

**First Trimester Uterine Artery Doppler Screening in the Prediction of Pre-Eclampsia**Chitra K.S.<sup>1</sup>, Sakthi Priya A.<sup>2</sup>, Saajeevani Naidu<sup>3</sup><sup>1</sup>HOD, Department of OG, Velammal Medical College Hospital, Madurai, Tamil Nadu, India<sup>2</sup>Associate Professor, Department of OG, Velammal Medical College Hospital, Madurai, Tamil Nadu, India<sup>3</sup>Assistant Professor, Department of OG, Government Tirunelveli Medical College Hospital, Madurai, Tamil Nadu, India

Received: 01-11-2025 / Revised: 15-12-2025 / Accepted: 21-01-2026

Corresponding author: Dr. Sakthi Priya A.

Conflict of interest: Nil

**Abstract****Background:** Preeclampsia is a significant contributor to maternal and perinatal morbidity and mortality. Early identification of women at risk is crucial for improving outcomes. This study evaluates the utility of Uterine Artery Doppler screening in predicting preeclampsia during the first trimester.**Methods:** A prospective cohort study was conducted involving 219 women attending the antenatal outpatient department of Velammal Medical College Hospital and Research Institute between 11+0 weeks and 13+6 weeks of gestation. Uterine artery Doppler velocimetry was performed to measure the pulsatility index (PI), and patients were followed until delivery to assess the development of preeclampsia and gestational hypertension.**Results:** Among participants, 25% exhibited abnormal Uterine Artery Doppler findings, with a significant association between high PI (>2.3) and the development of gestational hypertension and preeclampsia. The sensitivity and specificity of uterine artery PI as a predictor was 68% and 52.99% respectively. Early screening combined with interventions may reduce morbidity and mortality associated with hypertensive disorders.**Conclusion:** This study assesses the effectiveness of first-trimester Uterine Artery Doppler assessments in predicting preeclampsia with PI of > 2.3. Usage of such screening could enhance risk stratification, facilitate timely interventions, and ultimately improve maternal and fetal health outcomes. Further research is required to refine screening protocols and improve predictive accuracy across various populations.**Keywords:** Preeclampsia, uterine artery Doppler, pulsatility index (PI), Gestational hypertension.**DOI:** 10.25258/ijcpr.18.2.155This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

Preeclampsia remains one of the leading causes of maternal morbidity and mortality worldwide. It is characterized by new-onset hypertension with proteinuria or evidence of multiorgan involvement occurring after 20 weeks of gestation. [1,2] Hypertensive disorders of pregnancy which include gestational hypertension, preeclampsia, chronic hypertension, and eclampsia complicate up to 10% of pregnancies, with preeclampsia, either alone or superimposed on chronic hypertension, representing the most severe form. [3,4]

Given its unpredictable nature and potential for rapid deterioration, considerable research has focused on identifying women at high risk for preeclampsia, with increasing emphasis on first-trimester screening as the optimal window for prediction.(5) Among the various predictive strategies, the Uterine Artery Doppler waveform

has emerged as one of the most extensively studied tools for early identification of placental insufficiency. Uterine artery Doppler is simple, non-invasive, reproducible, and has shown promise in predicting complications such as gestational hypertension, preeclampsia, and fetal growth restriction. [6,7,8] Despite these advantages, accurate prediction during early gestation remains challenging.

Gestational hypertension, defined as blood pressure  $\geq 140/90$  mmHg arising after mid-pregnancy without proteinuria, is another important clinical concern. [1] Approximately half of these women later progress to preeclampsia. [9] Preeclampsia itself is recognized as a multisystem pregnancy-specific syndrome that can affect virtually every organ. Normally, during early pregnancy, trophoblastic invasion and remodeling of maternal

uterine vessels reduce uterine vascular resistance. [10,11] Failure of this physiological process leads to inadequate uteroplacental perfusion, a central contributor to maternal and fetal complications. Several approaches have been explored to predict, prevent, or attenuate the severity of preeclampsia, including Gestosis scoring system, biochemical markers, assessment of clinical risk factors, and Doppler velocimetry of the uterine arteries during early and mid-pregnancy. [3,5] Although many women with elevated blood pressure ultimately achieve safe deliveries with favorable neonatal outcomes, others experience severe disease progression, often with complications arising after 28 weeks gestation. [3,4] Without meticulous antenatal surveillance, early signs of preeclampsia can be missed, emphasizing the importance of timely detection.

