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## Original Research Article

# Incidence of preeclampsia and fetal growth restriction among antenatal women with normal uterine artery Doppler at 11-14 weeks

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## ABSTRACT

**Background:** Preeclampsia remains a leading contributor to maternal morbidity and mortality worldwide, while fetal growth restriction is associated with an increased risk of adverse neonatal outcomes, including preterm birth, low birth weight, and long-term developmental challenges. Early prediction and prevention of these conditions are crucial for improving maternal and fetal outcomes. This study aims to estimate the incidence of preeclampsia and fetal growth restriction in antenatal women with normal uterine artery Doppler at 11-14 weeks.

**Methods:** A prospective observational study for a period of one and a half year, clinical data and demographic data were collected, analysed and the p-value will be calculated by the Pearson Chi-square test. The significance level will be set a  $p < 0.05$ .

**Results:** Despite normal uterine artery Doppler indices at 11–14 weeks, the study population showed a 7.3% incidence of preeclampsia and 36% fetal growth restriction. These women also had higher risks of small-for-gestational-age neonates, gestational hypertension, and diabetes. Maternal age, body mass index (BMI), socioeconomic status, education, and parity were significantly associated with adverse outcomes, and fetal growth restriction was notably linked to preeclampsia.

**Conclusion:** The study highlights that even with normal uterine artery Doppler PI at 11–14 weeks, women remain at risk for preeclampsia and fetal growth restriction. Early identification and monitoring, including aspirin therapy and attention to borderline PI values, may help prevent adverse outcomes. The findings support further research combining Doppler with biochemical markers for improved early prediction.

**Keywords:** First trimester, Preeclampsia, Fetal growth restriction, Uterine artery Doppler, Pulsatility index

## INTRODUCTION

Preeclampsia is a pregnancy specific multisystem disorder and a major contributor to maternal and perinatal morbidity, ranking as the second leading cause of maternal mortality worldwide.<sup>1,2</sup> It affects 3–5% of pregnancies globally, with reported incidence of 8–10% in India. The syndrome involves multiple organs including kidney, liver, brain, lungs, and blood and is associated with severe complications such as eclampsia, organ failure, fetal growth restriction, intrauterine death, and preterm labor. Hypertensive disorders occur in ~10% of pregnancies.

Advances in pathogenesis research have identified predictive biomarkers, including maternal characteristics, PAPP A, ADAM 12, PlGF, and Doppler ultrasonography, offering promise for early detection and prevention.<sup>3</sup>

Pre-eclampsia, fetal growth restriction, and placental abruption major complications linked to uteroplacental insufficiency remain significant contributors to maternal and perinatal morbidity and mortality. Their origins are associated with complex interactions of pregnancy specific immunological and vascular adaptations, maternal constitutional factors, and abnormal trophoblastic

development leading to impaired placentation between 8 and 18 weeks. This cascade results in endothelial dysfunction, ischemia, inflammation, and increased vascular permeability, with clinical manifestations emerging in the second half of pregnancy. Although precise aetiologies remain unclear, evidence supports a role for impaired trophoblastic invasion in the first trimester, underscoring the importance of early pathophysiological investigations.<sup>1,4</sup>

With the advent of nuchal translucency measurement, combined with maternal serum biochemistry and sonographic markers, screening for chromosomal abnormalities has shifted from the second to the first trimester. The 11–14 weeks scan now offers an opportunity to identify pregnancy complications early. Preeclampsia arises from impaired trophoblastic invasion of maternal spiral arteries, preventing conversion to low resistance vessels. Doppler studies show uterine artery impedance normally decreases until 24 weeks, but pregnancies that develop preeclampsia exhibit persistently elevated pulsatility indices in both first and second trimesters.

In early pregnancy, uterine artery Doppler typically shows low end diastolic velocities and a diastolic notch. Impedance is influenced by maternal factors such as heart rate, antihypertensive use, hormonal variation, and polycystic ovarian syndrome. Elevated pulsatility index reflects resistance within the utero-placental circulation, with values affected by ethnicity and body mass index. Normally, PI and RI decline as gestation advances due to trophoblastic invasion. For nearly three decades, uterine artery Doppler studies have been utilized as a screening tool for utero-placental insufficiency, mostly in the second trimester. Just as aneuploidy screening in the first trimester has become the accepted standard of care, so too is there an increasing need for the earlier prediction of other pregnancy complications.<sup>5</sup> Recent evidence suggests that giving low dose aspirin to women at high risk can reduce the prevalence of severest form of preeclampsia by more than 60%, but the treatment must be started before 16 weeks of gestation. Therefore, early detection is the key.

