International Journal of Reproduction, Contraception, Obstetrics and Gynecology
Kuttiamu S et al. Int J Reprod Contracept Obstet Gynecol. 2025 Dec;14(12):4259-4262
www.ijrcog.org
pISSN 2320-1770 | eISSN 2320-1789

DOI: https://dx.doi.org/10.18203/2320-1770.ijrcog20253893

Original Research Article

Gestational trends in uterine artery pulsatility index and maternal blood pressure among pregnant women at 11-14 weeks to 34 weeks of gestation

Shahna Kuttiamu[1]*, M. R. Balachandran Nair[1], Binoj Varghese V.[1], Lola Ramachandran[2]

[1]Department of Radiodiagnosis, Jubilee Mission Medical College and Research Institute, Kerala, India
[2]Department of Obstetrics and Gynaecology, Jubilee Mission Medical College and Research Institute, Kerala, India

Received: 09 October 2025
Accepted: 05 November 2025

***Correspondence:**
Dr. Shahna Kuttiamu,
E-mail: zaaraonline@gmail.com

ABSTRACT

Background: Pre-eclampsia (PE) and fetal growth restriction (FGR) are significant obstetric complications associated with impaired placental perfusion and adverse maternal and perinatal outcomes. Uterine artery pulsatility index (PI) and maternal mean arterial pressure (MAP) are established biophysical markers for predicting these conditions. However, longitudinal evaluation of these parameters in low-resource populations remains limited. This study aimed to assess gestational trends in uterine artery PI and MAP from 11–14 weeks to 34 weeks of gestation and their association with pregnancy outcomes.
Methods: This prospective observational study was conducted over 18 months at a private medical college in Kerala, India. Pregnant women with singleton pregnancies at 11–14 weeks undergoing routine nuchal translucency scans were enrolled (n=128). Uterine artery Doppler and MAP were measured at 11–14, 20–24 and 30–34 weeks of gestation. PI was obtained using standard Doppler techniques and MAP was calculated from four arm measurements. Data were analyzed using paired-samples t tests, with $p<0.05$ considered statistically significant.
Results: The mean uterine artery PI decreased progressively from 1.6±0.4 at 11–14 weeks to 1.1±0.4 at 20–24 weeks and further to 0.8±0.2 at 30–34 weeks ($p<0.01$). MAP remained relatively stable across gestation, within normal physiological ranges. The cohort was predominantly young (21–30 years, 60.9%) and primigravida (57.8%).
Conclusions: Uterine artery PI shows a significant progressive decline with advancing gestation, reflecting normal uteroplacental adaptation, while MAP remains stable, indicating adequate cardiovascular adjustment. These findings support the utility of uterine artery Doppler and MAP monitoring in predicting adverse pregnancy outcomes and highlight the need for population-specific reference ranges.

Keywords: Fetal growth restriction, Mean arterial pressure, Pre-eclampsia, Pregnancy, Uterine artery pulsatility index

INTRODUCTION

PE is a hypertensive disorder of pregnancy characterized by new-onset hypertension and proteinuria or end-organ dysfunction after 20 weeks of gestation. It remains one of the leading causes of maternal and perinatal morbidity and mortality worldwide, affecting approximately 2–8% of pregnancies.[1] Hypertensive disorders in pregnancy account for an estimated 14% of all maternal deaths globally and Southeast Asia recorded the highest average regional prevalence, with 136.8 cases per 100,000 women of reproductive age.[2,3] The mortality is even higher when the condition is of early onset and in low- and middle-income countries (LMIC).[4] In LMICs, hypertensive disorders in pregnancy are associated with 10-15% of direct maternal mortality.[5] With respect to neonatal mortality, globally, 500,000 babies die each year as a result of this disorder among their mothers.[6] Intrauterine growth

restriction (IUGR), now referred to as FGR, another significant obstetric complication, results from impaired placental perfusion and fetal hypoxia, contributing to perinatal morbidity and long-term health consequences for the offspring.[7]

Current guidelines advocate for a multimodal approach in PE screening, integrating biophysical (uterine artery PI, MAP) and biochemical markers (placental growth factor, pregnancy-associated plasma protein-A) to enhance predictive performance.[8] The Fetal Medicine Foundation (FMF) has developed predictive models incorporating these parameters, demonstrating high detection rates for early-onset PE.[9] Despite advancements, challenges remain in implementing universal screening strategies due to resource constraints, variability in doppler expertise and population-specific differences in predictive thresholds.

