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## Uterine artery Doppler as a screening modality to predict pre-eclampsia and its complications in high risk pregnancies in a rural set-up

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### Abstract

**Background:** Pre-eclampsia (PE) is a major cause of maternal morbidity and mortality. Several studies have shown that a, generalized endothelial dysfunction is associated with these complications. Uterine artery Doppler studies both in the second and the first trimester can predict pregnancies at increased risk of the complications of impaired placentation. Uterine artery Doppler screening at 20 to 24 weeks' gestation is superior to first trimester screening, and appears to fulfil the requirements for a worthwhile screening test. This study is about to see the usefulness of uterine artery Doppler in predicting pre-eclampsia and its complications.

**Methods:** A prospective observational study to see the usefulness of uterine artery Doppler in predicting pre-eclampsia and its complications was conducted on 100 high risk pregnancies. High risk Pregnant women between 16-28 weeks of gestational age with both normal and abnormal uterine artery Doppler are selected for the study. Detailed history, physical examination and necessary investigations will be undertaken. Uterine artery Doppler U/S was performed to evaluate uterine artery's flow velocity waveforms. They were then used to calculate the presence of diastolic notch, resistance index (RI) and pulsatile index (PI). At each antenatal visit, the risk factors for PE such as BP, proteinuria, and signs and symptoms were noted. The patients are followed up with regular antenatal care including blood pressure measurement, urine examination for albumin, weight gain and other parameters as clinically indicated in each visit until termination of pregnancy.

**Results: Age Distribution:** Participants are under the age group of less than 20 years and more than 35 years, with a mean age of  $25.08 \pm 5$ .

**BMI:** The mean Body mass index  $\pm$  SD of the high risk women was  $25.415 \pm 4$ .

**Blood Pressure:** Blood pressure measurements showed a mean systolic blood pressure (SBP) of  $153.76 \pm 15.383$  mmHg and a mean diastolic blood pressure (DBP) of  $101.98 \pm 11.528$  mmHg.

**Uterine artery Doppler parameters:** Uterine artery Doppler parameters revealed that the right uterine artery had a mean resistive index (RI) of  $0.7396 \pm 0.16114$ , a pulsatility index (PI) of  $1.772 \pm 0.7117$ , and a systolic/diastolic (S/D) ratio of  $4.1673 \pm 1.71155$ . The left uterine artery had a mean RI of  $0.7618 \pm 0.15057$ , a PI of  $1.8781 \pm 0.61973$ , and an S/D ratio of  $4.4913 \pm 1.87162$ .

**Gestational age at delivery:** The gestational age at delivery indicated that 62% of participants delivered pre-term and 38% delivered at term, with a mean gestational age of  $34.5 \pm 4.442$  weeks.

**Neonatal Outcomes:** Neonatal outcomes showed that 27% of newborns were normal, 25% were dead, 46% had intrauterine growth restriction (IUGR), and 2% were stillborn.

**Conclusion:** uterine artery Doppler indices, specifically the resistive index (RI) and pulsatility index (PI), are significant predictors of preeclampsia. The findings indicated that elevated RI and PI values were strongly associated with the development of preeclampsia, highlighting the potential of these indices as early screening tools. In conclusion, the use of uterine artery Doppler indices can significantly enhance the early prediction and management of preeclampsia. This can facilitate timely interventions and potentially reduce the adverse outcomes associated with this condition.

**Keywords:** Preeclampsia, uterine artery Doppler, screening, ultrasound

### Introduction

Hypertensive disorders, including preeclampsia, are a significant concern in pregnancy. These disorders affect 5-10% of pregnancies and contribute substantially to maternal and fetal complications [1]. Preeclampsia, affecting around 2% of pregnancies, is a multisystem disorder posing a major threat to both mother and baby [2]. While eclampsia is a dreaded complication, preeclampsia itself can also lead to significant maternal and perinatal problems. Studies suggest

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preeclampsia is a major contributor to maternal and fetal morbidity and mortality

Globally, it's estimated that over 14% (60,000) of maternal deaths annually are related to preeclampsia and eclampsia. However, in developed countries, the primary impact is often on the fetus<sup>[3]</sup>. Preeclampsia is also associated with a roughly 15% rate of preterm birth<sup>[4]</sup>.

