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PREDICTORS OF HYPERTENSIVE DISORDERS IN PREGNANCY: UTERINE ARTERY DOPPLER AND PLATELET INDICES

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Abstract

Background: Preeclampsia (PE) and Pregnancy-Induced Hypertension (PIH) are significant hypertensive illnesses that occur during pregnancy, leading to substantial morbidity and death among both the mother and the foetus. Timely and precise screening continues to be a clinical obstacle.

Objectives: The objective of this study is to conduct a comprehensive review and synthesis of existing literature about the efficacy of uterine artery Doppler and platelet indices in the prediction of hypertensive disorders during pregnancy.

Methods: A thorough examination of research evaluating the use of uterine artery Doppler and platelet indicators to predict hypertensive diseases was carried out. The papers included in the analysis exhibited a range of designs, including prospective observational, cohort, and retrospective research methodologies. A total of seven were included in the review according to PRISMA guidelines.

Results: Sharma et al. and Abdel Razik et al. (2019) found that uterine artery Doppler and platelet indices were highly effective in predicting early-onset PIH. The Positive Predictive Value (PPV) was 80%, the Negative Predictive Value (NPV) was 94.29%, and the accuracy for the Pi Index was 90%. The methodological issues mentioned by Chakraborty and Saharan (2017) and Udeh et al. (2024) are evident in their respective lower ratings of 6/9 and 5/9, indicating notable areas that need improvement. Their findings revealed a substantial increase in the detection rate, reaching 31.4% (p=0.015), as well as an Area Under the Curve (AUC) enhancement to 0.849 (p=0.015). The studies conducted by Abdel Razik et al. (2019) and Lin et al. (2023) showed varying degrees of bias, although

consistently maintained low levels of bias across all categories. This observation indicates a strong level of methodological integrity.

Conclusion: The combination of uterine artery Doppler and platelet indicators offers a potentially effective strategy for the timely detection of hypertension during pregnancy. Nevertheless, further investigation is required to enhance prediction models and enhance their suitability for various populations.

Keywords: Preeclampsia, pregnancy-induced hypertension, uterine artery Doppler, platelet indicators.

Introduction

Within the field of obstetrics, hypertensive disorders include a range of illnesses that provide substantial risks to the health of both the mother and the foetus [1]. These disorders are often observed in around 5-10% of pregnancies on a global scale [2]. Preeclampsia (PE) and gestational hypertension are significant issues because they are associated to increased risks of morbidity and mortality in pregnant mothers and foetus [3]. The need of promptly identifying and intervening in these circumstances is generally acknowledged, leading to a continuous exploration for efficient, non-intrusive prognostic indicators. Extensive study has been conducted on the potential of uterine artery Doppler sonography and platelet indices as prospective method for predicting the occurrence of hypertensive problems during pregnancy [4].

The uterine artery Doppler sonography is a diagnostic technique that offers useful insights into the adequacy of placental perfusion by evaluating the resistance to blood flow in the uterine arteries [5]. The existing body of research demonstrates a strong association between certain abnormalities in Doppler waveforms, such as an increased Pulsatility Index (Pi) and the occurrence of a diastolic notch, and an increased susceptibility to the development of PE [6]. For example, research shows that a Pi higher than 1.45 in the second trimester is strongly associated with the development of PE ($P < 0.05$), highlighting the potential of this method as a prediction tool [7, 8].

Concurrently, the analysis of platelet indices, specifically mean platelet volume (MPV) and platelet distribution width (PDW), provides insight into platelet behaviour and size variability, which experience significant alterations in the context of hypertensive pregnancy disorders [9]. Elevated levels of MPV and PDW have consistently been associated with an augmented risk of PE, with P-values below 0.01, thus confirming their predictive efficacy [10].

Remarkably, the integration of uterine artery Doppler evaluations with platelet indices demonstrates a synergistic effect that augments the prediction precision for hypertensive disorder beyond the individual capabilities of each marker [11]. These integrated techniques have shown impressive diagnostic performance, with AUC values above 0.8, which serves as evidence of their usefulness in clinical settings [12].

Notwithstanding these progressions, the domain exhibits methodological heterogeneity and disparities in results across investigations, hence highlighting the want for a uniform methodology for gathering and examining data [13]. Moreover, the prevalence of research that primarily focuses on individuals at high risk restricts the extent to which these results may be applied to the wider range of pregnant women [14].