Among the available screening methods, Uterine Artery Doppler has gained increasing attention as an early marker of abnormal placentation. [6] Abnormal first-trimester Doppler waveforms particularly elevated resistance indices may reflect impaired vascular remodeling and endothelial dysfunction, thereby identifying women at risk for future preeclampsia. [12] While numerous studies have evaluated Doppler findings in both the first and second trimesters, the predictive value of first-trimester abnormalities alone remains an area of ongoing investigation.

The present study focuses exclusively on first-trimester Uterine Artery Doppler waveform abnormalities and evaluates their ability to predict the subsequent development of preeclampsia. By examining Doppler changes at the earliest feasible gestational stage, this study aims to contribute to the evolving evidence on early, non-invasive prediction of preeclampsia.

### Material and Methodology

This prospective cohort study was conducted in the Department of Obstetrics and Gynecology over a one-year period. A total of 219 pregnant women attending the outpatient clinic between 11+0 and 13+6 weeks of gestation were recruited using convenience sampling. The sample size was calculated using standard proportion-based methods at a 95% confidence interval and 3% margin of error, and after adjusting for a 25% attrition rate, the final required sample size was 219.

Eligible participants included antenatal women with singleton pregnancies within 11+0 to 13+6 weeks of gestation who had no history of cardiac, hepatic, or renal disease and no prior hypertension. Women with gestational age below 11 weeks or above 14 weeks, those with underlying cardiac, hepatic, or renal disorders, multiple pregnancies, fetal anomalies, pregnancies ending before 28 weeks, or those on medication for chronic hypertension were excluded from the study.

All enrolled women underwent first-trimester ultrasonography for nuchal translucency measurement, during which Uterine Artery Doppler velocimetry was also performed. Uterine artery flow waveforms and pulsatility index (PI) values were recorded. An abnormal Doppler result was defined as bilateral uterine artery notching and/or a mean PI greater than 2.35. Participants with abnormal Doppler findings were followed until delivery to observe the development of gestational hypertension or preeclampsia. Blood pressure parameters, mean arterial pressure, ultrasound findings, timing of delivery, and other complications related to hypertensive disorders of pregnancy were monitored and documented. Neonatal outcomes were also recorded. Data were entered into a master spreadsheet and categorized based on normal or elevated uterine artery PI values. Statistical analysis was performed to determine the predictive value of first-trimester uterine artery Doppler in identifying women at risk of developing preeclampsia or gestational hypertension later in pregnancy. All women with a PI value greater than 2.3 were followed closely through the second and third trimesters for the occurrence of hypertensive disease. The study adhered to ethical standards, and all procedures were conducted in accordance with institutional and national guidelines for research involving human participants.

### Results

A total of 219 pregnant women between 11 and 13+6 weeks of gestation were included in the study. The demographic distribution showed that the largest proportion of participants were between 21–25 years (42.8%), followed by 26–30 years (36.8%), while only 6.8% were below 20 years and 0.8% were above 36 years. Most women were primigravidae (85.6%), whereas multigravidae accounted for 28.4%. (Figure 1)

