regular check-ups for this age group.

The data in Table 3 reveal that the majority of pregnant women (68.5%) were in the normal BMI range, followed by 23.25% who were underweight. The mean BMI was approximately 23.1 ± 2.5 kg/m$^2$. These findings are consistent with those reported by Kominiarek *et al*., who highlighted that maintaining a normal BMI during pregnancy is associated with favorable outcomes, including reduced risks of gestational diabetes and preeclampsia.[11] In addition the World Health Organization supports that a normal BMI reduces the risk of complications such as hypertension and gestational diabetes.

The prevalence of underweight women (23.25%) in this study is significant, as underweight pregnant women are at higher risk for preterm birth and low birth weight infants, according to research's similar associations, emphasizing the need for adequate nutritional support for underweight pregnant women.[12,13] Conversely, the study found that 6.25% of the women were overweight and 2% were obese. Although these figures are relatively low, they highlight important risks. Catalano and Catalano noted that overweight and obese pregnant women face increased risks of gestational diabetes, preeclampsia, and cesarean delivery, underscoring the necessity for prepregnancy and prenatal nutritional counseling to ensure optimal maternal and fetal health outcomes.[14]

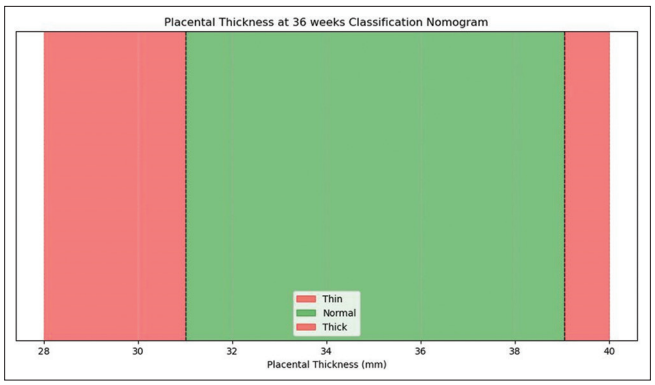


**Figure 3:** Nomogram showing placental thickness at 36 weeks of gestation

**Table 2: Distribution of females according to body mass index**

| BMI (kg/m$^2$) | Frequency, *n* (%) |
|---|---|
| <18.5 | 93 (23.25) |
| 18.5–24.9 | 274 (68.5) |
| 25–29.9 | 25 (6.25) |
| >30 | 8 (2) |
| Total | 400 (100) |

BMI: Body mass index

Table 4 analyzes the impact of PT on birth outcomes for preterm deliveries at 32 weeks, showing that thinner placentas (<28 mm) are associated with significantly worse outcomes. Specifically, out of the nine women with a thin placenta, five (55.6%) underwent cesarean delivery and all had babies with low birth weights (<2.5 kg), poor APGAR scores (<4) and required NICU admission. These findings are in line with those reported by a study which found that reduced PT was a significant predictor of adverse perinatal outcomes, including low birth weight and increased NICU admissions.[15] Afrakhteh *et al*., had highlighted that thin placentas were linked to higher rates of preterm birth and fetal growth restriction, reinforcing the importance of PT as a critical parameter in assessing fetal health risks.[16]

In contrast, the group with PT between 28 and 35 mm showed relatively better outcomes, though risks remained notable. Among this group, only 2 out of 13 women (15.4%) required cesarean sections and while 8 infants (61.5%) had low birth weights, the rates of poor APGAR scores and NICU admissions were lower compared to the thin placenta group. This is supported by the findings of Balakrishnan, who indicated that moderate PT correlates with improved neonatal outcomes, with only 20% of infants requiring NICU admission when PT was within this range.[17] The group with PT >35 mm had the least adverse outcomes, with only 1 out of 3 women (33.3%) undergoing cesarean delivery and fewer infants had low birth weights (2 cases), poor APGAR scores (1 case) and NICU admissions (2 cases). These observations align with the results from a study by Agwuna *et al*. who noted that thicker placentas within a certain range generally indicate better perinatal outcomes, with only 10% of infants in their study requiring NICU care when PT was optimal.[18] Furthermore, a study by Ohagwu *et al*. supports these findings with a positive correlation between adequate PT and healthier birth outcomes.[19]