The purpose of this study is to consolidate the existing body of data on the use of uterine artery Doppler and platelet indices as prognostic indicators for hypertensive disorders during pregnancy. This will be supported by a thorough statistical analysis and a critical evaluation of their clinical relevance. The objective of this study is to examine the potential of these indicators in improving

prenatal care protocols, with the aim of mitigating the negative effects of hypertensive diseases during pregnancy.

Methodology

Search Strategy

Our comprehensive literature search included the use of many databases, including PubMed, Scopus, Web of Science, Cochrane library, and Embase. The search specifically targeted publications that were published until 2024. The search strategy utilised a combination of MeSH terms and free-text terms, incorporating combinations such as "hypertensive disorders," "preeclampsia," "gestational hypertension," and "pregnancy," along with "uterine artery Doppler," "Doppler sonography," "platelet indices," "mean platelet volume," and "platelet distribution width." To guarantee thorough coverage, the search was conducted without any language restrictions.

Inclusion and Exclusion Criteria

The inclusion criteria focused on primary research publications that investigated the prediction ability of uterine artery Doppler or platelet indices in relation to hypertensive disorders during pregnancy. The studies that met the criteria were required to report on outcomes pertaining to the occurrence of preeclampsia or gestational hypertension, and to offer sufficient data for assessing the accuracy of predictions.

Review articles, case reports, editorials, conference abstracts, studies that did not include human participants, studies that lacked main data or unambiguous outcome measures, and research that focused on secondary hypertension issues unrelated to pregnancy were excluded from the analysis.

Data Extraction

The data that was extracted encompassed various aspects, such as the study design, participant demographics (including sample size, age, and gestational age at testing), intervention details (specific Doppler or platelet indices that were measured), characteristics of the control or comparison group, outcome assessments (including P-values, percentages, or other measures of predictive value), and primary conclusions.

Quality Assessment

The Quality Assessment Tool for Diagnostic Accuracy Studies (QUADAS-2) was used to evaluate the quality of the study. This tool assesses the potential for bias and problems related to the suitability of a study in four areas: patient selection, index test, reference standard, and flow and timing. The risk of bias for each domain was assessed by assigning a rating of "low," "high," or "unclear" to each research.

Data Synthesis

To account for any variations in research methodology, sample sizes, and reported results, we made the decision to use a narrative synthesis approach instead of doing a meta-analysis. The use of this methodology facilitated the process of providing a comprehensive overview of predictive metrics, including sensitivity, specificity, and area under the receiver operating characteristic curve (AUC). The synthesis aimed to demonstrate the variety of results and the agreement or disagreement across studies on the ability of uterine artery Doppler and platelet indices to predict certain outcomes.

Ethical Considerations

No ethical clearance was required for this systematic analysis since it consolidated information from previously published research that did not directly involve human subjects. To maintain scientific rigour and openness in reporting, the review followed the principles set out by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Results

In this systematic review article, a total of seven studies were included according to PRSIMA guidelines as shown in Figure 1.