Normally, by the eighth week, trophoblast cells begin invading the decidual portion of the spiral arteries, with this invasion typically completed by week thirteen.) After this stage, a second phase of invasion occurs, where the trophoblast invades the myometrial portion of the spiral arteries. This process usually finishes by weeks 18-19 but can be delayed up to 22-24 weeks. In the vast majority of preeclampsia cases, this transformation in the spiral artery bed fails to occur, leading to increased resistance to blood flow into the intervillous space. The preferred method for indirectly monitoring the status of the spiral artery bed is to analyze upstream information provided by uterine artery waveforms using Doppler ultrasound. Increased uterine artery velocimetry detected by Doppler ultrasound in the first and second trimester can indirectly offer evidence of this process, potentially serving as a predictive test for preeclampsia<sup>[4]</sup>. In non-pregnant women, uterine artery Doppler shows low peak flow velocity and an early diastolic notch. Between 18-20 weeks, there is typically high flow with no diastolic notch. Impaired uterine artery flow is characterized by high-resistance uteroplacental waveforms and the presence of a diastolic notch. This notch reflects arterial vessel tone and represents vessel elasticity and potential vasospasm. The notch typically disappears in the second trimester. A high-resistance pattern is associated with a higher rate of pregnancy complications, with a 70% chance of developing proteinuric hypertension and a 30% chance of having a coexisting small-for-gestational-age fetus<sup>[7]</sup>. While numerous studies have investigated uterine artery Doppler as a screening tool for preeclampsia and fetal growth restriction in the general population, its value remains debated. Sensitivity varies depending on the type of Doppler used, the sampling site, the definition of abnormal uterine artery resistance, gestational age at assessment, and the specific outcomes being studied (7). This study aims to evaluate the effectiveness of mid-trimester uterine artery Doppler examination in predicting preeclampsia in high-risk women.

### **Aims and objectives of the study**

#### **AIM**

To study Uterine Artery Doppler as a screening modality to predict pre-eclampsia In High risk pregnancy in a rural set-up.

#### **Objectives**

To study the uterine artery Doppler for high risk pregnant women during mid-trimester to predict

- **Maternal Complications:** Pre-Eclampsia, Miscarriage, Preterm Labour, Abruptio Placenta, Eclampsia, HELLP Syndrome, Maternal mortality
- **Fetal Complications:** IUGR, small for gestational age, low birth weight, need for NICU admission and still Birth/ IUD.

#### **Source of data**

The study will be conducted over a period of two years starting in July 2022. High risk pregnant women between 16-28 weeks of gestational age with both normal and abnormal uterine artery Doppler are selected for the study, at our hospital Hoskote, Bangalore Rural and will be counselled for participating in the

study. Details of study will be explained to the patient and informed consent will be taken before recruitment.

#### **Study Design**

Present study is a prospective observational study to see the usefulness of uterine artery Doppler in predicting pre-eclampsia and its complications.

#### **Inclusion Criteria**

Singleton pregnancies with gestational age between 16-28 weeks with a risk factors like-

- Hypertension
- Diabetes mellitus
- Oligohydromnios
- Renal disease
- Thyroid disease
- Obesity or any other medical complications
- Previous history of pre-eclampsia
- Family history of pre-eclampsia
- Bad obstetric history

#### **Exclusion criteria**

- Multiple pregnancy
- Confirmed case of of pre-eclampsia
- Molar pregnancies
- Congenital anomalies of the foetus

#### **Sample size**

- This study involves 100 patients between 16-28 weeks period of gestation with high risk pregnancy.

#### **Methods of collection of data**

- A total of 100 high risk pregnancy cases studied over a period of two years, will be screened between 16-28 weeks of gestation with Doppler studies to know: resistance index, pulsatile index, SD ratio of the uterine artery is calculated.
- The resistance index, Pulsatile index, SD ratio Of the uterine artery, presence of a notch in early diastole, a systolic notch are used to find out abnormalities.
- Data will be collected using a pre-tested proforma meeting the objectives of the study.
- Detailed history, physical examination and necessary investigations will be undertaken. The patients are followed up with regular antenatal care including blood pressure measurement, urine examination for albumin, weight gain and other parameters as clinically indicated in each visit until termination of pregnancy. Final outcomes are tabulated and assessed statistically.