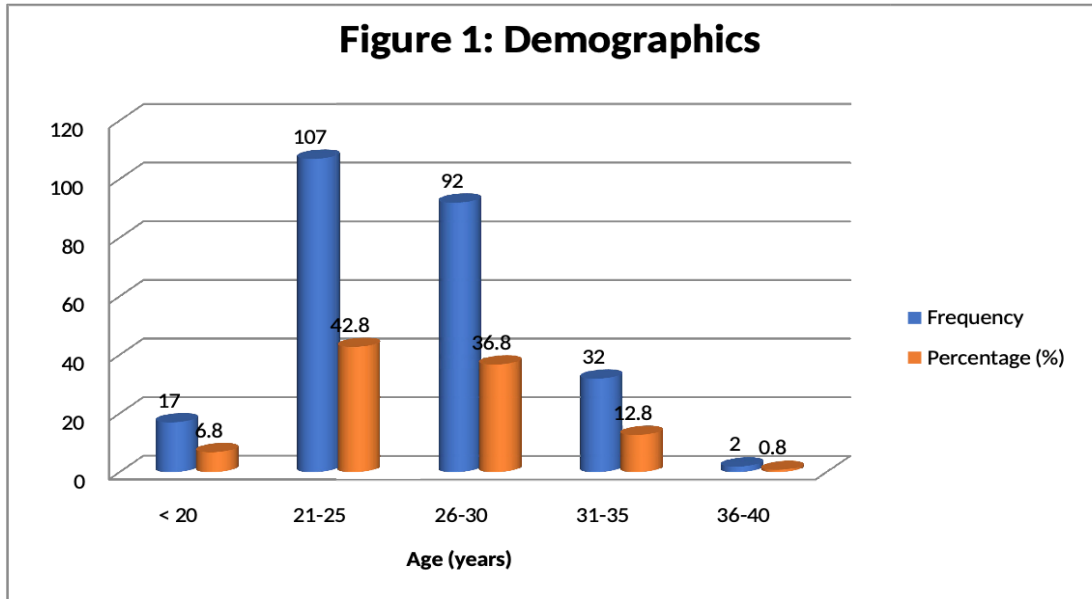


Figure 1: Demographics of included patients

With respect to method of conception, the majority conceived spontaneously (88.4%), and only 11.6% required ovulation-inducing drugs.

based on early pregnancy blood pressure profiles indicated that 78% of the participants belonged to the low-risk category, 15.6% were moderate-risk, and 6.4% were high-risk. (Table 1)

**Blood Pressure Risk and Development of Gestational Hypertension: Risk stratification**

Table 1: Risk Stratification

Risk stratification	Frequency	Percentage (%)
low-risk	195	78
moderate-risk	39	15.6
high-risk	16	6.4

By the end of 28 weeks gestation, 93.6% of the cohort remained normotensive, whereas 6.4% developed gestational hypertension. All women in the study received prophylactic low-dose aspirin (Ecospirin) as per institutional protocol. (Figure 2)