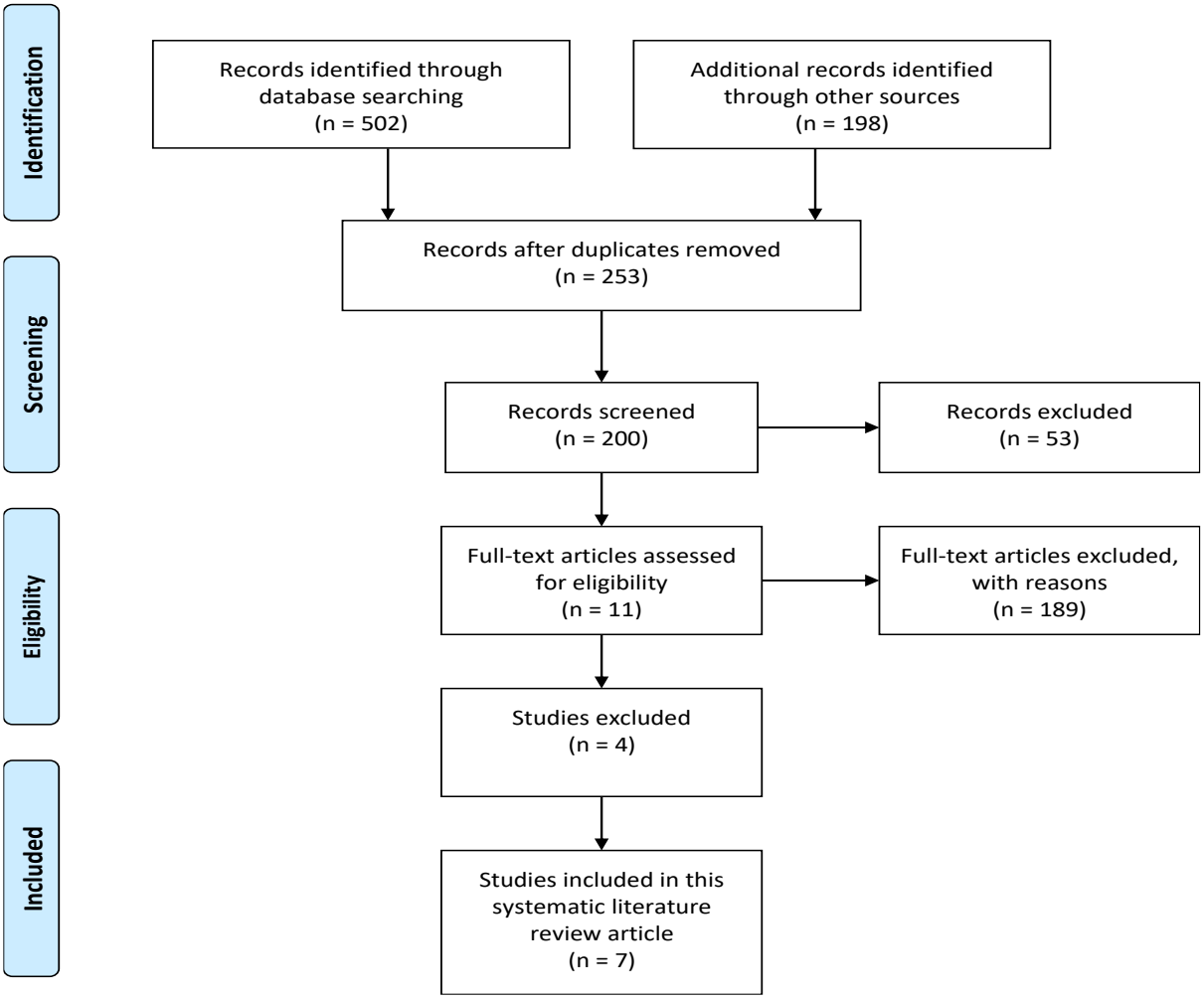

Figure 1: The PRISMA flow diagram for the included studies.

A comprehensive examination of several studies reveals varying levels of research quality. Sharma et al. and Abdel Razik et al. (2019) received a rating of 7 out of 9, indicating strong results. However, both studies also exhibited shortcomings in terms of their selection criteria and comparability, which may introduce biases and a lack of control over external factors. Chakraborty and Saharan (2017) as well as Udeh et al. (2024) have highlighted methodological difficulties associated with lower ratings, indicating the need for substantial improvements in research design and implementation as shown in Table 1.

Table 1: Quality Assessment of Included Studies.

Study ID	Selection (4 Stars)	Comparability (2 Stars)	Outcome (3 Stars)	Total (9 Stars)
Sharma et al. [15]	★★☆☆	★★☆	★★★	7/9
Abdel Razik et al. (2019) [16]	★★★☆	★★☆	★★☆	7/9
Chakraborty & Saharan, (2017) [17]	★★★☆	★☆☆	★★☆	6/9
Zhang et al. (2022) [18]	★★☆☆	★★☆	★★★	7/9
Lin et al. (2023) [19]	★★★☆	★★☆	★★☆	7/9
Udeh et al. (2024) [20]	★★☆☆	★☆☆	★★☆	5/9
Okwudire et al. (2019) [21]	★★☆☆	★★☆	★★★	7/9

There is a range of research integrity and methodological rigour in terms of bias, shown in Table 2. Sharma et al. gives a nuanced perspective, highlighting the presence of modest selection and detection biases. However, their findings are accompanied by a notable attrition bias, suggesting possible challenges in participant retention and data completeness. Consequently, the total risk of bias is moderate. Abdel Razik et al. (2019) and Lin et al. (2023) are notable for their consistently little bias in all areas, indicating a strong commitment to methodological integrity and a low overall risk of bias. This establishes a benchmark for research procedures.