#### **Statistical data analysis**

Data collected will be entered and analyzed using Microsoft Excel and SPSS software packages. Chi square test, proportions and standard deviations between two means will be used to test statistical significance.

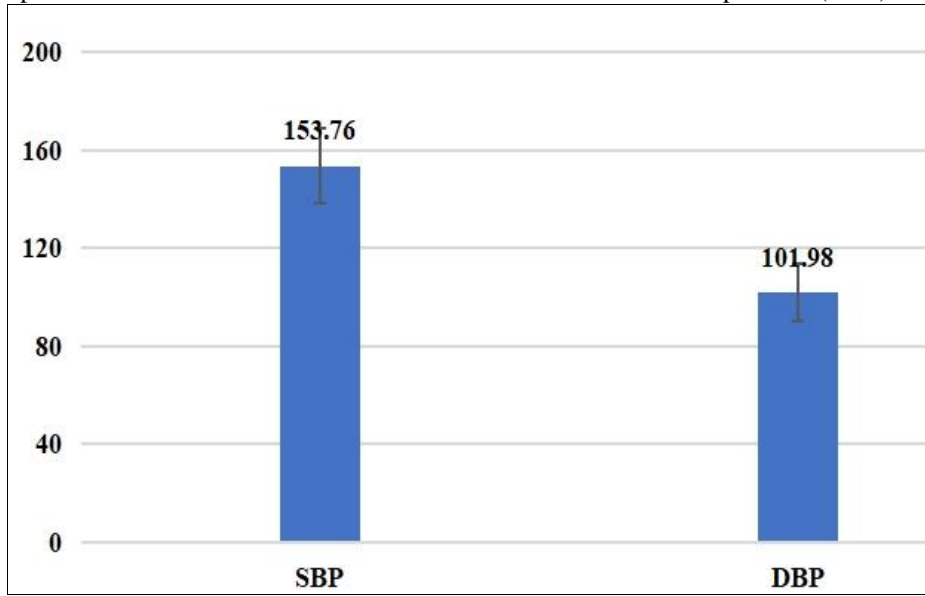
#### **Results**

**Age Distribution:** Participants are under the age group of less than 20 years and more than 35 years, with a mean age of 25.08±5.

**BMI:** The mean Body mass index± SD of the high risk women was 25.415±4.

**Blood Pressure:** Blood pressure measurements showed a mean

systolic blood pressure (SBP) of  $153.76 \pm 15.383$  mmHg and a mean diastolic blood pressure (DBP) of  $101.98 \pm 11.528$  mmHg.



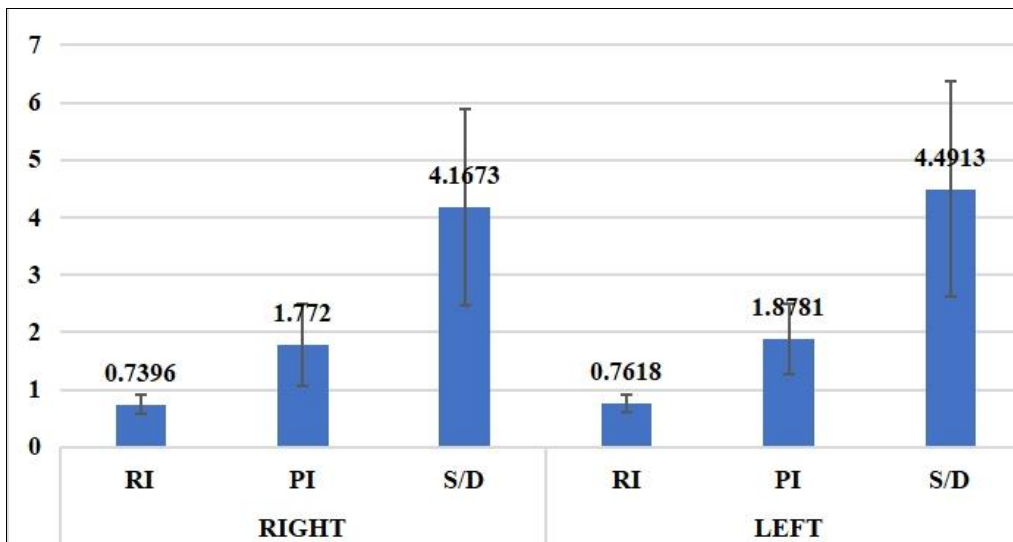
**Fig 1:** Blood pressure

**Uterine artery doppler parameters:** Uterine artery Doppler parameters revealed that the right uterine artery had a mean resistive index (RI) of  $0.7396 \pm 0.16114$ , a pulsatility index (PI) of  $1.772 \pm 0.7117$ , and a systolic/diastolic (S/D) ratio of  $4.1673 \pm 1.71155$ .