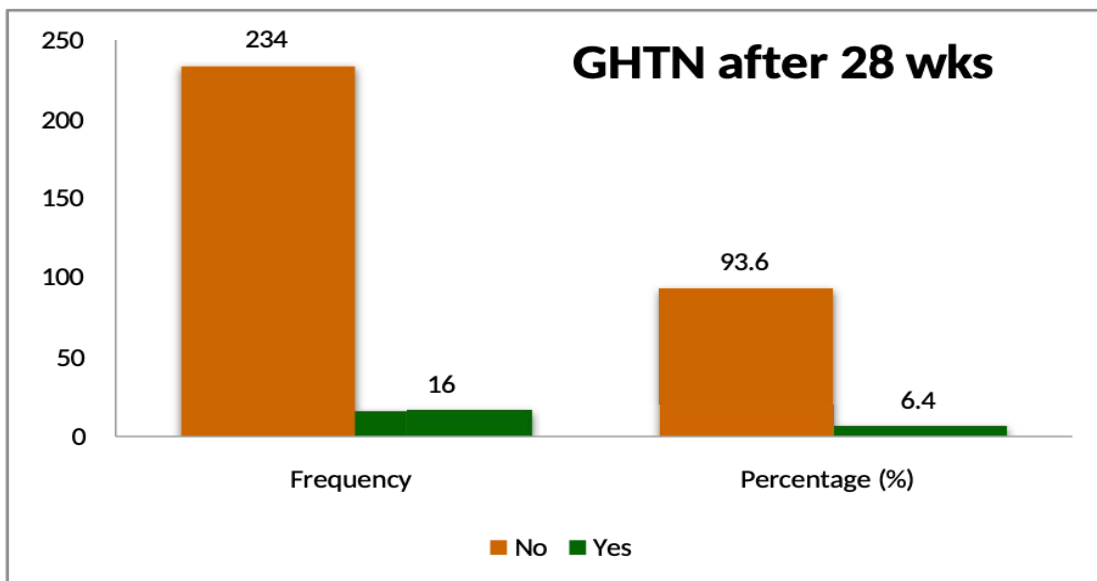


Figure 2: Gestational hypertension after 28 weeks

**Association between Uterine Artery PI and Maternal Factors:** A significant association was observed between uterine artery pulsatility index (PI) and maternal age. Women aged below 20 years demonstrated uniformly lower PI values (<2.3),

while those aged 26–35 years showed a higher prevalence of elevated PI values (>2.3) ( $p < 0.005$ ). Similarly, primigravidae exhibited significantly lower PI values compared with multigravidae ( $p < 0.005$ ). (Table 2)

**Table 2: Association of Uterine PI with risk factors**

	Uterine	PI with age	P Value
	>2.3	<2.3	
Below 20	0	17	
21-25	12	95	
26-30	12	80	<0.005
31-35	4	28	
36-40	0	2	

Uterine PI and parity					
	Yes	No			
>2.3	4	20	<0.005		
<2.3	32	194			
Uterine PI with gestational hypertension					
>2.3	16	8	<0.005		
<2.3	0	226			
Uterine PI with Preeclampsia					
>2.3	8	16	<0.005		
<2.3	0	226			
Uterine PI with delivery					
	Emergency 34 weeks	Emergency 36 weeks	LSCS	NVD	<0.005
>2.3	5	3	8	8	

Elevated uterine PI (>2.3) showed a strong and statistically significant correlation with adverse maternal outcomes. All women who developed gestational hypertension ( $n = 16$ ) and all who developed preeclampsia ( $n = 8$ ) had PI values above 2.3 ( $p < 0.005$ ). In contrast, none of the women with normal PI (<2.3) progressed to either condition.

**Pregnancy and Delivery Outcomes:** Higher uterine PI values were also associated with a greater likelihood of emergency deliveries. Among women with PI >2.3, emergency deliveries were noted at 34 weeks and 36 weeks, and a higher

frequency of cesarean deliveries was recorded compared to those with normal PI values ( $p < 0.005$ ). Women with normal PI (<2.3) predominantly delivered at term and experienced uncomplicated vaginal deliveries.

**Neonatal Outcomes:** Neonatal outcomes were specifically assessed among mothers diagnosed with preeclampsia ( $n = 8$ ). There were no fetal deaths, but two newborns were diagnosed with intrauterine growth restriction (IUGR).

None of the neonates required ICU admission, although six mothers required clinical management for complications related to preeclampsia. (Table 3)

**Table 3: Neonatal outcomes for mothers with Preeclampsia (n=8)**

Fetal death	0
Intrauterine Growth Restriction (IUGR)	2
ICU stay	0
Mother side	6

## Discussion

Preeclampsia remains a major cause of maternal and fetal morbidity, and its early detection is crucial for preventing severe complications. [10] Identifying high-risk women allows for intensified surveillance and timely intervention, ultimately improving pregnancy outcomes. [11] The present study highlights the usefulness of first-trimester

Uterine Artery Doppler assessment as a predictive tool for hypertensive disorders of pregnancy.

In our study, 75% of women demonstrated normal first-trimester uterine artery pulsatility index (PI) values, while 25% exhibited abnormal Doppler findings. Among those with abnormal PI values, 40% developed complications associated with hypertensive disorders, including gestational

hypertension (13.2%), pulmonary embolism (10.29%), eclampsia (1.47%), oligohydramnios (22.05%), fetal growth restriction (42.64%), placental abruption (4.41%), and stillbirth (5.88%). [11] These results are consistent with previous research demonstrating the significant risks associated with abnormal uteroplacental perfusion and underscore the need for close monitoring of such pregnancies.