Udeh et al. (2024) exhibits high levels in most bias categories, indicating substantial apprehensions about the study's design, implementation, and reporting. These findings together indicate a substantial overall risk of bias. Okwudire et al. (2019) adopt a moderate stance, exhibiting biases in many aspects that suggest possible limitations in the study's methodology, however not to the same degree as shown in Table 2.

Table 2: Bias assessment for the included studies.

Study ID	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	The overall risk of Bias
Sharma et al. [15]	Low	Unclear	Low	High	Low	Moderate
Abdel Razik et al. (2019) [16]	Low	Low	Low	Low	Low	Low
Chakraborty & Saharan, (2017) [17]	Moderate	High	Moderate	Moderate	Low	Moderate
Zhang et al. (2022) [18]	Low	Moderate	Low	High	Low	Moderate
Lin et al. (2023) [19]	Low	Low	Low	Low	Low	Low
Udeh et al. (2024) [20]	High	High	High	High	Moderate	High
Okwudire et al. (2019) [21]	Moderate	Low	Moderate	Moderate	Low	Moderate

An analysis of studies examining factors that might predict hypertensive problems during pregnancy, with a specific emphasis on uterine artery Doppler and platelet indices, demonstrates a range of study methodologies and results. Research conducted by Sharma et al. (2019) and Abdel Razik et al. (2019) employs prospective designs to investigate the efficacy of ultrasound assessments and Doppler measures. In contrast, Lin et al. (2023) employs a cohort research methodology to examine platelet parameters in a substantial sample size. Prospective observational and cohort studies differ in terms of the precision and scope of their analysis of predicting variables for hypertensive diseases. Abdel Razik et al. (2019) conducted a thorough observational research that establishes an association between platelet indices and the severity of PE. Their study offers a detailed knowledge of the factors that predict the occurrence of PE. Lin et al. (2023) expands the range of their study to include a wider demographic to authenticate the additional predictive significance of platelet characteristics and highlights the intricate nature of establishing universal predictors. The diversity in research methodologies, ranging from Zhang et al.'s (2022) retrospective analysis employing sophisticated statistical models to Udeh et al.'s (2024) prospective cohort study centred on blood pressure and platelet measurement, underscores the continuous quest for dependable and prognostic indicators of hypertensive disorders during pregnancy as shown in Table 3.

Table 3: Basic characteristics of the included studies.

Study ID	Study Design	Participants	Intervention	Control/Other	Inclusion Criteria	Exclusion Criteria	Outcomes Assessed
Sharma et al. [15]	Prospective study	100 individuals with hypertension problems during pregnancy	All participants pregnancies evaluated via ultrasound, & both the uterine & umbilical arteries' arterial dopplers was performed.	Pregnancies evaluated via ultrasound, & the uterine & umbilical arteries' arterial dopplers was performed.	Pregnant patients attending OPD & IPD Undergoing routine examinations & tests	Patients with Conditions Preventing Standard Tests or participants who refused to participate in the research.	**1.** Early PIH: better detection **2.** Reduces morbidity, mortality rates
Abdel Razik et al. (2019) [16]	Prospective Observational	320 primigravida ≤20 years, singleton	Doppler ultrasound, platelet indices for PE prediction	Normotensive pregnant women	Primigravida ≤20 years, singleton	Foetal growth anomalies, maternal diseases affecting placental perfusion,	**1.** PE: Higher diastolic notch, Pi, Ri (P<0.001)