While individual markers such as uterine artery PI and MAP have demonstrated predictive potential, their combined utility remains under explored in certain populations, particularly in low-resource settings. This study aims to address these gaps by evaluating uterine artery PI and MAP longitudinally from 11–14 weeks to 34 weeks of gestation to evaluate the change in PI value and MAP during pregnancy and to find the association between the change in uterine artery PI value with MAP with the development of PE and IUGR during pregnancy. To evaluate the changes in uterine artery pulsatility index (PI) and maternal mean arterial pressure (MAP) during pregnancy.

METHODS

This hospital-based prospective observational study was conducted in the Department of Radiodiagnosis in collaboration with the Department of Obstetrics and Gynaecology, Private Medical College, Thrissur, Kerala, India, over a period of 18 months from January 1st, 2024-September 1st 2025. Pregnant women at 11–14 weeks of gestation attending for routine nuchal translucency (NT) scan were recruited consecutively after obtaining institutional ethics committee approval and written informed consent. Singleton pregnancies were included, while women with multiple gestation, known congenital or chromosomal abnormalities, chronic kidney disease, chronic hypertension or unwillingness for follow up were excluded. Based on prior data with 95% confidence level and 80% power, the minimum sample size was calculated as 100, accounting for 10% attrition, 110 participants were enrolled.[10]

At baseline, demographic details, clinical history and physical measurements were recorded in a structured proforma. Antenatal ultrasound was performed using a 3.5–5.0 MHz curvilinear transducer. Uterine artery Doppler waveforms were obtained with an insonation angle <30° and 2 mm sample volume and the pulsatility index (PI) was derived from the waveform using PSV, EDV and mean velocity. Maternal mean arterial pressure (MAP) was measured with an automated device in the sitting position after 5 minutes of rest, using appropriately sized cuffs based on mid-arm circumference. Two simultaneous BP recordings were taken in both arms and MAP was calculated as the average of four readings. Each participant was re-evaluated at 20–24 weeks and 30–34 weeks for uterine artery PI and MAP.

The study variables included maternal demographic and clinical factors, PI and MAP at the three gestational time points. Data were analyzed using SPSS version 26. Continuous variables were expressed as mean (SD) or median (IQR) and categorical variables as frequency and percentage. Changes in PI and MAP across gestation were assessed using paired-samples t test. A p value <0.05 was considered statistically significant.

RESULTS

A total of 128 individuals participated in the study. The majority of participants (60.9%) were between 21 and 30 years of age, followed by 31.3% who were above 30 years and only 7.8% were 20 years or younger. With respect to parity, 57.8% were primigravida and 42.2% were multigravida, indicating that most participants were young women in their first pregnancy (Table 1).

The mean uterine artery pulsatility index (PI) showed a progressive decline with advancing gestational age from 1.6±0.4 at 11–14 weeks to 1.1±0.4 at 20–24 weeks and further to 0.8±0.2 at 30–34 weeks indicating a reduction in uterine vascular resistance as pregnancy advances. The observed change was statistically significant ($p<0.01$). The MAP showed minimal variation across trimesters, remaining within the normal physiological range (Table 2).

Table 1: Distribution of study participants according to age and parity (n=128).

Variable	Category	Frequency (%)
Age category (in years)	≤20	10 (7.8)
	21–30	78 (60.9)
	>30	40 (31.3)
Parity	Primigravida	74 (57.8)
	Multigravida	54 (42.2)

Table 2: Comparison of uterine artery pulsatility index (PI) and mean arterial pressure (MAP) at different periods of gestation.