## METHODS

A hospital-based prospective observational study done in obstetrics and gynecology department of Pushpagiri Institute of Medical Sciences and Research Centre, Thiruvalla, with primary objective of estimating the incidence of preeclampsia and fetal growth restriction in antenatal women with normal uterine artery Doppler at 11-14 weeks and secondary objective to explore the association of maternal factors with preeclampsia, fetal growth restriction and other adverse pregnancy outcomes for a period of 18 months (June 2023 to November 2024). Consecutive sampling till the sample size has reached. Antenatal women satisfying inclusion criteria was recruited to the study till the required sample size of 164 were met. Exclusion criteria were chromosomal or

structural abnormalities multiple pregnancies, antiphospholipid antibody syndrome, pre-conception medical conditions like chronic hypertension, overt diabetes mellitus, chronic renal disease, heart diseases, antenatal women with abnormal uterine artery Doppler at 11-14 weeks and pregnancies with no follow-up.

## Data analysis

Data will be properly coded and entered in Microsoft excel and will be analysed using statistical software statistical package for the social sciences (SPSS) version 27. Qualitative variables will be summarised as percentages and for quantitative variables mean with standard deviation will be calculated. Incidence of antenatal women with normal uterine normal doppler at 11-14 weeks developing preeclampsia and foetal growth restriction will be calculated. For evaluating the association of maternal factors related to development of pre-eclampsia and foetal growth restriction, chi square test will be used for qualitative variables and t test/ANOVA will be used for quantitative variables. Significance level will be set as  $p < 0.05$ .

## RESULTS

Among the 164-study population majority, as depicted in the Figure 1, were aged 25–35 years (76.2%), with a nearly even split between rural (47.6%) and urban (52.4%) residences. Educational status was also balanced, with 52.4% being non-graduates. Most participants belonged to the lower middle class (54.9%). Regarding BMI, 41.5% had normal weight, while 36% were overweight and 15.8% fell into various obesity classes. Nearly half were primigravida (48.2%), and the most common gestational age at assessment was 12–12+6 weeks (58.5%) (Table 1).

A history of FGR was the most prevalent, reported in 28.2% of participants, followed closely by PCOS at 26.8%. A quarter (25.9%) had experienced previous abortions, while a smaller proportion (7.9%) reported a history of preeclampsia as shown in Figure 2.

The present pregnancy outcomes, as marked in the Figure 3, reveal a high prevalence of gestational complications. Gestational diabetes mellitus (GDM) was the most common, affecting 41.5%, followed by fetal growth restriction (FGR) in 36%, with the majority being stage I (94.93%). Small for gestational age (SGA) infants were noted in 40.2%, and gestational hypertension occurred in 27.4% of cases. Preeclampsia and HELLP syndrome were less frequent, at 7.3% and 0.6% respectively. Vaginal delivery was the predominant mode (66.5%), while 33.5% underwent caesarean section. Postpartum hemorrhage (PPH) was reported in 18.9%. Perinatal outcomes showed that 59.1% of neonates required NICU admission, 25% developed respiratory distress syndrome (RDS), and 19.5% had abnormal APGAR scores, indicating substantial neonatal morbidity.

Inferring from the Table 2, preeclampsia was significantly more common among women with higher BMI only 8.3% of preeclamptic women had normal weight compared to 51.3% in the non-preeclampsia group, while 25% had obesity class I and another 25% had obesity class II/III (versus 11.2% and 2% in non-preeclampsia, respectively).

Additionally, 58.3% of women with preeclampsia had PCOS, compared to 24.3% without preeclampsia. In contrast, FGR showed no statistically significant associations, though it was slightly more prevalent among women aged 25–35 years (81.4%), those with obesity class II/III (8.5%), and those without PCOS (77.8%).