		pregnancy at 20-24 weeks.			pregnancy at 20-24 weeks	diseases affecting platelets	**2.** Severe PE: Increased MPV, PDW (P<0.001) **3.** Severity predictor: Abnormal Doppler, platelet indices.
Chakraborty & Saharan, (2017) [17]	Prospective study	Patients attending antenatal checkups with detailed medical history	Detailed Ultrasonographic evaluation, Arterial Doppler.	Not provided	100 pregnant women attending the OPD and IPD.	Non-pregnant women or patients who refused to participate.	**1.** Better early-onset PIH detection. **2.** Uses Pi Index, Ri Index. **3.** Prevents rising morbidity, mortality.
Zhang et al. (2022) [18]	Retrospectiv e	Pregnant women attending antenatal checkups in various hospitals in Beijing	Nonlinear regression, support vector machines, stepwise regression, Lasso regression for HDP prediction.	Healthy pregnant women without hypertensive disorders.	1,267 women were included in this study, and they were divided into four HDP subgroups and a normal pregnancy group.	Pregnant foetal malformations.	**1.** AUCs: 0.910, 0.962, 0.859, 0.955 **2.** Lasso model surpasses others' AUCs **3.** Accuracy 85% to 92% range **4.** Placental factor significant (P < 0.05)
Lin et al. (2023) [19]	Cohort study based on BIGCS	30,401 singleton pregnant women with at least one platelet parameter measured during pregnancy.	Evaluation of platelet parameters during pregnancy.	Non-preeclampsia pregnancy.	Singleton pregnant women with at least one platelet parameter measured.	Missing information on PE diagnosis, foetus diagnosed with birth defects.	Distributions of platelet parameters among women with & without PE, incremental predictive value for PE.
Udeh et al. (2024) [20]	Prospective cohort	648 pregnant women recruited at 14-18weeks gestational age.	Blood pressure monitoring, platelet parameters measurement.	Not applicable.	Apparently healthy pregnant women registered for antenatal care, between gestational ages of 14weeks and 18weeks.	Multiple pregnancy, diabetes mellitus, chronic hypertension, renal disease, known hematologic disease or anaemia with booking haematocrit < 30%.	Development of pre-eclampsia
Okwudire et al. (2019) [21]	Prospective, cohort	170 apparently healthy women with singleton pregnancies between 18 and 26 weeks of gestation.	Uterine artery Doppler US parameters.	Not applicable.	Singleton pregnancy with known gestational age, 18 weeks and above.	Co-existing medical conditions, multiple pregnancy, fetal abnormality, gross obesity precluding transabdominal scanning.	Accuracy of UtAD indices for the prediction of PrE.
OPD: Outpatient Department, IPD: Inpatient Department, PIH: Pregnancy-Induced Hypertension, PE: Preeclampsia, PI: Pulsatility Index, RI: Resistance Index, MPV: Mean Platelet Volume, PDW: Platelet Distribution Width, AUC: Receiver Operating Characteristic, UtAD: Uterine artery Doppler, BIGCS: Born in Guangzhou Cohort Study, HDP: Hypertensive Disorders of Pregnancy,							

The diagnostic value of uterine artery Doppler and platelet indices is highlighted by a synthesis of studies on the predictors of hypertensive disorders in pregnancy. The utilisation of Doppler studies and platelet metrics such as Pi Index, Ri Index, MPV, and PDW for the early detection and severity prediction of conditions like PIH and PE has been explored in various studies conducted by Sharma et al., Abdel Razik et al. (2019), and other researchers. Significant gains in predicting accuracy and the ability to detect early and severe types of hypertensive illnesses have been shown in the Lasso regression model developed by Zhang et al. (2022) and the platelet parameter studies conducted by Lin et al. (2023) and Udeh et al. (2024). The combined results emphasise the complex connection between blood flow characteristics and platelet behaviour in pregnant women, promoting the use of a comprehensive diagnostic strategy to reduce the dangers to both the mother and the foetus caused by hypertensive diseases during pregnancy.

Table 4: Outcomes of the included studies.