Our analysis of PT and its relationship to birth outcomes at 36 weeks gestation revealed several important findings [Table 5]. Thin placentas were associated with the highest rates of adverse outcomes across all categories. Specifically, 56% of these cases required cesarean delivery and 89% resulted in low birth weight, poor APGAR scores, and NICU admission. This aligns with findings from Dombrowski *et al*., who noted that thin placentas diagnosed by ultrasound were associated with significantly increased incidences of perinatal mortality (odds ratio = 2.9), NICU admissions (odds ratio = 2.2), and birth weight below the 10$^{th}$ percentile (odds ratio = 2.8).[20]

Placentas of normal thickness showed improved outcomes compared to thin placentas but still carried considerable risks. 15% required cesarean delivery, while 62% resulted in low birth weight and 54% required NICU admission. These rates, while lower than for thin placentas, still indicate significant risks associated with preterm birth even with normal PT. This underscores the complex interplay of factors influencing preterm birth outcomes beyond just PT. Wang *et al*. reported that abnormal shaped singleton placentas, including those with normal thickness, showed variable extents of inadequate

**Table 3: Analysis of placental thickness categories in relation to birth weight, APGAR scores and neonatal intensive care unit admissions for preterm deliveries at 32 weeks**

| Placental thickness (mm) | Number of women (%) | Cesarean delivery | Low birth weight (<2.5 kg) | Poor APGAR score (<4) | NICU admission |
|---|---|---|---|---|---|
| <28 | 9 (36) | 5 | 8 | 8 | 9 |
| 28–35 | 13 (52) | 2 | 8 | 6 | 7 |
| >35 | 3 (12) | 1 | 2 | 1 | 2 |
| Total | 25 (100) | 8 | 18 | 15 | 18 |

NICU: Neonatal intensive care unit

**Table 4: Analysis of placental thickness impact on birth weight, APGAR scores and neonatal intensive care unit admissions for term deliveries at 36 weeks**

| Placental thickness (mm) | Number of women (%) | Cesarean delivery | Low birth weight (<2.5 kg) | Poor APGAR score at 5 min (<4) | NICU admission |
|---|---|---|---|---|---|
| <31 | 43 (11.4) | 15 | 35 | 27 | 22 |
| 31–39 | 303 (80.8) | 20 | 90 | 45 | 38 |
| >39 | 29 (7.7) | 5 | 10 | 6 | 5 |
| Total | 375 (100) | 40 | 135 | 78 | 65 |

NICU: Neonatal intensive care unit

**Table 5: Correlation coefficients and statistical significance of relationships involving placental thickness at 32 and 36 weeks**

| Variable comparison | 32 weeks (*r*, *P*) | 36 weeks (*r*, *P*) |
|---|---|---|
| PT versus birth weight | 0.316, <0.001 | 0.432, <0.001 |
| PT versus APGAR score | 0.140, <0.005 | 0.214, <0.000 |
| BMI versus placental thickness | 0.684, <0.001 | 0.630, <0.001 |
| PT versus maternal parity | −0.103, 0.041 | −0.102, 0.039 |

BMI: Body mass index, PT: Placental thickness

maternal–fetal perfusion, leading to adverse pregnancy outcomes such as premature delivery and fetal growth restriction.[21]

Thick placentas showed the lowest rates of adverse outcomes, though the small sample size ($n = 3$) limits definitive conclusions. Only 33% required cesarean delivery and 67% resulted in low birth weight, poor APGAR scores, and NICU admission. While these rates are lower than for other thickness categories, they still reflect the overall elevated risks associated with preterm birth at 32 weeks. Raio *et al*. found that PT <25 mm at 36 weeks was associated with a 3.7-times increased risk of low birth weight. The higher rates observed in our study likely reflect the earlier gestational age (32 weeks vs. 36 weeks).[22]

Our results showed a moderate positive correlation between PT and birth weight at 32 weeks ($r = 0.516$, $P < 0.001$). This is consistent with findings by Afrakhteh *et al*., who reported a positive correlation between PT and birth weight in both 2nd and 3rd trimesters in their study of 250 singleton pregnancies. However, they concluded that changes in PT alone could not predict low birth weight.[16]

We observed higher antenatal, intrapartum, and postpartum complications (including pregnancy-induced hypertension, IUGR, preterm delivery, oligohydramnios, low birth weight, NICU admission, poor Apgar scores, and need for emergency cesarean) in pregnancies with thin placentas. This aligns with findings by Ahmed *et al*., who observed a higher incidence of IUGR with thin placentas (<25 mm) at 36 weeks of gestation in their study of 53 Sudanese women.[23]