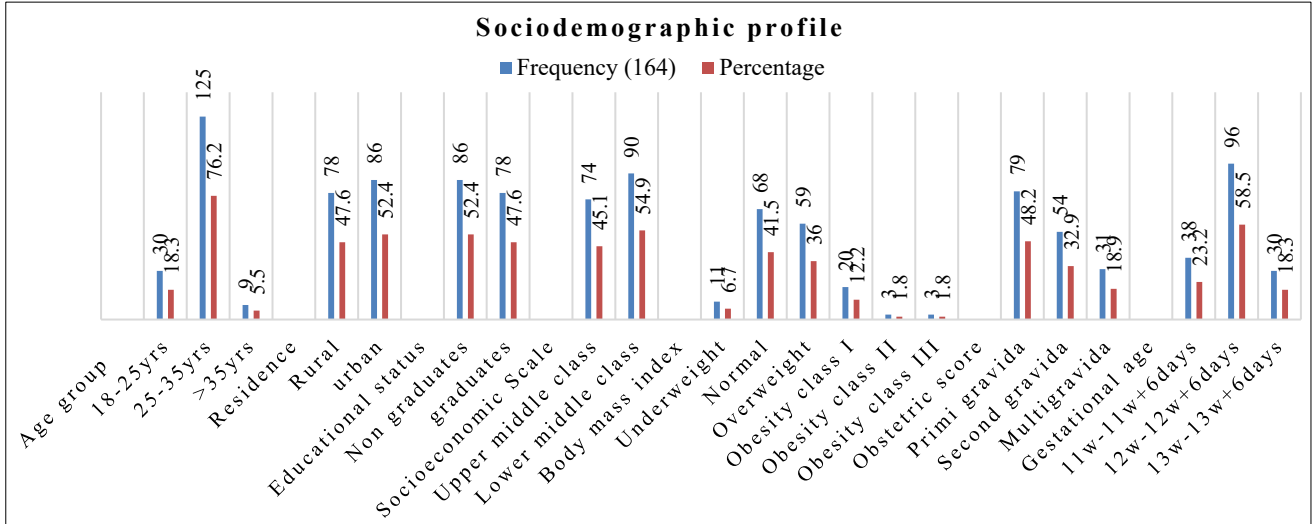


Figure 1: Representing the sociodemographic factors.

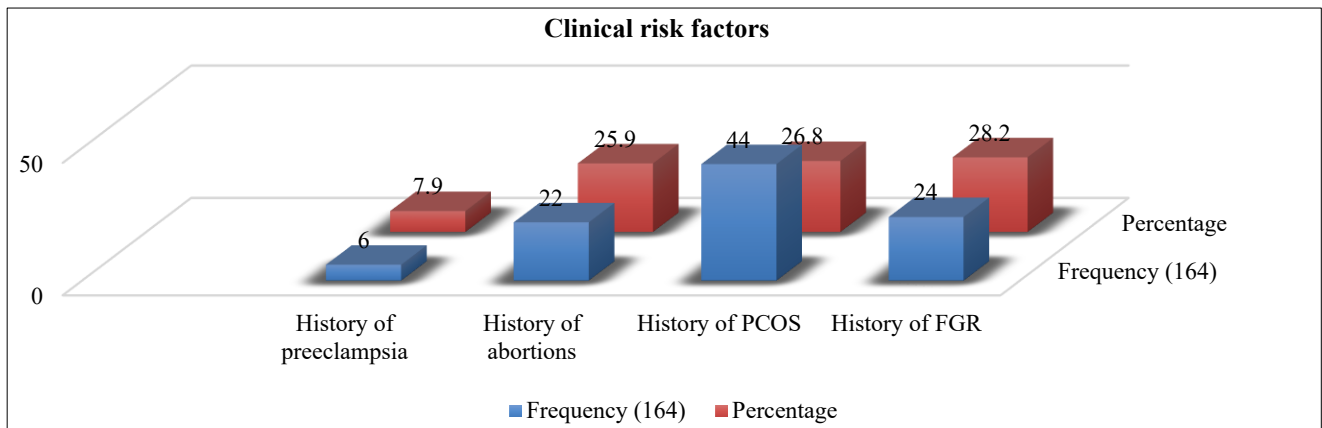


Figure 2: Representing the clinical risk factors.

Table 1: Representing the sociodemographic factors.

Variables	Category	Frequency	Percent
Age group (years)	18-25	30	18.3
	25-35	125	76.2
	≥35	9	5.5
Residence	Rural	78	47.6
	Urban	86	52.4
Education	Non graduates	86	52.4
	Graduates	78	47.6
Socioeconomic scale	Upper middle class	74	45.1
	Lower middle class	90	54.9
Obstetric score	Primi gravida	79	48.2
	Second gravida	54	32.9
	Multi gravida	31	18.9

Continued.