The particularly high rate of fetal growth restriction (42.64%) in our cohort is concerning, given its long-term implications for neonatal health. Doppler ultrasound plays a central role in evaluating placental vascular function, and our study reinforces its relevance. We observed that a PI value greater than 2.3 was significantly associated with the development of gestational hypertension, and half of these women progressed to preeclampsia. This association is supported by findings from Satish et al. (mean PI 2.34), Gómez et al. (2.04), and Narang et al. (1.94), strengthening the evidence that abnormal first-trimester PI is linked to adverse pregnancy outcomes. [13]

However, the predictive accuracy of uterine artery PI varies across populations, indicating that Doppler indices may be influenced by demographic, physiological, or methodological factors. Our findings support the use of a first-trimester PI cutoff of 2.3 for predicting gestational hypertension and preeclampsia, which aligns with earlier studies such as Staboulidou et al., who reported a cutoff of 1.52, and Narang et al., who documented a sensitivity of 75.9% and specificity of 79.6%.

The predictive values in our study correspond with those reported by Singh et al., who found a similar negative predictive value of 97.33%, although their positive predictive value (92%) was significantly higher. [14] Variations in sample characteristics, inclusion criteria, and Doppler methodology may explain these differences and highlight the importance of population-specific thresholds.

Further supporting evidence comes from a meta-analysis by Velauthar et al., involving 55,974 women across 18 studies, which reported a sensitivity of 26.4% for predicting preeclampsia using abnormal uterine artery PI. [12] Although sensitivity varies widely, these findings establish uterine artery Doppler as a valuable screening tool when used alongside clinical and biochemical markers. Additionally, Plasencia et al. demonstrated that 77% of early-onset preeclampsia cases showed PI >90th percentile in the first trimester, with 94% maintaining elevated PI later in pregnancy. [6] When combined with Gestosis scoring, detection rates reached up to 90%, highlighting the added value of multimodal screening. [13]

Gómez et al. further reported that adverse outcomes remained significantly higher in women who initially had elevated PI values, even if indices normalized later, emphasizing the importance of continued monitoring throughout pregnancy. [15]

The role of aspirin in reducing the incidence of preeclampsia has been evaluated in several trials. The ASPRE trial demonstrated that aspirin administered to high-risk women significantly reduced the incidence of preterm preeclampsia. [16] Similarly, systematic reviews and meta-analyses by Roberge et al. and Daniel et al. confirmed that aspirin is most effective when initiated before 16 weeks of gestation at doses exceeding 100 mg/day. [17,18] A meta-analysis by Ghesquiere et al. also concluded that 150 mg of aspirin started in the first trimester is more effective than 75 mg for preventing preterm preeclampsia. [19]

Despite prophylactic administration of low-dose aspirin (Ecospirin) to all participants in our study, a notable proportion still developed preeclampsia. This observation suggests that factors beyond aspirin responsiveness may influence disease progression and warrants further exploration of dose, timing, adherence, and individual biological variation.

Overall, our findings reinforce the clinical value of incorporating first-trimester uterine artery Doppler into routine prenatal screening. Women identified as high risk can benefit from intensified follow-up, timely intervention, and preventive strategies to minimize the risk of hypertensive complications. The integration of Doppler assessment with maternal risk factors and biochemical markers would further enhance predictive accuracy and allow for more individualized antenatal care.

## Conclusion

This study shows that a first-trimester uterine artery PI greater than 2.3 is strongly predictive of gestational hypertension and preeclampsia, with all women in this category developing hypertension and half progressing to preeclampsia requiring emergency delivery. Early Doppler assessment, combined with timely clinical monitoring, can help prevent severe complications. Integrating uterine artery PI with biochemical markers may further improve early risk prediction and enhance maternal and fetal outcomes.

