

EVALUATION OF PLACENTAL MATURITY GRADING ON ULTRASONOGRAPHY ACROSS THE 2ND & 3RD TRIMESTERS IN NORMOTENSIVE AND HYPERTENSIVE PATIENTS

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Abstract

Objective: The placenta provides hormonal, nutritional, and immunological support for fetal growth, however, maternal hypertension may cause aberrant placental maturation, thereby, causing adverse outcomes. This study evaluates placental maturity grading on Ultrasonography across the 2nd & 3rd trimesters in normotensive and hypertensive patients. Method: This study involves two equal groups of 70 pregnant women; Group A having normotensive patients, and Group B having hypertensive patients. With the progression of the pregnancy, the placenta's location and maturity grade were assessed and comparisons were made using data analysis. Results: The study reveals that placental maturity significantly advances with increasing gestational age ($p < 0.001$), with higher grades (II and III) predominantly observed in the third trimester. The overall findings failed to show a statistically significant difference in placental grading between normotensive and hypertensive women ($p = 0.237$ from ordinal logistic regression). Placental thickness ($p < 0.001$) and estimated fetal weight (EFW) ($p < 0.001$) significantly increased from the second to the third trimester, consistent with physiological growth. Conclusion: This study found that placental maturity significantly advances with increasing gestational age, with higher grades predominating in the third trimester. Early advanced grades in hypertensive cases emphasize the necessity of continued ultrasound surveillance in high-risk pregnancies, even though variations in grading between normotensive and hypertensive women were not statistically significant.

INTRODUCTION:

The placenta is a transient, highly specialized organ that develops during pregnancy and is indispensable for fetal growth and development, as well as maternal physiological adaptation.¹ The placenta serves multiple requisite functions including nutrient and oxygen transport, metabolic waste clearance, hormone production, and immune protection. It regulates the bidirectional (passive and active) transfer of glucose, amino acids, and lipids to the fetus while removing carbon dioxide and urea.² The structural or functional perturbations in these processes can have profound clinical consequences, with conditions such as fetal growth restriction, pre-eclampsia, and placenta accreta spectrum disorders adversely impacting maternal and fetal health.³

Placental grading is assessed sonographically using the Grannum grading system (Grades 0–III) to evaluate placental maturation during the second and third trimesters.

Grade 0, typically observed before 30 weeks of gestation, is characterized by homogeneous placental parenchyma without calcifications,⁴ Grade I presents with mild scattered calcifications, slight chorionic indentations usually between 30–34 weeks.⁵ Grade II exhibits distinct indentations that do not reach the basal plate, linear calcifications along the basal layer, and heterogeneous echotexture, generally observed at 34–37 weeks.⁶

Grade 3 denotes advanced maturity with deep indentations extending from the chorionic to the basal plate while physiologically appropriate after 37 weeks, its early appearance before 34–35 weeks may be associated with maternal hypertensive disorders, IUGR, or other pregnancy complications.⁷

Abnormal placental maturity refers to early changes in the placenta's shape and structure that happen sooner than usual during pregnancy. This often results from poor blood flow between the mother and placenta. Doctors can diagnose these changes on an ultrasound.⁸

Several studies have demonstrated that these abnormal maturational changes are more frequent in hypertensive pregnancies compared to those with normal blood pressure, with placental damage

reported in 66.7 to 75% of women with high blood pressure and only 12.3% of women with normal blood pressure.⁹

Early recognition and management of hypertensive disorders are critical for preventing adverse maternal and fetal outcomes. In uncomplicated pregnancies, placental maturation generally follows a gestational age-dependent trajectory; however, this process can be frequently accelerated in the context of hypertensive pregnancies. Thus, ultrasound remains a safe, noninvasive and pivotal tool in managing high-risk pregnancies, enabling early identification of placental dysfunction and ultimately improving maternal and neonatal outcomes.¹⁰

However, limited data exist comparing placental maturity grading across the second and third trimesters in normotensive and hypertensive pregnancies in the Pakistani population. This study aimed to use ultrasonography to evaluate placental grading in normotensive and hypertensive pregnancies across the second and third trimesters.

MATERIALS AND METHODS:

A case control study was conducted in Younas Hospital Daska over a period of three months from August 2025 to October 2025. Before data collection, the study was approved by UMT ethical committee with ERC number Kuhs/miu/umt-skt-002. Signed informed consent was taken from each participant before enrollment.