The left uterine artery had a mean RI of  $0.7618 \pm 0.15057$ , a PI of  $1.8781 \pm 0.61973$ , and an S/D ratio of  $4.4913 \pm 1.87162$ .

**Table 1:** Uterine Artery Doppler

Uterine Artery Doppler Parameters		Mean	Std. Deviation
Right	RI	0.7396	0.16114
	PI	1.772	0.7117
	S/D	4.1673	1.71155
Left	RI	0.7618	0.15057
	PI	1.8781	0.61973
	S/D	4.4913	1.87162



**Fig 2:** Uterine Artery Doppler

**Table 2:** Uterine artery Doppler

		Frequency	Percentage
RI values	<0.55	18	18
	>0.55	82	82
PI values	<1.45	29	29
	>1.45	71	71

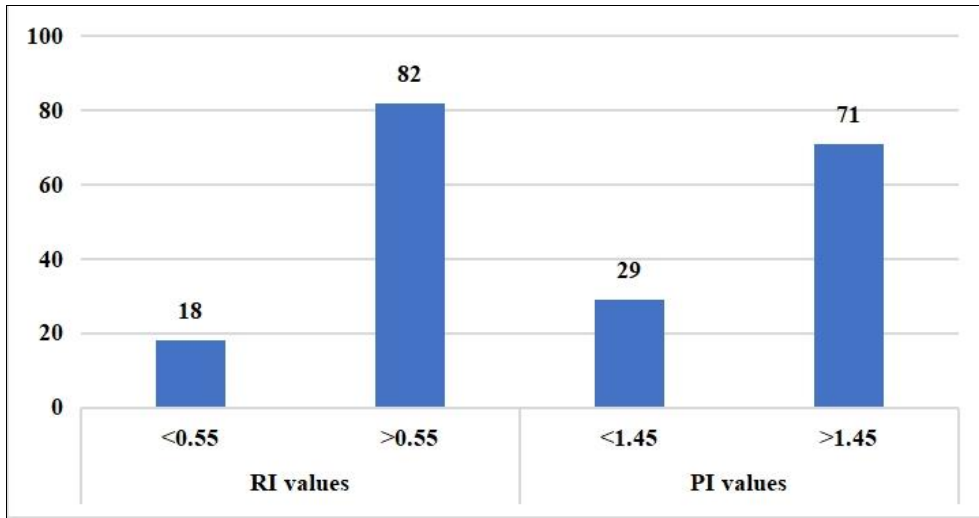


Fig 3: Uterine artery doppler

Regarding RI values, 18% of participants had PI values less than 0.55, while 82% had RI values greater than 0.55. Regarding PI values, 29% of participants had PI values less than 1.45, while 71% had PI values greater than 1.45.

**Gestational age at delivery:** The gestational age at delivery indicated that 62% of participants delivered pre-term and 38% delivered at term, with a mean gestational age of 34.5±4.442 weeks.