## Declaration

I hereby declare that the article titled "First Trimester Uterine Artery Doppler Screening in the Prediction of Pre-Eclampsia" is an original and independent work carried out by me under the guidance of my supervising faculty. This article has

not been submitted, in part or full, to any other university, institution or journal.

**Acknowledgement:** The author expresses sincere gratitude to all faculty members, clinical staff, and participants involved in the study.

#### References

1. American College of Obstetricians and Gynecologists. Hypertension in pregnancy. *Obstet Gynecol.* 2020.
2. World Health Organization. WHO recommendations for prevention and treatment of pre-eclampsia and eclampsia. Geneva: WHO; 2019.
3. Brown MA, Magee LA, Kenny LC, Karumanchi SA, McCarthy F, Saito S, et al. The hypertensive disorders of pregnancy: ISSHP classification, diagnosis & management recommendations. *Pregnancy Hypertens.* 2018.
4. Steegers EA, von Dadelszen P, Duvekot JJ, Pijnenborg R. Pre-eclampsia. *Lancet.* 2010; 376:631-44.
5. Poon LC, Kametas NA, Chelemen T, Leal A, Nicolaides KH. First-trimester screening for pre-eclampsia. *Obstet Gynecol.* 2012.
6. Plasencia W, Maiz N, Bonino S, Kaihura C, Nicolaides KH. Uterine artery pulsatility index at 11–13+6 weeks and prediction of preeclampsia. *Ultrasound Obstet Gynecol.* 2007.
7. Gómez O, Martínez JM, Figueras F, Del Río M, Borobio V, Puerto B, et al. Uterine artery Doppler at 11–14 weeks and pregnancy outcome. *Ultrasound Obstet Gynecol.* 2008.
8. Narang S, Nagrath A, Goel P, Huria A. Role of uterine artery Doppler in prediction of pregnancy-induced hypertension. *Int J Reprod Contracept Obstet Gynecol.* 2016.
9. Sibai BM. Diagnosis and management of gestational hypertension and preeclampsia. *Obstet Gynecol.* 2003.
10. Duley L. The global impact of pre-eclampsia and eclampsia. *Semin Perinatol.* 2009.
11. Redman CW, Staff AC. Preeclampsia, biomarkers, syncytiotrophoblast stress, and placental ischemia. *Placenta.* 2015.
12. Velauthar L, Plana MN, Kalidindi M, Zamora J, Thilaganathan B, Khan KS, et al. First-trimester uterine artery Doppler and adverse pregnancy outcome: a systematic review and meta-analysis. *Ultrasound Obstet Gynecol.* 2014.
13. Staboulidou I, Galindo A, Maiz N, Hüsler M, Nicolaides KH. Cardiac examination at 11–13 weeks and prediction of preeclampsia. *Am J Obstet Gynecol.* 2009.
14. Singh A, Verma ML, Verma N. Uterine artery Doppler study as a predictive tool for hypertensive disorders of pregnancy. *Int J Reprod Contracept Obstet Gynecol.* 2017.
15. Gómez O, Martínez JM, Figueras F, Del Río M, Puerto B, Coll O, et al. Uterine artery Doppler in first trimester and adverse outcomes. *Ultrasound Obstet Gynecol.* 2008.
16. Rolnik DL, Wright D, Poon LC, O’Gorman N, Syngelaki A, de Paco Matallana C, et al. Aspirin versus placebo in pregnancies at high risk for preterm pre-eclampsia. *N Engl J Med.* 2017.
17. Roberge S, Bujold E, Nicolaides KH. Aspirin for the prevention of preeclampsia: systematic review and meta-analysis. *BJOG.* 2017.
18. Daniel S, King J, McCaw-Binns A, Ashley D. Aspirin therapy for prevention of preeclampsia. *Am J Obstet Gynecol.* 2015.
19. Ghesquiere L, Devlieger R, Witters I, Van Calsteren K, Hanssens M, Verhaeghe J, et al. Low-dose aspirin for prevention of preterm preeclampsia: systematic review & meta-analysis. *Am J Obstet Gynecol.* 2021.