Variables	Category	Frequency	Percent
Period of gestation	11 weeks – 11 weeks + 6 days	38	23.2
	12 weeks – 12 weeks + 6 days	96	58.5
	13 weeks – 13 weeks + 6 days	30	18.3
BMI	Underweight	11	6.7
	Normal weight	68	41.5
	Overweight	59	36
	Obesity class I	20	12.2
	Obesity class II	3	1.8
	Obesity class III	3	1.8

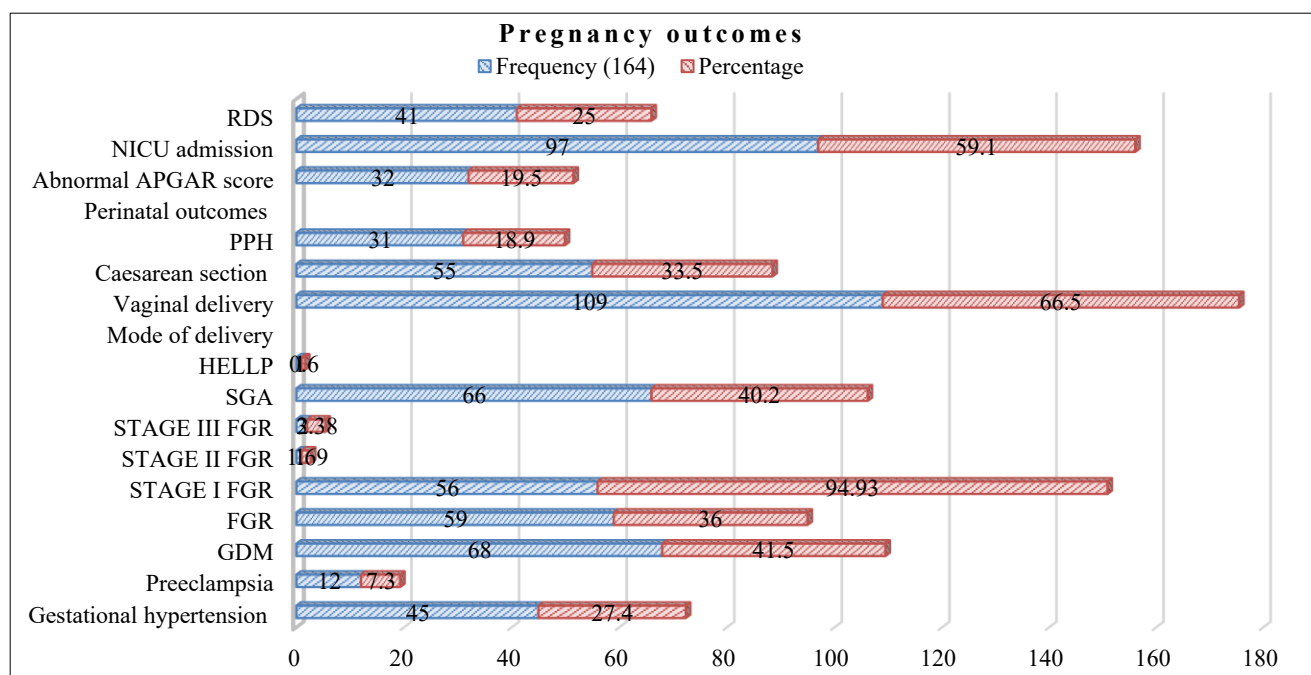


Figure 3: Representing the present pregnancy outcomes.

Preeclampsia was significantly more common in FGR cases (20.3% versus 0%,  $p < 0.001$ ). Gestational hypertension (33.9% versus 23.8%) and GDM (37.3% versus 43.8%) showed no significant differences between FGR and non-FGR groups, depicted in Table 3.

As shown in Table 4, gestational diabetes mellitus (GDM) showed a significant association with obstetric score and socioeconomic status. GDM was more common among multigravidas (25% versus 14.6% in non-GDM;  $p = 0.04$ ) and among women from upper middle class (54.4% versus 38.5%;  $p = 0.044$ ). No significant associations were found between gestational hypertension (G.HTN) or small for gestational age (SGA) and maternal age, education, BMI, PCOS, or history of FGR or abortion. Although not

statistically significant, SGA was more frequent among younger women (24.2% in 18–25 years) and those with a history of FGR (15.2%). Comparing maternal and fetal outcomes based on history of preeclampsia as in Table 5, women with a history of preeclampsia had higher rates of recurrent preeclampsia (33.3% versus 6.3%), FGR (66.7% versus 34.8%), gestational hypertension (33.3% versus 27.2%), and small for gestational age (SGA) infants (100% versus 62.1%), though none of these differences reached statistical significance. Interestingly, gestational diabetes mellitus (GDM) was less common in those with a history of preeclampsia (16.7% versus 42.4%). Overall, while trends suggest increased risk of adverse outcomes with prior preeclampsia, statistical significance was not achieved.

Table 2: Association of preeclampsia FGR with maternal factors.

Variables	Category	No preeclampsia	Pre-eclampsia	P value	No FGR	FGR	P value
Age group (years)	18-25	28 (18.4)	2 (16.7)	0.24	21 (20)	9 (15.3)	0.566
	25-35	117 (77)	8 (66.6)		77 (73.3)	48 (81.4)	
	≥35	7 (4.6)	2 (16.7)		7 (6.7)	2 (3.4)	

Continued.