We found an increased chances of polyhydramnios, glucose intolerance and gestational diabetes mellitus (GDM) associated with thick placentas (≥26.4 mm at 32 weeks). This is consistent with Ahmed *et al*.'s conclusion that thick placentas (>45 mm) could be predictive of GDM and other complications.[23]

The results displayed in Table 2 provide a thorough statistical analysis of the relationships between PT at 32 and 36 weeks of gestation and various clinical and demographic factors. At 32 weeks, the correlation coefficient between PT and birth weight is 0.316 ($P < 0.001$) and at 36 weeks, it is 0.432 ($P < 0.001$). This significant positive correlation is supported by the study conducted which found that low birth weight was significantly associated with thin placentas measured at both 18–20 weeks and 30–32 weeks of gestation.[5] Similarly, a positive correlation between PT and birth weight, emphasizing that PT can be a reliable predictor of fetal weight.[24]

The correlation between PT and APGAR score at 32 weeks is 0.140 ($P < 0.005$) and at 36 weeks, it is 0.214 ($P < 0.000$). This relationship is supported by the findings of El-Maghraby who observed that PT was significantly associated with higher APGAR scores at birth.[25] In addition, the study by Patil *et al*. found that normal PT was associated with higher APGAR scores and better neonatal outcomes.[26]

The correlation between BMI and PT is strong at both 32 weeks ($r = 0.684$, $P < 0.001$) and 36 weeks ($r = 0.630$, $P < 0.001$). This is consistent with the findings which reported a significant positive correlation between maternal BMI and

PT in their study of 250 singleton pregnancies.[16] Similarly a study found a significant positive correlation between maternal weight gain and PT, further supporting this relationship.[3]

The correlation between PT and maternal parity is slightly negative at both 32 weeks ($r = -0.103$, $P = 0.041$) and 36 weeks ($r = -0.102$, $P = 0.039$). This inverse relationship is supported by the study, which found that placental mass and birth weight were influenced by various morphometric parameters, including maternal parity.[27] Ashmawy *et al*. observed that PT was inversely related to maternal parity, indicating that higher parity was associated with thinner placentas.[28]

### Limitations

Our study has a few limitations, such as a smaller sample size, which may explain the lower observed abnormal PT. Furthermore, the nutritional and socioeconomic status of the women included in our study was not taken into account when evaluating the neonatal outcomes in relation to placental measures. Additional research is necessary to assess how lifestyle, nutrition, and socioeconomic status influence birth outcomes.

## Conclusion

The study suggests a relationship between placental measurements and the overall health of the newborn, as well as maternal characteristics. While there appears to be a general trend linking increased PT with higher birth weight and better APGAR scores, it is essential to consider that extreme variations in thickness might present certain risks. This highlights the intricate nature of prenatal monitoring. The findings indicate that placental measurements could potentially serve as valuable indicators in clinical settings, though further research is needed to confirm this. Further research is necessary to deepen our understanding of these relationships and their implications across different populations.

### Acknowledgment

The authors take this opportunity to thank the Department of Obstetrics and Gynecology for their clinical and technical support.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