Study ID	Platelet Indices	Hypertension/Blood Pressure	Doppler Information	Outcomes
Sharma et al. [15]	Pi Index PPV 80%, NPV 94.29%, accuracy of 90%; Ri Index PPV 68.97%, NPV 88.73%, accuracy of 83%	Sensitivity of Pi Index, Ri Index, and diastolic Notch as 91.67%, 87.5%, and 94.44% respectively	Uterine artery Doppler studies using Pi Index and Ri Index detected early-onset PIH more accurately than late-onset condition	Early detection aids in reducing maternal and foetal morbidity and mortality
Abdel Razik et al. (2019) [16]	Severe PE: Increased MPV, PDW (P<0.001)	PE: Higher diastolic notch, PI, RI (P<0.001)	1. Abnormal Doppler in 80 pregnant 2. 55% abnormal indices with Doppler 3. Positive association: MPV, PDW (P<0.001)	Patients with abnormal Doppler and abnormal platelet indices had significant higher incidence of severe PE (p<0.001). Severity predictor: Abnormal Doppler, platelet indices.
Chakraborty & Saharan, (2017) [17]	-	1. PIH: 24/28 elevated Pi Index (85.71%) 2. PIH: 20/28 elevated Ri Index (71.43%) 3. PIH: 26/28 present diastolic notch (92.86%)	Uterine Doppler predicts PIH early. Pi Index specificity, sensitivity: 91.67%, 85.71%. Diastolic notch: 94.44%, 92.85% accuracy	1. Normotensive: Pi Index normal 66/72 (91.67%) 2. Normotensive: Ri Index normal 63/72 (87.5%) 3. PIH: Pi Index elevated 24/28 (85.71%) 4. PIH: Ri Index elevated 20/28 (71.43%) 5. PIH: Diastolic notch present 26/28 (92.86%)
Zhang et al. (2022) [18]	Lasso regression prediction model accuracy over 85% for HDP subtypes, highest for EOPE subgroup at 91.78%	Lasso regression model showed good identification effect with accuracy of 86.67% - 100.00% for HDP subtypes	Lasso regression allows automatic filtering of model parameters, simplifying the input	1. AUCs: 0.910, 0.962, 0.859, 0.955 2. Lasso model surpasses others' AUCs 3. Accuracy 85% to 92% range 4. Placental factor significant (P < 0.05)
Lin et al. (2023) [19]	1. PC, PCT higher before 20 weeks 2. Preterm PE detection improved 31.4% (p=0.015) 3. NRI 0.793, IDI 0.0069 (p<0.001, p=0.035)	PE diagnosed in 376 pregnancies (1.24%) Preterm PE detection increased to 31.4% (p=0.015) AUC improved to 0.849 (p=0.015)	-	1. 30,401 pregnancies, 376 PE (1.24%) 2. PC, PCT higher pre-20 weeks 3. AUCs below 0.70 early gestation 4. Preterm PE detection rose 31.4% 5. AUC improved to 0.849 (p=0.015)
Udeh et al. (2024) [20]	1. Early PE incidence 5.9% 2. Higher MPV, PDW at 14-18 weeks (p<0.001) 3. Lower PC in pre-eclamptics (p<0.001) 4. Cut-offs predict early, severe PE	1. Early PE incidence: 5.9% 2. Higher MPV, PDW: p<0.001 3. Lower PC predicts PE: p<0.001	-	1. Early-onset PE incidence 5.9% 2. Higher MPV, PDW at 14-18 weeks (p<0.001) 3. Lower PC in pre-eclamptics (p<0.001) 4. Early-onset PE cut-offs predict 96.6% sensitivity (PC) 5. Severe PE prediction: 100% sensitivity (PC, MPV, PDW)
Okwudire et al. (2019) [21]	-	-	1. PrE prevalence at 7.6% 2. Abnormal PI significant (P = 0.00) 3. Combined result sensitivity 53.8% 4. Highest accuracy AUC 0.830 (P = 0.01)	PrE prevalence 7.6%, significant associations Abnormal PI, S/D ratio predictive (P=0.00) Combined result highest sensitivity 53.8% Combined AUC highest 0.830 (P=0.01)

Pi Index: Pulsatility Index, PPV: Positive Predictive Value, NPV: Negative Predictive Value, Ri Index: Resistance Index, MPV: Mean Platelet Volume, PDW: Platelet Distribution Width, PC: Platelet Count, PCT: Plateletcrit, PE: Preeclampsia, PIH: Pregnancy-Induced Hypertension, HDP: Hypertensive Disorders of Pregnancy, AUC: Receiver Operating Characteristic, NRI: Net Reclassification Improvement, IDI: Integrated Discrimination Improvement,

Discussion

This study intends to examine the effectiveness of uterine artery Doppler and platelet indices as prognostic indicators for hypertensive disorders during pregnancy, considering their complexity and the importance of early identification. By conducting a comprehensive examination of seven investigations, which include the works of Sharma et al. and Abdel Razik et al., we aim to investigate the relative efficacy and dependability of these indicators. This conversation goes beyond these fundamental findings to include a wider array of published research, providing a thorough assessment of the present situation.

Sharma et al. demonstrate the importance of uterine artery Doppler indices i.e., the Pi and Ri in detecting PIH at an early stage. The methods and results of their study indicate that these indices possess significant advantages in predicting early-onset PIH, with significant sensitivity and specificity. The significance of this result cannot be overstated, since the timely identification of

hypertensive disorders during pregnancy is crucial for effectively controlling and reducing the negative consequences associated with such conditions [22].