Variables	Category	No preeclampsia	Pre-eclampsia	P value	No FGR	FGR	P value
<b>Education</b>	Non-graduates	79 (52)	7 (58.3)	0.671	57 (54.3)	30 (50.8)	0.672
	Graduates	73 (48)	5 (41.7)		48 (45.7)	29 (49.2)	
<b>OBS score</b>	Primi	76 (50)	3 (25)	0.145	47 (44.8)	32 (54.2)	0.506
	Second	47 (30.9)	7 (58.3)		37 (35.2)	17 (28.8)	
	Multi	29 (19.1)	2 (16.7)		21 (20)	10 (16.9)	
<b>BMI</b>	Normal weight	78 (51.3)	1 (8.3)	<0.001*	54 (51.4)	25 (42.4)	0.506
	Overweight	54 (35.5)	5 (41.7)		39 (37.1)	20 (33.9)	
	Obesity class I	17 (11.2)	3 (25)		11 (10.5)	9 (15.3)	
	Obesity class II and III	3 (2)	3 (25)		1 (1)	5 (8.5)	
<b>SES</b>	Lower middle class	83 (54.6)	7 (58.3)	0.803	57 (54.3)	33 (55.9)	0.839
	Upper middle class	69 (45.4)	5 (41.7)		48 (45.7)	26 (44.1)	
<b>History of FGR</b>	No	56 (73.7)	5 (55.6)	0.221	115 (96.6)	43 (95.6)	0.742
	Yes	20 (26.3)	4 (44.4)		4 (3.4)	2 (4.4)	
<b>History of Abortion</b>	No	58 (76.3)	5 (55.6)	0.229	101 (84.9)	41 (91.1)	0.296
	Yes	18 (23.7)	4 (44.4)		18 (15.1)	4 (8.9)	
<b>PCOS</b>	No	115 (75.7)	5 (41.7)	0.017*	85 (71.4)	35 (77.8)	0.413
	Yes	37 (24.3)	7 (58.3)		34 (28.6)	10 (22.2)	
<b>Obesity</b>	No	121 (79.6)	7 (58.3)	0.093	93 (78.2)	35 (77.8)	0.958
	Yes	31 (20.4)	5 (41.7)				

\*Statistically significant

**Table 3: Association of FGR with maternal complications.**

Variables	Category	Non FGR, N (%)	FGR, N (%)	P value
<b>Preeclampsia</b>	No	105 (100)	47 (79.7)	<0.001*
	Yes	0 (0)	12 (20.3)	
<b>Gestational hypertension</b>	No	80 (76.2)	39 (66.1)	0.165
	Yes	25 (23.8)	20 (33.9)	
<b>Gestational diabetes mellitus</b>	No	59 (56.2)	37 (62.7)	0.416
	Yes	46 (43.8)	22 (37.3)	

\*Statistically significant

**Table 4: Association of GHTN, GDM and SGA with maternal factors.**

Variables	Category	No G.HTN	G.HTN	P value	No GDM	GDM	P value	Non-SGA	SGA	P value
<b>Age group (years)</b>	18-25	21 (17.6)	9 (20)	0.948	19 (19.8)	11 (16.2)	0.089	5 (12.8)	16 (24.2)	0.338
	25-35	91 (76.5)	34 (75.6)		75 (78.1)	50 (73.5)		31 (79.5)	46 (69.7)	
	≥35	7 (5.9)	2 (4.4)		2 (2.1)	7 (10.3)		3 (7.7)	4 (6.1)	
<b>Education</b>	Non-graduates	66 (55.5)	21 (46.7)	0.314	55 (57.3)	32 (47.1)	0.196	20 (51.3)	37 (56.1)	0.526
	Graduates	53 (44.5)	24 (53.3)		41 (42.7)	36 (52.9)		19 (48.7)	29 (43.9)	
<b>OBS Score</b>	Primi	52 (43.7)	27 (60)	0.172	54 (56.3)	25 (36.8)	0.04*	16 (41)	31 (47)	0.268
	Second	43 (36.1)	11 (24.4)		28 (29.2)	26 (38.2)		12 (30.8)	25 (37.9)	

Continued.