Time of investigation	Uterine PI Mean (SD)	MAP in mmHg Mean (SD)	P value
11-14 weeks	1.6 (0.4)	81.6 (7.3)	<0.01
20-24 weeks	1.1 (0.4)	79.5 (8.4)	
30-34 weeks	0.8 (0.2)	83.7 (7.1)	

DISCUSSION

This study evaluated uterine artery pulsatility index and mean arterial pressure across different gestational ages in 128 pregnant women, with the majority being young primigravidae. Findings demonstrate a significant progressive decline in uterine artery PI with advancing gestation and stability of MAP across trimesters, consistent with normal physiological adaptation of the uteroplacental circulation during pregnancy.

The study demonstrated a progressive and statistically significant decline in mean uterine artery PI from 1.6±0.4 at 11-14 weeks to 1.1±0.4 at 20-24 weeks and further to 0.8±0.2 at 30-34 weeks ($p<0.01$). These findings align closely with multiple large-scale studies establishing reference ranges for uterine artery Doppler parameters. Gómez et al, published comprehensive reference ranges for uterine artery mean PI from 11-41 weeks of gestation in 620 singleton pregnancies, demonstrating a similar declining trend in PI values throughout pregnancy with gestational age-specific centiles that support our observed pattern.[11]

More recently, Cavoretto et al provided updated reference ranges based on longitudinal serial Doppler measurements in a low-risk population from 10-39 weeks' gestation using multilevel modelling, confirming the expected physiological decline in uterine artery PI throughout pregnancy.[12] Plasencia et al established reference ranges for uterine artery PI at 11-13 weeks' gestation, reporting values comparable to our first-trimester findings and emphasizing the reproducibility of these measurements.[13] The progressive decline in uterine artery PI observed in our study reflects the physiological process of trophoblastic invasion and remodelling of the spiral arteries during pregnancy, transforming high-resistance vessels into low-resistance, high-flow channels. Tan et al demonstrated that uterine artery Doppler pulsatility index in first and second trimesters shows statistically significant differences between normal and adverse pregnancy outcomes, with sensitivity of 97% and specificity of 76.5% in first-trimester screening, highlighting the clinical relevance of the declining PI pattern we observed.[14]

The finding of minimal variation in MAP across trimesters, remaining within the normal physiological range, is consistent with established patterns of blood pressure changes during normal pregnancy. Wright et al conducted a comprehensive study examining MAP across three trimesters in a large cohort of pregnant women, demonstrating that in uncomplicated pregnancies, MAP shows relatively stable values throughout gestation with only modest changes related to maternal characteristics.8 This stability in MAP during normal pregnancy results from a complex interplay of cardiovascular adaptations, where increased cardiac output and blood volume are balanced by decreased systemic vascular resistance due to hormonal influences and the creation of the low-resistance uteroplacental circulation. The combination of normal declining PI values and stable MAP in our study population suggests adequate uteroplacental perfusion and successful cardiovascular adaptation to pregnancy, consistent with the predominantly low-risk cohort of young primigravidas in our study.

CONCLUSION

The current study concludes that uterine artery pulsatility index demonstrates a significant progressive decline with advancing gestational age, from 1.6±0.4 at 11-14 weeks to 0.8±0.2 at 30-34 weeks ($p<0.01$), reflecting normal physiological adaptation of uteroplacental circulation. Mean arterial pressure remained stable across trimesters, indicating appropriate cardiovascular adaptation in this predominantly young primigravida population. These findings are consistent with established literature and confirm the utility of uterine artery Doppler as a reliable marker of placental vascular development. Future research should focus on establishing population-specific reference ranges and correlating Doppler parameters with pregnancy outcomes to enhance the predictive value of these measurements for adverse obstetric complications.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Obstetricians ACo G. Hypertension in pregnancy. Report of the American College of Obstetricians and Gynecologists' task force on hypertension in pregnancy. Obstet Gynecol. 2013;122(5):1122.
2. Jiang L, Tang K, Magee LA, von Dadelszen P, Ekeroma A, Li X, et al. A global view of hypertensive disorders and diabetes mellitus during pregnancy. Nat Rev Endocrinol. 2022;18(12):760-75.