**Preeclampsia:** Pre-eclampsia was observed in 86% of the participants, while 14% did not have pre-eclampsia.

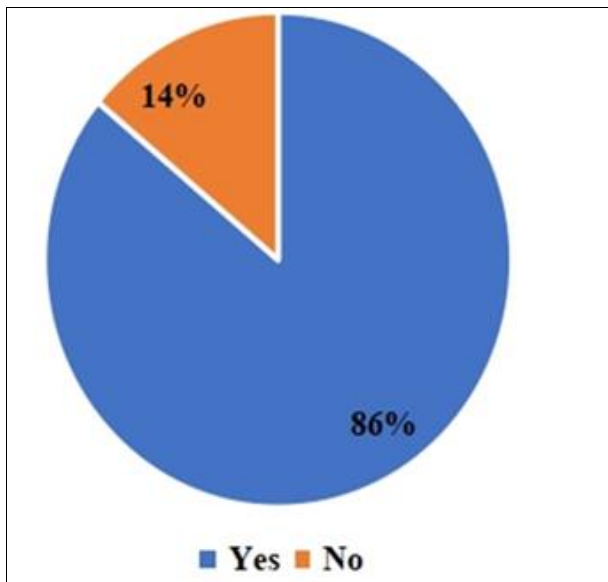


Fig 4: Preeclampsia

**High Risk Factors**

Various high risk factors and the associated risk of preeclampsia was studied like age, body mass index, maternal history of chronic hypertension, diabetes, renal disease, past bad obstetric history and family history was taken into account as these factors have been seen to be associated with the higher incidence of preeclampsia and is shown in table.

Patients in extremes of age, teenage and elderly combined constitute major group. While past h/o preeclampsia, IUGR, IUFD was also a significant factor.

Table 2: High risk factors

Risk factors	No. of women
Age <20	26
Age >35	14
BMI >30	8
H/O Chronic Hypertension	12
H/O Diabetes	8
H/O Chronic Renal Disease	2
Past H/O Preeclampsia, IUGR, IUFD	22
Family H/O Preeclampsia, IUGR	8

**Mode of Delivery:** In terms of the mode of delivery, 86% had a normal vaginal delivery (NVD), 2% had an assisted vaginal delivery (AVD), and 12% underwent a lower segment cesarean section (LSCS).

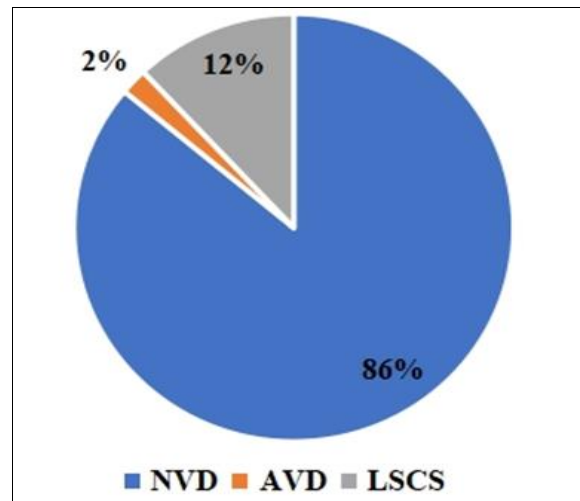


Fig 5: Mode of delivery

**Neonatal Outcomes:** Neonatal outcomes showed that 27% of newborns were normal, 25% were dead, 46% had intrauterine growth restriction (IUGR), and 2% were stillborn.

Neonatal outcomes	Frequency	Percentage
Normal	36	36
Dead	8	8
IUGR	54	54
Still born	2	2

Total	100	100
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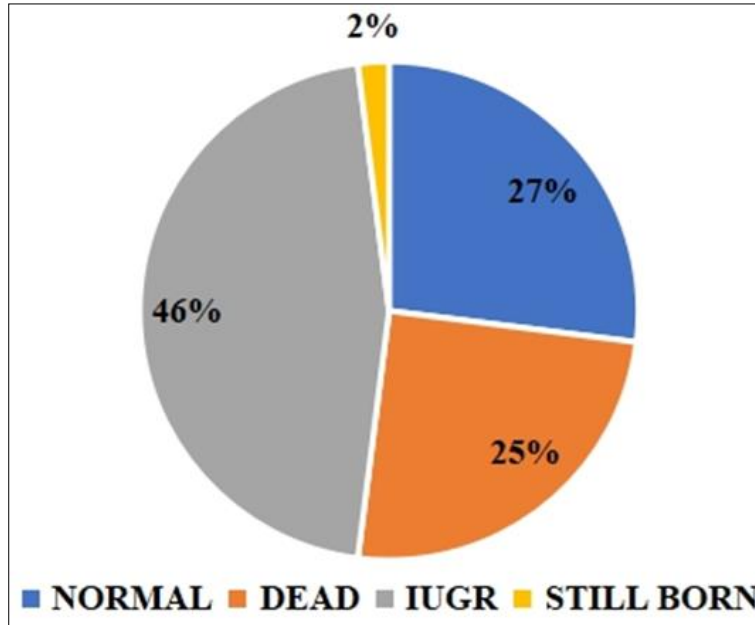


Fig 6: Neonatal outcomes

NICU Admission	Frequency	Percentage
Yes	69	69
No	29	29
Na	2	2
Total	100	100

that participants with pre-eclampsia had a mean RI of  $0.77919 \pm 0.131274$  and a mean PI of  $1.9327 \pm 0.58508$ , while those without pre-eclampsia had a mean RI of  $0.57214 \pm 0.134002$  and a mean PI of  $1.1171 \pm 0.36716$ . The association was found to be statistically significant between higher uterine artery Doppler values and pre-eclampsia.