Variables	Category	No G.HTN	G.HTN	P value	No GDM	GDM	P value	Non-SGA	SGA	P value
	Multi	24 (20.2)	7 (15.6)		14 (14.6)	17 (25)		11 (28.2)	10 (15.2)	
BMI	Normal weight	63 (52.9)	16 (35.6)	0.506	52 (54.2)	27 (39.7)	0.276	21 (53.8)	33 (50)	0.433
	Overweight	39 (32.8)	20 (44.4)		32 (33.3)	27 (39.7)		12 (30.8)	27 (40.9)	
	Obesity class I	11 (9.2)	9 (20)		9 (9.4)	11 (16.2)		6 (15.4)	5 (7.6)	
	Obesity class II and III	6 (5)	0 (0)		3 (3.1)	3 (4.4)		0 (0)	1 (1.5)	
SES	Lower middle class	70 (58.8)	20 (44.4)	0.09	59 (61.5)	31 (45.6)	0.044*	21 (53.8)	36 (54.5)	0.945
	Upper middle class	49 (41.2)	25 (55.6)		37 (38.5)	37 (54.4)		18 (46.2)	30 (45.5)	
History of FGR	No	103 (86.6)	37 (82.2)	0.484	86 (89.6)	54 (79.4)	0.069	37 (94.9)	56 (84.8)	0.203
	Yes	16 (13.4)	8 (17.8)		10 (10.4)	14 (20.6)		2 (5.1)	10 (15.2)	
History of abortion	No	101 (84.9)	41 (91.1)	0.296	85 (88.5)	57 (83.8)	0.382	34 (87.2)	57 (86.4)	0.905
	Yes	18 (15.1)	4 (8.9)		11 (11.5)	11 (16.2)		5 (12.8)	9 (13.6)	
PCOS	No	85 (71.4)	35 (77.8)	0.413	73 (76)	47 (69.1)	0.324	281 (71.8)	49 (74.2)	0.799
	Yes	34 (28.6)	10 (22.2)		23 (24)	21 (30.9)		11 (28.2)	17 (25.8)	
Obesity	No	93 (78.2)	35 (77.8)	0.959	79 (82.3)	49 (72.1)	0.119	31 (79.5)	56 (84.8)	0.084
	Yes	26 (21.8)	10 (22.2)		17 (17.7)	19 (27.9)		8 (20.5)	10 (15.2)	

\*Statistically significant

**Table 5: Association of maternal and fetal outcomes based on history of preeclampsia.**

Variables	Category	No history of preeclampsia	History of pre-eclampsia	P value
Preeclampsia	No	148 (93.7)	4 (66.7)	0.063
	Yes	10 (6.3)	2 (33.3)	
FGR	No	103 (65.2)	2 (33.3)	0.189
	Yes	55 (34.8)	4 (66.7)	
Gestational HTN	No	115 (72.8)	4 (66.7)	0.66
	Yes	43 (27.2)	2 (33.3)	
GDM	No	81 (57.6)	5 (83.3)	0.206
	Yes	67 (42.4)	1 (16.7)	
SGA	No	39 (37.9)	0 (0)	0.529
	Yes	64 (62.1)	2 (100)	

Table 6 compares maternal characteristics with mode of delivery and NICU admissions. Caesarean section was significantly more common among women aged  $\geq 35$  years (12.7% versus 1.8%) and those with a history of abortion (21.8% versus 9.2%), while primigravidas were more likely to have normal deliveries (56% versus 32.7%;

$p=0.009$ ). NICU admissions were more frequent among infants born to older mothers (8.2% in  $\geq 35$  years) and those with higher BMI or a history of FGR, though these associations were not statistically significant. No significant differences were observed in education, socioeconomic status, PCOS, or obesity across delivery mode or NICU admission groups.