3. Mohapatra I, Harshini N, Samantaray SR, Naik G. Association Between Early Pregnancy Body Mass Index and Gestational Weight Gain in Relation to Neonatal Birth Weight. Cureus. 2022;14(7):27089.
4. Poon LC, Shennan A, Hyett JA, Kapur A, Hadar E, Divakar H, et al. The International Federation of Gynecology and Obstetrics (FIGO) initiative on pre-eclampsia: A pragmatic guide for first-trimester screening and prevention. Int J Gynaecol Obstet. 2019;145(1):1-33.
5. Duley L. Maternal mortality associated with hypertensive disorders of pregnancy in Africa, Asia, Latin America and the Caribbean. Br J Obstet Gynaecol. 1992;99(7):547-53.
6. Kuklina EV, Ayala C, Callaghan WM. Hypertensive disorders and severe obstetric morbidity in the United States. Obstet Gynecol. 2009;113:1299-306.
7. Calkins K, Devaskar SU. Fetal origins of adult disease. Curr Probl Pediatr Adolesc Health Care. 2011;41(6):158-76.
8. Wright D, Syngelaki A, Akolekar R, Poon LC, Nicolaides KH. Competing risks model in screening for preeclampsia by maternal characteristics and medical history. Am J Obstet Gynecol. 2015;213(1):62-2.
9. Poon LC, Shennan A, Hyett JA, Kapur A, Hadar E, Divakar H, et al. The International Federation of Gynecology and Obstetrics (FIGO) initiative on pre-eclampsia: A pragmatic guide for first-trimester screening and prevention. Int J Gynaecol Obstet. 2019;145(1):1-33.
10. Baghel A, Patekar TY, Choorakuttil RM, Sharma LK, Satarkar SR, Gupta A, et al. A Comparison of Changes in the Mean Arterial Blood Pressure and Mean Uterine Artery Pulsatility Index from 11-14 to 19-24 + 6 Gestation Weeks in Low-Risk and High-Risk Asian Indian Pregnant Women. Indian J Radiol Imaging. 2023;33(2):195-200.
11. Gómez O, Figueras F, Fernández S, Bennasar M, Martínez JM, Puerto B, et al. Reference ranges for uterine artery mean pulsatility index at 11-41 weeks of gestation. Ultrasound Obstet Gynecol. 2008;32(2):128-32.
12. Cavoretto PI, Rossi E, Macchi E, Viganò P, Stampalija T, Farina A, et al. Reference ranges for uterine artery pulsatility index from first to third trimester based on serial Doppler measurements: longitudinal cohort study. Ultrasound Obstet Gynecol. 2023;62(3):415-24.
13. Plasencia W, Maiz N, Bonino S, Kaihura C, Nicolaides KH. Uterine artery Doppler at 11 + 0 to 13 + 6 weeks in the prediction of pre-eclampsia. Ultrasound Obstet Gynecol. 2007;30(5):742-9.
14. Tan MY, Poon LC, Rolnik DL, Syngelaki A, de Paco Matallana C, Akolekar R, et al. Prediction and prevention of small-for-gestational-age neonates: evidence from SPREE and ASPRE. Ultrasound Obstet Gynecol. 2018;52(1):52-9.

Cite this article as: Kuttiamu S, Nair MRB, Binoj Varghese V, Ramachandran L. Gestational trends in uterine artery pulsatility index and maternal blood pressure among pregnant women at 11-14 weeks to 34 weeks of gestation. Int J Reprod Contracept Obstet Gynecol 2025;14:4259-62.