**Association of uterine artery doppler with pre-eclampsia**

The association of artery Doppler with pre-eclampsia indicated

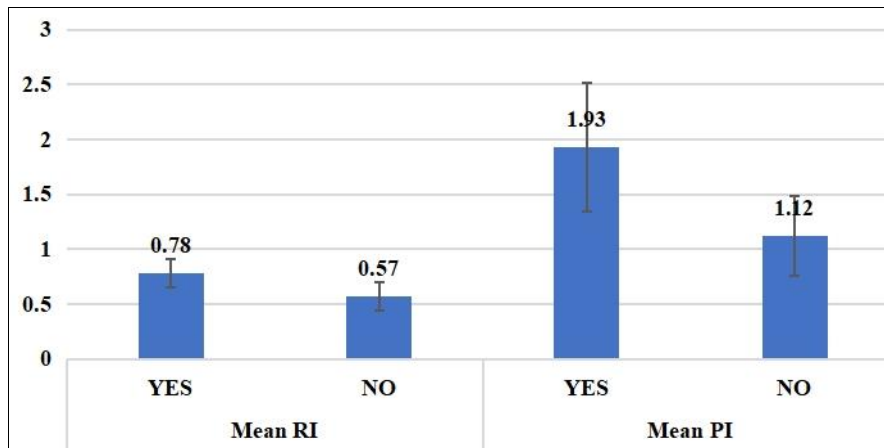
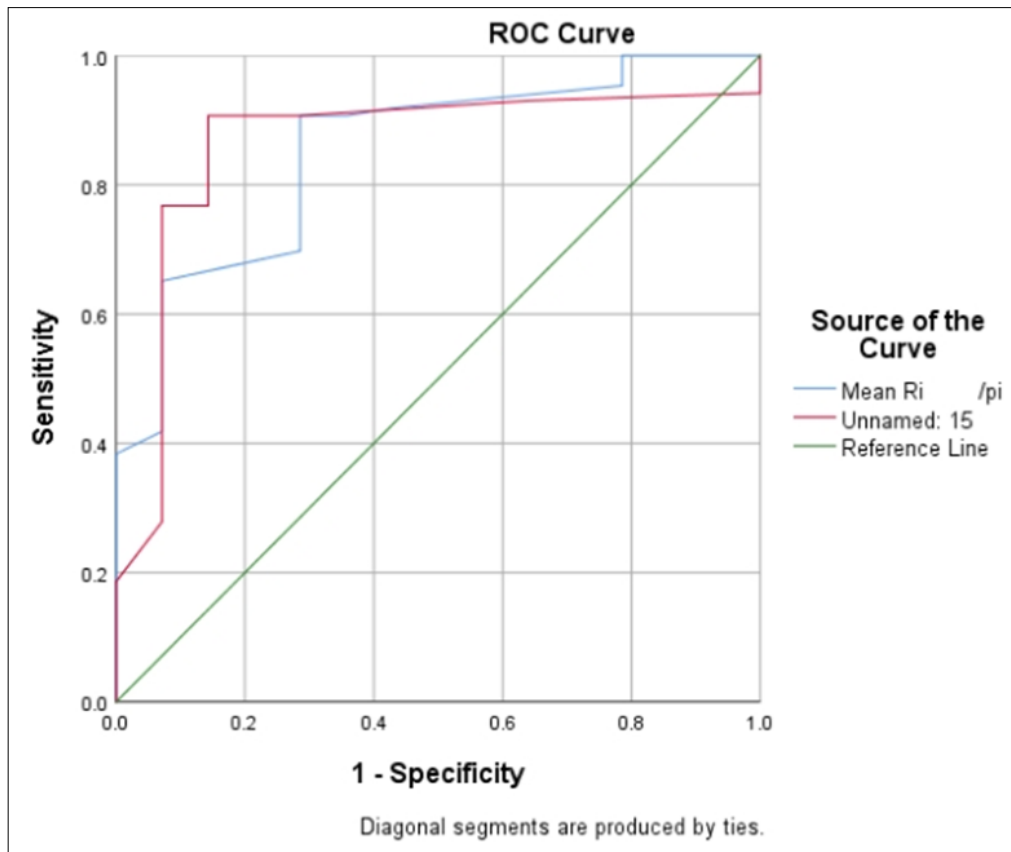