Non-probability Convenience sampling technique was used to enroll 70 participants that were divided into two groups. One group of 35 Normotensive pregnant patients and one group of 35 Hypertensive pregnant patients.

Pregnant patients carrying single pregnancy, in their second trimester (weeks 13–26) or Third trimester (28–40 weeks) with normal blood pressure throughout pregnancy (Systolic BP <140 mmHg and diastolic BP <90 mmHg throughout pregnancy) 48 and no previous history of hypertensive diseases were included in control group (normotensive pregnant women).^{11, 12, 13}

Pregnant patients carrying single pregnancy, in their second trimester (weeks 13–26) or Third trimester (28–40 weeks) and having generalized hypertension were included in the case group (hypertensive pregnant women).^{11, 12}

Pregnant women carrying more than one fetus or having any Placental Abnormalities (such as placenta Previa, placenta accreta, or placental abruption), Fetal anomalies, chronic medical conditions or having an uncertain gestational age were excluded.^{13,14}

After selecting the subjects according to the inclusion and exclusion criteria, the questionnaire (attached) was used for the data collection. Informed Consent was taken from each patient. Patients were positioned in a comfortable supine position. A 3.5 MHz convex transducer was used to perform a USG on all of the patients. The placental positioning and grading were assessed in both normal and hypertensive patients.

SPSS 2020 was used for the analysis of the data. Both the variables (quantitative and qualitative) were examined. Quantitative data were reported as mean values with standard deviations. The

Qualitative data were described using frequencies and percentages.

RESULTS

After following inclusion and exclusion criteria, total of 70 pregnant women were included, the numbers of normotensive and hypertensive participants were kept equal (n=35 each). Women in their third trimester were most common (74.3%) and the overall mean maternal age was found to be 27.2 ± 5.1 years. The average parity was 1.29 meaning that majority of the participants had one or more prior pregnancies. The mean value of the gestational age is 29.43 weeks, and standard deviation is 5.96 weeks. The average of the placental thickness was 31.51 with a standard deviation of 13.89. Moreover, the average estimated fetal weight was 1642.02 grams standard deviation of 968.37 grams. The mean values of AFI were 12.06 cm and standard deviation 3.04 cm.

(Table 1)

Table 1: *Descriptive Statistics for Continuous Variables*

	N	Minimum	Maximum	Mean	Std. Deviation
Age	70	17.00	40.00	27.2143	5.07021
Parity	70	.00	5.00	1.2857	1.28698
Gestational Age	70	16.00	38.00	29.4286	5.96019
Placental Thickness	70	5.07	96.20	31.5127	13.89479
Estimated fetal weight (grams)	70	26.40	3436	1642.02	968.37
Amniotic fluid index (cm)	70	.00	18.90	12.0569	3.03901

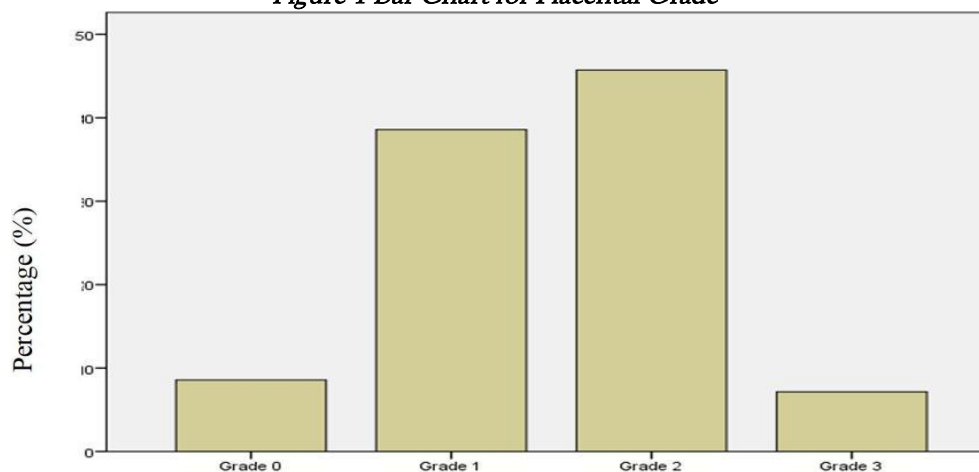
The overall mean gestational age was 29.4 ± 6.0 weeks. Grading wise Grade II placental maturity was found to be the most common (45.7%),

followed by Grade I (38.6%), while Grade III was least frequent (7.1%). (Table 2, Fig 1)