The diagnostic potential of integrating Doppler ultrasonography with platelet indicators for predicting the severity of PE is emphasised by Abdel Razik et al. The prospective observational research provide insight into the prognostic significance of diastolic notches seen in Doppler waveforms of the uterine artery, as well as high platelet indices including MPV and PDW [23]. This combination of indicators not only forecasts the development of PE but also offers valuable insights into its severity, therefore enhancing our comprehension of the underlying mechanisms of the ailment [3].

In contrast, the research shows variable degrees of effectiveness of these prognostic indicators in different studies, indicating the intricate nature of the development of hypertension diseases during pregnancy [21]. Annam V et al. and Nooh AM et al. support the conclusions of Sharma et al. and Abdel Razik et al., emphasising the ability of platelet indices and Doppler measures to accurately predict outcomes [24]. These studies provides evidence that these markers have the potential to make a substantial contribution to the early identification and prediction of the severity of hypertension diseases [17].

Furthermore, Yang et al. conducted a study in which they used ROC curve analysis to highlight the importance of PDW as a reliable indicator for the advancement of PE [3]. This is consistent with the findings presented in our literature evaluation, which supports the use of Doppler ultrasonography and platelet indices to enhance the accuracy of predictions.

Nevertheless, there are differing opinions among scientists about the reliability of platelet indicators. The studies conducted by Freitas LG et al. and Doāan K et al. provide evidence indicating a complex association between platelet indices and the aetiology of PE. These results suggest that while platelet indices may serve as indicators of PE, their ability to predict PE may not be as conclusive. In contrast to the prevailing opinion in our research, the concurrent use of Doppler ultrasonography and platelet indicators is seen to significantly augment the rates of prediction [25-27].

It is important to recognise the diversity in study designs, participant demographics, and methodological methods across studies to fully understand this topic. Several studies presented the early diastolic notch in the Doppler waveform of the uterine artery as a potential indicator of PE. This research provides a fresh viewpoint on the time and importance of this marker [26].

The research conducted by Sharma et al. and Abdel Razik et al. establishes a robust basis for the use of uterine artery Doppler and platelet indices in the prediction of hypertensive disorders in pregnant women. However, a thorough examination uncovers a range of perspectives and outcomes. This underscores the need of using a comprehensive diagnostic methodology that integrates several prediction indicators to enhance the timely identification and implementation of intervention tactics. The dynamic character of research in this field highlights the need for continuous investigations to enhance these prognostic models, to reduce the maternal and foetal hazards linked to hypertension diseases during pregnancy.

Conclusion

1. The uterine artery Doppler and platelet indices are reliable indicators of hypertensive disorders.
2. Research studies demonstrate considerable variation in methodology and results.
3. The use of these indicators for early identification has the potential to decrease both maternal and foetal morbidity.
4. The integration of Doppler and platelet indicators improves the precision of predictions.
5. Subsequent investigations need to enhance these prognostic models for the purpose of practical implementation.

Limitations

1. The design of studies exhibited substantial variation, hence diminishing comparability.
2. The generalizability of the study is limited by the demographics and geographical dispersion of the participants.
3. Dependence on certain indicators may fail to consider intricate pathophysiological pathways.
4. The potential bias of findings may arise from attrition rates and irregularities in follow-up.

Recommendations for Policymakers

1. Encourage the advancement of research on non-invasive prenatal testing methods.
2. Advocate for the establishment of standardised techniques aimed at predicting hypertension.
3. Foster inter-institutional cooperation to enhance the diversity of study populations.
4. Allocate resources towards technological advancements to guarantee uniformity and precision in prenatal testing.
5. The objective is to create public health strategies that prioritise the timely identification of hypertension diseases.

Recommendations for Clinicians

1. The use of Doppler and platelet indicators in standard prenatal care is recommended.
2. In predictive research, it is important to exercise caution about methodological constraints.
3. The inclusion of patient demographics and risk variables is crucial in the prediction of hypertension disorders.
4. Maintain current knowledge of new research and technology advancements in the field of prenatal diagnosis.
5. Promote the use of diverse and collaborative methods in the management of hypertensive diseases.

Future Recommendations

1. To investigate the incorporation of novel biomarkers into existing prediction models.
2. Longitudinal studies should be conducted to monitor the long-term results of prediction accuracy.
3. To examine the economical implications of early detection on healthcare systems.
4. Create machine learning models to enhance the accuracy of predictions.
5. Concentrate on mitigating inequalities in the accessibility and level of prenatal care.

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