**Table 6: Association of maternal factors with mode of delivery and fetal NICU admission.**

Variables	Category	Normal	Caesarean section	P value	No NICU admission	NICU admission	P value
<b>Age group (years)</b>	18-25	26 (23.9)	4 (7.3)	<0.001*	15 (22.4)	15 (15.5)	0.115
	25-35	81 (74.3)	44 (80)		51 (76.1)	74 (76.3)	
	≥35	2 (1.8)	7 (12.7)		1 (1.5)	8 (8.2)	
<b>Education</b>	Non-graduates	55 (50.5)	32 (58.2)	0.349	36 (53.7)	51 (52.6)	0.884
	Graduates	54 (49.5)	23 (41.8)		31 (46.3)	46 (47.4)	
<b>OBS score</b>	Primi	91 (56)	18 (32.7)	0.009*	37 (55.2)	42 (43.3)	0.295
	Second	33 (30.3)	21 (38.2)		20 (29.9)	34 (35.1)	
	Multi	15 (13.8)	16 (29.1)		10 (14.9)	21 (21.6)	
<b>BMI</b>	Normal weight	54 (49.5)	25 (45.5)	0.183	36 (53.7)	43 (44.3)	0.400
	Overweight	42 (38.5)	17 (30.9)		24 (35.8)	35 (36.1)	
	Obesity class I	11 (10.1)	9 (16.4)		5 (7.5)	15 (15.5)	
	Obesity class II and III	2 (1.8)	4 (7.3)		2 (3)	4 (4.1)	
<b>SES</b>	Lower middle class	61 (56)	29 (52.7)	0.694	40 (59.7)	50 (51.5)	0.302
	Upper middle class	48 (44)	26 (47.3)		27 (40.3)	47 (48.5)	
<b>History of FGR</b>	No	94 (86.2)	46 (83.6)	0.656	No	Yes	0.087
	Yes	15 (13.8)	9 (16.4)		61 (91)	79 (81.4)	
<b>History of abortion</b>	No	99 (90.8)	43 (78.2)	0.02*	6 (9)	18 (18.6)	0.354
	Yes	10 (9.2)	12 (21.8)		60 (89.6)	82 (84.5)	
<b>History of PCOS</b>	No	82 (75.2)	38 (69.1)	0.402	7 (10.4)	15 (15.5)	0.993
	Yes	27 (24.8)	17 (30.9)		49 (73.1)	71 (73.2)	
<b>Obesity</b>	No	89 (81.7)	39 (70.9)	0.117	18 (26.9)	26 (26.8)	0.299
	Yes	20 (18.3)	16 (29.1)		55 (82.1)	73 (75.3)	

\*Statistically significant

## DISCUSSION

This study was conducted at a tertiary care centre in Southern Kerala among 164 antenatal women enrolled after applying inclusion and exclusion criteria. Participants were followed until delivery, with antenatal and immediate postnatal events recorded. The mean uterine artery PI, measured during the first-trimester ultrasound (11–14 weeks), was assessed for its predictive value in PE and FGR. Only women with normal uterine artery PI values, below the 95th centile, were included.

The incidence of PE was 12 (7.3%), comparable to Gupta et al who reported 12.12%.<sup>6</sup> FGR occurred in 59 cases (36%), with 56 (94.96%) classified as stage I by Barcelona criteria. Statistical analysis showed no significant association ( $p=0.976$ ), suggesting that larger studies may be required to establish an optimal PI cut-off.

Hypertensive disorders were observed in 54/164 (34.7%), including 45 (27.4%) with gestational hypertension and 12 (7.3%) with PE. All PE cases were associated with FGR, with Pearson chi-square test showing significance ( $p<0.001$ ), highlighting the need diligent follow-up even in those who had normal uterine artery Doppler PI at 11–14weeks scan.

GDM was more common, affecting 68 (41.5%), likely due to prior history, obesity, PCOS, and the diabetic-prone Indian population.

Small for gestational age (SGA) was noted in 66 (40.2%), higher than FGR incidence. Among 105 antenatal women, 66 (62.8%) had fetuses with AC and EFW below the 10th centile in third-trimester scans, but did not progress to FGR. These findings emphasize that normal uterine artery Doppler in the first trimester does not preclude complications such as PE, FGR, GDM, and SGA, warranting stringent monitoring.

Age distribution showed most participants (76.2%) were 25–35 years, considered optimal for reproduction but still at risk due to obesity or prior complications. Younger women (18–25 years, 18.3%) may face placental development issues, while advanced maternal age ( $\geq 35$  years, 5.5%) carries vascular risks. No significant association was found between age and PE ( $p=0.24$ ) or FGR ( $p=0.566$ ). However, maternal age was significantly associated with mode of termination ( $p<0.001$ ), with caesarean section highest (80%) in the 25–35 age group.

Rural participants comprised 47.6% and urban 52.4%, reflecting better urban access to antenatal care but highlighting rural healthcare needs. Jabeen et al reported

lower PE incidence in urban areas, while Lijima et al found higher maternal complications in urban populations.<sup>7,8</sup> Jabeen also noted higher FGR prevalence in rural women, higher percentage of small for gestational age and adverse outcomes such as stillbirth.<sup>7,9</sup>

Educational distribution showed 52.4% non-graduates and 47.6% graduates. Education influenced health awareness and antenatal care-seeking, with significant association found between education and gestational age at termination ( $p=0.03$ ). Graduates were more likely to access care and follow medical advice, reducing risks of PE and FGR.