Table 2: *Frequency Distribution Of Placental Grading*

	Frequency	Percent	Valid Percent	Cumulative Percent
Grade 0	6	8.6	8.6	8.6
Grade 1	27	38.6	38.6	47.1
Grade 2	32	45.7	45.7	92.9
Grade 3	5	7.1	7.1	100.0
Total	70	100.0	100.0	

Figure 1 Bar Chart for Placental Grade



The location of the placenta was also assessed. Anterior placenta was present in most of the patients (54.3%) whereas, posterior placenta was in

45.7% with posterior placenta present. Anterior placental placement was somewhat more prevalent than posterior. (Table 3)

Table 3: Frequency Distribution of the Location of the Placenta

	Frequency	Percent	Valid Percent	Cumulative Percent
Anterior	38	54.3	54.3	54.3
Posterior	32	45.7	45.7	100.0
Total	70	100.0	100.0	

Chi-Square Test was used in testing the association between placental grading and hypertensive status (normotensive vs. hypertensive). The table below shows the results of the analysis made. According

to the Pearson Chi-Square test, the relation between placental grading and hypertensive status was statistically significant ($p = 0.044$). (Table 4)

Table 4: Placental Grading and Hypertensive Status

Chi - Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.121 ^a	3	.044
Likelihood Ratio	8.906	3	.031
Linear-by-Linear Association	2.319	1	.128
N of Valid Cases	70		

The analyzed Chi-square test indicated that the relationship between trimester and placental grading was highly significant ($p < 0.001$). These results indicate that the occurrence of higher

placental grades (Grade III) was significantly more frequent during the third trimester than in the second trimester. (Table 5)

Table 5: Placental grading across trimesters

Chi - Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	18.443 ^a	3	.000
Likelihood ratio	18.893	3	.000
Linear-by-Linear Association	16.561	1	.000

N of Valid cases	70
Symmetric Measures	

		Value	Approx. Sig
Nominal by Nominal	Phi	.513	.000
	Cramer's V	.513	.000

N of Valid Cases	70
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No significant association was found between Hypertension and trimester using Chi square test (Pearson $\chi^2 = 2.692$, $p = 0.101$). This finding was also supported by other tests including continuity correction ($p = 0.172$), likelihood ratio ($p = 0.098$), and Fisher's exact test ($p = 0.171$). The linear-by-linear association was also not significant ($p = 0.103$). Phi and Cramer's V (0.196) indicated a weak relationship however it was not statistically significant based on 70 cases. **(Table 6)**

Table 6: Hypertensive Patients across trimesters

Chi - Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (3-sided)
Pearson Chi-square	2.692 ^a	1	.101		
Continuity Correction ^b	1.870	1	.172		
Likelihood ratio	2.733	1	.098		
Fisher's Exact Test				.171	.085
Linear-by-Linear Association	2.654	1	.103		
N of Valid cases	70				

Symmetric measures

		Value	Approx. Sig
Nominal by Nominal	Phi	-.196	.101
	Cramer's V	.196	.101

N of Valid Cases	70
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There was no significant relationship between the status of hypertension and placental grading. The strength of the relationship was weak as the effect size was 0.240 estimated in terms of Cramer's V. **(Table 7)**

Table 7: Placental Grading across hypertension

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-square	4.029 ^a	3	.258
Likelihood ratio	4.281	3	.233
Linear-by-Linear Association	1.598	1	.206
N of Valid cases	70		

Symmetric Measures

		Value	Approx. Sig
Nominal by Nominal	Phi	.240	.258
	Cramer's V	.240	.258

N of Valid Cases	70
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No significant differences were observed between hypertensive and normotensive groups in gestational age, placental thickness, estimated fetal weight, or amniotic fluid index (all $p > 0.05$).

Discussion

The main purpose of the study conducted was evaluation of placental maturity in hypertensive pregnancies and normotensive pregnancy. Our result failed to show a statistically significant variance in placental grading between hypertensive and normotensive women.