## References

1. Khorami-Sarvestani S, Vanaki N, Shojaeian S, Zarnani K, Stensballe A, Jeddi-Tehrani M, *et al.* Placenta: An old organ with new functions. Front Immunol 2024;15:1385762.
2. Kadam D, Patil Y, Patange RP, Patil S, Sebastian S, Jarag R. Relationships between ultrasonographic placental thickness in the third trimester and foetal outcomes. Res J Pharm Technol 2024:746-50
3. Shinde GR, Kshirsagar N, Laddad M, Shivade V. Ultrasonographic placental thickness versus fetal outcome: A prospective study in Southern India. Caspian J Intern Med 2021;12:562-7.
4. Rashid S, Mumtaz U, Naeem A, Hanif S, Khalid A, Bangash M. Ultra sonographic measurement of placental thickness during pregnancy as a parameter for estimating gestational age of the fetus. Pak J Med Health Sci 2022;16:813-5.
5. Rawal S, Ray S, Sharma N. Correlation between ultrasonographic placental thickness and adverse fetal and neonatal outcomes. Cureus 2024;16:e56410.
6. Kakumanu PK, Kondragunta C, Gandranr YH. Evaluation of placental thickness as an ultrasonographic parameter for estimating gestational age of the fetus in 2nd and 3rd trimesters. Int J Contemp Med Surg Radiol 2018;3:128-32.
7. Sun X, Shen J, Wang L. Insights into the role of placenta thickness as a predictive marker of perinatal outcome. J Int Med Res 2021;49:300060521990969.
8. Martin JA, Hamilton BE, Osterman MJ, Driscoll AK, Drake P. Births: Final data for 2017. Natl Vital Stat Rep 2018;67:1-50.
9. Mathews TJ, Hamilton BE. Mean Age of Mothers is on the Rise: United States, 2000-2014. NCHS Data Brief. 2016:1-8.
10. Cleary-Goldman J, Malone FD, Vidaver J, Ball RH, Nyberg DA, Comstock CH, *et al.* Impact of maternal age on obstetric outcome. Obstet Gynecol 2005;105:983-90.
11. Kominiarek MA, Seligman NS, Dolin CD. Gestational weight gain and obstetric outcomes in normal weight, overweight and obese women. Obstet Gynecol 2021;137:511-20.
12. Han Z, Mulla S, Beyene J, Liao G, Mcdonald SD. Knowledge synthesis group. Maternal underweight and the risk of preterm birth and low birth weight: A systematic review and meta-analyses. Int J Epidemiol 2011;40:65-101.
13. Bodnar LM, Siega-Riz AM, Simhan HN, Himes KP, Abrams B. Severe obesity, gestational weight gain, and adverse birth outcomes. Am J Clin Nutr 2010;91:1642-8.
14. Catalano PM, Ehrenberg HM. The short- and long-term implications of maternal obesity on the mother and her offspring. BJOG 2006;113:1126-33.
15. Schwartz N, Sweeting R, Hubbard A. Placental vascular development in normal and complicated pregnancies using three-dimensional ultrasound. Placenta 2017;57:331-7.
16. Afrakhteh M, Moeini A, Taheri MS, Haghighatkhah HR. Correlation between placental thickness in the second and third trimester and fetal weight. Rev Bras Ginecol Obstet 2013;35:317-22.
17. Balakrishnan M, Virudachalam T. Placental thickness: a sonographic parameter for estimation of gestational age. Int J Reprod Contracept Obstet Gynecol. 2016;5:4377-81
18. Agwuna KK, Eze CU, Ukoha PO, Umeh UA. Relationship between sonographic placental thickness and gestational age in normal singleton fetuses in Enugu, Southeast Nigeria. Ann Med Health Sci Res 2016;6:335-40.
19. Ohagwu CC, Abu PO, Udoh BE. Placental thickness: A sonographic indicator of gestational age in normal singleton pregnancies in Nigerian women. Internet J Med Update. 2009;4:9-14.
20. Dombrowski MP, Saleh AA, Berry SM, Cotton DB. Perinatal outcome with sonographically thin placentas. J Matern Fetal Neonatal Med 1992;1:137-9.
21. Wang AC, Xie JL, Wang YN, Sun XF, Lu LJ, Sun YF, *et al.* Singleton placentas with abnormal shape: A clinicopathological analysis of 130 cases. Zhonghua Bing Li Xue Za Zhi 2022;51:39-43.
22. Raio L, Ghezzi F, Cromi A, Nelle M, Dürig P, Schneider H. The thick heterogeneous (jellylike) placenta: A strong predictor of adverse pregnancy outcome. Prenat Diagn 2004;24:182-8.
23. Ahmed M, El-Sammani M, Kheir A. Placental thickness: A sonographic marker for estimating gestational age in the Sudanese population. Saudi J Health Sci 2015;4:187-92.
24. Bedi M, Sharma H, Sandhu PS, Minhas A. Correlation of placental thickness with birth weight in singleton pregnancies. Int J Reprod Contracept Obstet Gynecol 2021;10:3812.
25. El-Maghraby I. Ultrasonographic evaluation of placental sites and thickness at second trimester and its correlation with pregnancy outcome. Egypt J Hosp Med 2021;82:316-22.
26. Patil Y, Skariah OB, Patange RP. Role of Ultrasonography Placental Thickness in Third Trimester in the Prediction of Fetal Outcome. Natl J Med Res. 2024;14:43-50.
27. Tepla IV. The relationship between placental growth rates and the birth weight in dichorionic diamniotic twins. Med Sci Ukr 2021;17:66-75.
28. Ashmawy NEI, Saad AS, Soliman AS, Mohammed MH. Is there a correlation between Placental Thickness and Fetal Birth Weight? Benha Med J 2020;37:488-99.