Fig 6: Association of uterine artery doppler with pre-eclampsia

**ROC of Uterine artery parameters in predicting pre-eclampsia**

The ROC analysis of uterine artery PI in predicting pre-eclampsia showed an area under the curve (AUC) of 0.863, with a sensitivity of 80.2% and a specificity of 76.5% at a cut-off

value of 1.47. The ROC analysis of uterine artery RI in predicting pre-eclampsia showed an area under the curve (AUC) of 0.852, with a sensitivity of 91.2% and a specificity of 78.6% at a cut-off value of 0.50.



**Fig 7:** Roc curve

## Discussion

**Age Distribution:** In our study, the age distribution was as follows: 23% aged 18-20 years, 38% aged 21-25 years, 19% aged 26-30 years, and 20% aged 31-35 years, with a mean age of  $25.08 \pm 5.268$  years. Jyoti Bindal *et al.* included a similar range of reproductive-aged women, with most participants being in their early to mid-twenties. Mihaela Oancea *et al.* also had a comparable age range, highlighting that preeclampsia affects women across various age groups.

**Body Mass Index (BMI):** Our study reported a mean BMI of  $25.415 \pm 4.58$  kg/m<sup>2</sup>. This is consistent with findings from Nadia Shahid *et al.* and Surbhi Handa *et al.*, who reported BMI values around 25 kg/m<sup>2</sup>, indicating the role of BMI in preeclampsia risk (Shahid *et al.*, Handa *et al.*). Jyoti Bindal *et al.* also noted similar BMI values in their cohort, reinforcing the relevance of BMI in preeclampsia prediction (Bindal *et al.*).

**Gravida:** In our study, 47% of the participants were primipara, and 53% were multipara. Patricia Malini Pereira *et al.* and Mihaela Oancea *et al.* found similar distributions, showing that both primipara and multipara women are at risk for preeclampsia (Pereira *et al.*, Oancea *et al.*).

**Blood Pressure:** Our study recorded a mean systolic blood pressure (SBP) of  $153.76 \pm 15.383$  mmHg and a mean diastolic blood pressure (DBP) of  $101.98 \pm 11.528$  mmHg. Elevated blood pressure profiles are a common characteristic in preeclampsia cohorts. Jyoti Bindal *et al.* reported similar findings, with higher SBP and DBP values in their study population (Bindal *et al.*). Esha Das *et al.* also observed elevated blood pressure in preeclamptic women, aligning with our results (Das *et al.*).

**Uterine Artery Doppler Indices:** In our study, the right uterine

artery had a mean resistive index (RI) of  $0.7396 \pm 0.16114$  and a pulsatility index (PI) of  $1.772 \pm 0.7117$ , while the left uterine artery had a mean RI of  $0.7618 \pm 0.15057$  and a PI of  $1.8781 \pm 0.61973$ . The mean RI and PI values were  $0.7502 \pm 0.149556$  and  $1.8185 \pm 0.6265$ , respectively.

## Conclusion

Our study demonstrated that uterine artery Doppler indices, specifically the resistive index (RI) and pulsatility index (PI), are significant predictors of preeclampsia. The findings indicated that elevated RI and PI values were strongly associated with the development of preeclampsia, highlighting the potential of these indices as early screening tools. The ROC analysis further confirmed the robustness of these measures, with high sensitivity and specificity at the identified cut-off values, underscoring their predictive accuracy.

In conclusion, the use of uterine artery Doppler indices can significantly enhance the early prediction and management of preeclampsia. This can facilitate timely interventions and potentially reduce the adverse outcomes associated with this condition. Despite the study's limitations, the results contribute valuable knowledge to the field and lay the groundwork for future research aimed at improving the early detection and prevention of preeclampsia.

## Conflict of Interest

Not available

## Financial Support

Not available

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