Despite a slightly increased prevalence of the advanced grades in hypertensive women, the effect size (Cramer V = 0.240) was low. These results indicate that, in this study cohort, hypertension was not a significant determinant of placental maturity as compared with some previous studies that found greater placental aging in hypertensive pregnancies.^{11, 15} In comparison, trimester progression significantly correlated with placental grading ($\chi^2 = 18.44$, $p < 0.001$; Cramer V = 0.513). The higher grades (III-IV) were predominant during the third trimester as expected due to the physiological development of placenta maturity with gestational age advancement.¹⁶

These results demonstrate the need to identify advanced placental maturation early in hypertensive pregnancies. By detecting them early based on routine ultrasound assessments, practitioners can make necessary clinical management choices, including closely monitoring the mother and fetus, delivering the fetus early, or providing corticosteroid drugs to speed up maturation of the lung as a procedure of preventing into the preterm labor. Moreover, it might result in interventions that will help to avoid negative consequences like pre-eclampsia or fetal growth restriction.^{17, 18, 19}

Results of our study in comparison to those in the current literature on the grading of the placenta in normotensive and hypertensive pregnancies are similar in many ways but there are some discrepancies that should be discussed in more detail. Grade 2 placentas were more common (45.7 percent) in hypertensive pregnancies and Grade 3 placentas were also prevalent (7.1 percent) as compared to normotensive ones in our study. These results may be aligned with the work of Begum et al. (2020) who found that hypertensive pregnancies were characterized by a significant increase in the instances of Grade III placentas, being correlated with poor pregnancy-related

outcomes like fetal growth restriction (FGR) and prematurity.

Conversely, Patel et al. (2021) discovered that several pregnant women with hypertensive pregnancies are an earlier mature species, and Grade II and Grade III placental characteristics appear timelier compared to those with normal pregnant situations.²⁰

In normotensive pregnancies, our results found Grade 2 as the most common grade, in line with Begum et al. (2020), which also showed that Grade 2 was the most common grade among most of the normotensive women during the third trimester. Yet, whereas Aslam et al. (2022) observed that placental grading in normotensive pregnancy had a more conventional pattern, the relative proportion of Grade 3 placentas in the normotensive group in our case was lower, which could be attributed to either the sample or regional variation.²¹

We found no significant association between hypertension and accelerated placental maturation in contrast to several prior studies. Although other studies have shown that hypertensive disorders (i.e. pre-eclampsia) promote placental aging by Naik et al., 2021; Garain et al., 2024; Patel & Pajai, 2021; Sneha et al., 2019; Mushtaq et al., 2023, this relationship was not observed in this study. This inconsistency is either due to the sample size, or population characteristics or to methodological differences.^{15, 22, 20, 23, 11}

There is substantial connectivity between hypertensive disorders and early aged placenta in our study which thus has clinical implications. Similarly to what Elhassan & Mosaed, (2025) did by highlighting the importance of early detection of placental insufficiency in hypertensive pregnancies, our study would indicate that placental grading could become one of the methods to detect such high-risk pregnancies at an earlier time. Identifying faster aging in a placenta earlier might allow healthcare providers to carefully monitor such pregnancy to prevent difficulties like IUGR, preterm delivery, or fetal deaths, and act immediately to address the situation, such as the administration of corticosteroids to fetal lungs or arranging premature birth in case of its emergence.¹⁷

Our study proved that the placental grading performed using ultrasound was able to detect early alterations in the development of placenta in the pregnancies with hypertension. A marker of serious negative pregnancy outcomes, including intrauterine growth restriction (IUGR), preterm birth, and low birth weight in hypertensive women, is early advanced maturation of the placenta (e.g. Grade II and III).^{24,21}

Implementation of what is called placental grading as part of normal prenatal care examinations, especially among high-risk populations, is believed to enable clinicians to detect problems early and make subsequent informed decisions concerning how to deal with patients.

Moreover, the incorporation of placental grading into clinical care should decrease adverse outcomes in the pregnant population given the potential to identify pre-eclampsia or other forms of hypertensive complications early on thus preventing such poor outcomes such as stroke, renal failure, or placental abruption. The application of ultrasounds as a surveillance mechanism to monitor the placenta health and early intervention measures will eliminate the risk of hypertensive pregnancies and hence result in better maternal and fetal health.

To conclude, integration of placental grading into the practice of regular prenatal care may prove to be a decisive move on the way of pregnancy improvement especially in case of the hypertensive pregnant population. It allows detection of abnormalities in the placenta early in the pregnancy, which can be used to increase monitoring, use early interventions and develop more appropriate management strategies, ultimately preventing maternal and fetal morbidity.