Socioeconomic distribution revealed 54.9% lower middle class and 45.1% upper middle class, indicating moderate economic stability. Lower middle-class women may face financial constraints and limited healthcare access, which can increase the risk of complications.<sup>9</sup>

Obstetric score distribution showed 48.2% primigravida, 32.9% second gravida, and 18.9% multigravida. PE incidence was higher in second gravida (58.3%), while FGR was more common in primigravida (54.2%), though not statistically significant. GDM showed significant association ( $p=0.04$ ), with similar incidence in primi (36.8%) and second gravida (38.2%). Mode of termination was also significant ( $p=0.009$ ), with higher Caesarean rates in second gravida.

BMI distribution showed 41.5% normal weight, 36% overweight, 12.2% obesity class I, 1.8% each in obesity class II and III, and 6.7% underweight. Most participants were within healthy or overweight ranges, but obesity increased risks of PE and adverse outcomes. PE incidence was significantly associated with pre-pregnancy BMI ( $p<0.001$ ). The study by Oros et al reported that obesity is associated with 64% increase of developing preeclampsia (aOR 1.64, 95% CI: 1.19-2.26). Also predicts the higher risk of adverse pregnancy complications, increased neonatal morbidity low APGAR score.<sup>10</sup>

Clinical risk factors included history of PE in 6 (7.9%) women. Despite normal uterine artery Doppler at 11–14 weeks, these women remained at risk for gestational hypertension, PE, and FGR, with associations of 33.3% ( $p=0.66$ ), 33.3% ( $p=0.063$ ), and 66.7% ( $p=0.189$ ), respectively. Two developed SGA, highlighting the need for close monitoring even without statistical significance. The study by Coban et al concluded that preeclampsia recurrence in 70 patients (55.5%) during the next pregnancies and among which 55.7% developed severe preeclampsia.<sup>11</sup> The study published by Gottardi et al reported 20.8% of women among 107 study sample developed preeclampsia in subsequent pregnancy and 10.4% experienced severe preeclampsia before 34 weeks. They concluded that those with preeclampsia before 26 weeks have increased risk of adverse outcomes and recurrent preeclampsia.<sup>12</sup>

A history of FGR in previous pregnancy was noted in 24 (28.2%) women. Recurrence of FGR was observed in 2 (4.4%), with Chi-square test showing no statistical significance ( $p=0.742$ ). Gestational hypertension occurred in 8 (17.8%) and SGA in 10 (15.2%), though none were statistically significant. Soudian et al reported a 20% recurrence of FGR in 200 singleton pregnancies at 11–13 weeks, while Ananth et al found higher recurrence risk (24.3% versus 6.1%) with an odds ratio of 3.9.<sup>13,14</sup>

A history of abortion was present in 22 (25.9%). Associations with PE (44.4%), FGR (8.9%), GDM (16.2%), SGA (13.6%), and adverse neonatal outcomes (15.5%) were not statistically significant. Only mode of termination showed correlation ( $p=0.02$ ). Jia et al reported increased risks with prior abortion: PE (OR 2.06), preterm delivery (OR 1.80), caesarean section (OR 1.47), and NICU admission (OR 1.39).<sup>15</sup>

PCOS was present in 26.8% of participants. Significant association was found with PE (58.3%,  $p=0.017$ ). FGR (22.2%), gestational hypertension (22.2%), GDM (30.9%), SGA (25.8%), and NICU admission (26.8%) were observed but not statistically significant. Valdimarsdottir et al. reported increased PE risk in PCOS (adjusted OR 1.29), with stronger association for early-onset PE (OR 1.64).<sup>16</sup>

Obesity prevalence was 22%. Associations included PE (41.7%,  $p=0.093$ ), FGR (22.2%,  $p=0.958$ ), gestational hypertension (22.2%,  $p=0.959$ ), GDM (27.9%,  $p=0.119$ ), SGA (15.2%,  $p=0.084$ ), caesarean section (29.1%,  $p=0.117$ ), preterm termination (19.4%,  $p=0.127$ ), and NICU admission (24.7%), none statistically significant. Baeten et al confirmed obesity as a strong risk factor for PE and adverse pregnancy outcomes.<sup>17</sup>

## CONCLUSION

The study confirms that even if the mean uterine artery Doppler screening at 11–14 weeks of gestation is normal there is risk for PE and FGR, marking the importance of regular monitoring of women with borderline PI values which can help in early detection of placental insufficiency and prevent adverse fetal outcomes. Combining uterine artery Doppler findings with maternal factors like history of preeclampsia, obesity, and polycystic ovary syndrome (PCOS) can enhance predictive accuracy. The association between higher BMI and increased PE and FGR risk underscores the importance of nutritional counselling and weight management in preconception care.

The findings pave the way for further research on biochemical markers in combination with Doppler studies to enhance the early prediction of PE and FGR in our population where we lack such literatures and to enhance preventive strategies.

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