The study has several limitations that need to consider. Small sample size of only 70 participants from a single center limits the generalization of the data to broader populations. Moreover the study was conducted in a single city that limits the data applicability to other populations with different demographic or clinical characteristics. Another limitation is the lack of follow-up as this was a cross sectional study. lastly the analytical approach was also restricted as use of multivariate regression

models could have provided deeper insights into the factors influencing placental grading and their interrelationships.

Conclusion

This study found that placental maturity significantly advances with increasing gestational age, with higher grades predominating in the third trimester. While some initial analyses suggested an association, the overall findings indicated no statistically significant difference in placental grading between normotensive and hypertensive women. Placental thickness and estimated fetal weight increased significantly from the second to the third trimester, reinforcing their roles as indicators of gestational progression, while AFI remained stable. Despite the lack of statistical significance regarding hypertension, the presence of early advanced placental grades in some hypertensive patients underscores the importance of continued ultrasound surveillance in high-risk pregnancies.

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Author Contributions

Author 1 Zoha: Conceptualization, literature review, manuscript writing, final approval study design, and data collection

Author 2: Muhammad Areeb Shahid: Overall supervision, data interpretation, Proof reading.

Author 3: Nisha Asif Ali: data analysis and interpretation

Author 4: Arooj Shahzad: conceptual development and study design

Author 5: Aleesha Sabir: Literature review and data collection

Author 6: Rohma Parvaiz: Data collection and editing of final manuscript

Statements and Declarations

Declaration of conflicting interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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Ethical Consideration

This study was reviewed and approved by the Ethical Review Committee of the University of Management and Technology (UMT). The committee confirmed that the study procedures, including intervention and outcome assessment, were safe for human participants. The study was conducted in accordance with institutional ethical standards and the principles outlined in the Declaration of Helsinki. Institutional review board/ethical review committee certificate: Ref# Kuhs/miu / umt-skt-002

Informed Consent

Prior to data collection, written informed consent was obtained from all participants. Participants were assured of confidentiality, and all personally identifiable information was anonymized and securely stored. The data were handled with strict privacy measures to ensure protection of participant information throughout the study

Consent for publication

Written informed consent was obtained from all participants (or their legal guardians) for the publication of anonymized data in this study. Participants were informed that no personal identifiers would be disclosed, and that all information would be presented in a manner that ensures complete confidentiality.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and confidentiality restrictions of the participants. All personal identifiers have been removed to ensure anonymity, and access will be provided in accordance with institutional ethical guidelines and data protection policies.

Declaration of conflicting interest

The authors declare that there is no conflict of interest regarding the publication of this study. The research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Burton GJ, Fowden AL. The placenta: a multifaceted, transient organ. *Philosophical Transactions of the Royal Society B: Biological Sciences*. 2015;370(1663):20140066.
2. Jansson T, Powell TL. Role of placental nutrient sensing in developmental programming. *Clinical obstetrics and gynecology*. 2013;56(3):591-601.
3. Benirschke K, Burton GJ, Baergen RN. Early development of the human placenta. *Pathology of the human placenta*: Springer; 2012. p. 41-53.
4. Schoots MH, Bourgonje MF, Bourgonje AR, Prins JR, van Hoorn EG, Abdulle AE, et al. Oxidative stress biomarkers in fetal growth restriction with and without preeclampsia. *Placenta*. 2021;115:87-96
5. Adu-Bredu T, Aryananda R, Mathewlynn S, Collins S. Exploring pathophysiological insights to improve diagnostic utility of ultrasound markers for distinguishing placenta accreta spectrum from uterine-scar dehiscence. *Ultrasound in Obstetrics & Gynecology*. 2025;65(1):85-93.
6. Marijnen M, van der Meeren L, Schoots M, Freedman A, Ernst L, Bazyleva E, et al. Placental lesions in small for gestational age fetuses with and without clinical features of fetal growth restriction: a secondary analysis of the Doppler Ratio In fetal Growth restriction Intervention Trial At (near) Term (DRIGITAT) study. *American Journal of Obstetrics and Gynecology*. 2025.
7. Bartels HC, Walsh JM, Carroll S, Downey P, O'Brien DJ, McAuliffe FM, et al. Prenatal detection of placenta accreta spectrum using Maltepe E, Fisher SJ. *Placenta: the forgotten organ*. *Annual review of cell and developmental biology*. 2015;31(1):523-52.
8. Naresh M, Viral S, Sudham K, Mahesh C, Kalpesh G, Sudha Y. Assessment of risk factors of hypertension: a cross-sectional study. *Journal of Evolution of Medical and Dental Sciences*. 2012;1(4):519-26.
9. Keikkala E, Vuorela P, Laivuori H, Romppanen J, Heinonen S, Stenman U-H.

- First trimester hyperglycosylated human chorionic gonadotrophin in serum—a marker of early-onset preeclampsia. *Placenta*. 2013;34(11):1059-65.
10. Alfircvic Z, Stampalija T, Dowswell T. Fetal and umbilical Doppler ultrasound in high-risk pregnancies. *Cochrane database of systematic reviews*. 2017(6).
 11. Mushtaq S, Aziz R, Sharif A, Masood H, editors. Assessment of Placental Grading in Normal and Pregnancy Induced Hypertensive Mothers on Ultrasonography and Fetal Outcomes. *Medical Forum Monthly*; 2023 Schoots MH, Bourgonje MF, Bourgonje AR, Prins JR, van Hoorn EG, Abdulle AE, et al. Oxidative stress biomarkers in fetal growth restriction with and without preeclampsia. *Placenta*. 2021;115:87-96.
 12. Wisner K. Gestational hypertension and preeclampsia. *MCN: The American Journal of Maternal/Child Nursing*. 2019;44(3):170.
 13. Narang K, Szymanski LM. Multiple gestations and hypertensive disorders of pregnancy: what do we know? *Current Hypertension Reports*. 2021;23(1):1.
 14. Ogunwale SM, Mwinnyaa G, Wang X, Hong X, Henderson J, Bennett WL. Preeclampsia Across Pregnancies and Associated Risk Factors: Findings From a High-Risk US Birth Cohort. *Journal of the American Heart Association*. 2021;10(17):e019612.
 15. Naik A, Khoiwal S, Sharma N, Aarthy P. Clinical significance of ultrasonic placental grading during third trimester in hypertensive disorders in pregnancy and its correlation with fetal outcome in tertiary care centre. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology*. 2021;10(9):3325-31.
 16. Begum F, Jesmin S, Khatun R, Parvin S, Rahman A. Third trimester placental grading by ultrasonography and its relationship with fetal outcome. *TAJ: Journal of Teachers Association*. 2020;33(2):94-9.
 17. Siargkas A, Tsakiridis I, Michos G, Liberis A, Stavros S, Kyriakakis M, et al., editors. Impact of Placental Grading on Pregnancy Outcomes: A Retrospective Cohort Study. *Healthcare*; 2025: MDPI.
 18. Elhassan A, Mosaed MG. The Role of Doppler Ultrasonography in the Prediction of Fetal Outcome among Patients with Pregnancy Induced Hypertension (PIH). *Egyptian Journal of Hospital Medicine*. 2025;99(1).
 19. Siargkas A, Pachi C, Nigdelis MP, Stavros S, Domali E, Mamopoulos A, et al. The Association of Placental Grading with Perinatal Outcomes: A Systematic Review and Meta-Analysis. *Diagnostics*. 2025;15(10):1264.
 20. Patel T, Pajai S. Estimating the Association of Ultrasonographical Placental Grading in Utero to Gestational Age and Feto-maternal outcomes in Hypertensive Disorders of Pregnancy. *Journal of Pharmaceutical Research International*. 2021;33(60B):2653-9.
 21. Aslam J, Batool N, Ali A, John A, Manzoor H. Evaluation of Placental Grading in 2 nd and 3 rd Trimester Using Gray Scale Ultrasound. 2022.
 22. Garain P, Barman SC, Mandal P, Patra KK, Madhwani KP. Comparative study on ultrasonic placental grading among normotensive pregnancy and pregnancy-induced hypertension and its correlation with fetal outcome. *Asian Journal of Medical Sciences*. 2024;15(2):133-40.
 23. Sneha S, Sreelatha S, Ramaiah R. Comparison of placental grading at different periods of gestation in PIH patients and their outcome. *Int J Reproduction, Contraception, Obstet Gynecol*. 2019;8(12):4747-51.
 24. Wardinger JE, Ambati S. Placental insufficiency. 2020.