

MEAN ARTERIAL PRESSURE IN SECOND TRIMESTER – A PREDICTOR OF PRE-ECLAMPSIA

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ABSTRACT

Background: The aim is to determine whether mean arterial pressure in the second trimester can predict preeclampsia at term. **Materials and Methods:** A prospective observational study was conducted in the Department of Obstetrics and Gynaecology at Stanley Medical College between October 2023 and October 2024. The study recruited 138 patients who attended the Antenatal OPD for regular follow-up in their second trimester. This study did not include patients with pre-existing diagnoses of chronic hypertension, gestational diabetes mellitus, antiphospholipid antibody syndrome, chronic kidney disease, or multiparous women. **Result:** The study participants had a mean age of 25 years. Forty-five participants (33%) developed pre-eclampsia. Receiver Operating Characteristic analysis showed that a mean arterial pressure of 94 mmHg is the best cut-off for predicting pre-eclampsia, with a sensitivity of 89% and a specificity of 98%. **Conclusion:** Mean arterial pressure can be used to predict preeclampsia, and this measurement can be easily done in a resource-limited setting.

INTRODUCTION

Preeclampsia is a pregnancy-related complication occurring during the late second and third trimesters. The incidence of pre-eclampsia ranges from 3% to 7% for primi and 1% to 3% for multigravida.^[1] Preeclampsia is a hypertensive disorder of pregnancy that develops after 20 weeks of gestation and is associated with evidence of maternal organ dysfunction and sometimes fetal growth compromise.^[2]

Although the exact pathogenesis remains uncertain, several maternal risk factors, such as primigravida, obesity, multiple gestation, elderly age, pre-eclampsia during previous pregnancy, family history of preeclampsia, and pre-existing vascular or kidney disease, are known to increase the risk. But the exact mechanism of disease onset still remains unclear.^[3,4] Current antenatal care emphasises early detection and timely treatment of preeclampsia. Women identified as high risk are monitored closely with regular clinical and laboratory assessments to facilitate early diagnosis.^[5] Such patients require intensified surveillance during the peripartum period. Although these measures do not prevent preeclampsia, they may help prevent some complications.^[6]

This highlights the need for simple, reliable methods to predict preeclampsia early. Despite multiple studies, a universally applicable predictive model for preeclampsia has not yet been established, particularly one suitable for low-resource settings.^[7]

Several studies have evaluated second-trimester blood pressure measurements as a potential screening tool for predicting preeclampsia.^[3] Therefore, the present study was undertaken to evaluate the usefulness of second-trimester mean arterial pressure as a simple predictor of preeclampsia.

MATERIALS AND METHODS

Study Design: Prospective observational study

Study Area: Government RSRM Lying-In Hospital, Government Stanley Medical College and Hospital, Chennai, India.

Study population:

Inclusion Criteria:

All pregnant primigravida women in their second trimester who are without comorbidities

Exclusion Criteria:

This study excluded all pregnant women who were already diagnosed with gestational diabetes mellitus, overt diabetes mellitus, or chronic hypertension. Additionally, pregnant women who tested positive for APLA were not included.

Sampling: Convenience Sampling

Follow Up: Mean arterial pressure is recorded in the second trimester, and the patients are being followed up until delivery

Study Period: 1 year (October 2023 to September 2024).

Sample size calculation:

$$N = z^2 \times pq \div d^2$$

Where d is absolute precision and Z = 1.96 (statistical significance constant for 95% confidence interval).
 Based on previous studies, p is taken as 0.9 10
 $N = 1.96 \times 1.96 \times 0.9 \times (1 - 0.09) \div 0.05 \times 0.05$
 $= 3.8416 \times 0.09 \div 0.0025$
 $= 0.3457 \div 0.0025$
 $= 138$

The final sample size is 138

Study procedure: This prospective study was conducted in the Department of Obstetrics and Gynaecology, Government RSRM Lying-In Hospital, Government Stanley Medical College, Chennai, from October 2023 to September 2024 (1 year). After obtaining consent in their native language, participants were recruited according to inclusion and exclusion criteria. Their blood pressure was measured in the second trimester, and they were followed up until delivery. Those diagnosed with preeclampsia, as per the clinician's decision, were identified. The data was entered into Microsoft Excel.

Measurement of Blood Pressure: Blood pressure is measured in sitting posture in a relaxed state with the patient's right arm supported at the level of the heart. An appropriate blood pressure cuff is selected, and three readings are obtained, and the mean blood pressure is calculated using the formula

$$\text{MAP} = \text{DIASTOLIC BLOOD PRESSURE} + \frac{1}{3} (\text{PULSE PRESSURE})$$

Where Pulse pressure = Systolic blood pressure - Diastolic Blood Pressure

The cut-off for predicting preeclampsia was arbitrarily set at MAP >100 based on earlier research.^[10]

Statistical analysis: The necessary information was collected, compiled, and then entered into a Microsoft Excel document. The statistical program JASP was used to assist with the analysis. The mean and standard deviation were used to express all continuous variables. Percentages and proportions were used to express all categorical variables. If the p-value at a 95% confidence interval was less than 0.05, the test was deemed significant. The methodology is depicted in [Figure 1].

RESULTS

Baseline characteristics, vital signs and laboratory parameters of the study population are represented in Table 1. The mean age of the study population was 25 years. Patients with 1+ proteinuria on urine dipstick had an average urine protein-to-creatinine ratio of 1.05, and those with 2+ proteinuria had an average of 1.3. Thirty-three percent of the population developed pre-eclampsia.

The study population is divided into two groups based on the arbitrary MAP cut-off of 100 mm Hg. The incidence of preeclampsia was compared between these groups; the results are shown in Table 2A. Logistic regression was performed to determine whether MAP can predict pre-eclampsia. The results are shown in Table 2B. ROC analysis was performed to assess the predictive performance of MAP for preeclampsia; the results are shown in Table 2C and [Figure 2].

Table 1: Baseline characteristics of the study population

Parameter	n = 138
Age (years), Mean ± S.D.	25 ± 4
Height (cm), Mean ± S.D.	158 ± 9
Weight (kg), Mean ± S.D.	74 ± 11
BMI (kg/m ²), Mean ± S.D.	29.77 ± 4.61
BMI Category, n (%)	
Underweight (<18.50)	1 (1%)
Normal (18.50 to 22.99)	5 (4%)
Overweight (23.00 to 24.99)	17 (12%)
Obese I (25.00 to 29.99)	49 (35%)
Obese II (>30.00)	66 (48%)
Pallor on examination, n (%)	42 (30%)
Pedal Oedema, n (%)	64 (46%)
Pulse rate, Mean ± S.D.	83 ± 9
SBP, Mean ± S.D.	119 ± 12
DBP, Mean ± S.D.	75 ± 11
MAP, Mean ± S.D.	90 ± 11
Haemoglobin (gm/dL), Mean ± S.D.	11 ± 0.9
Platelet count (lakh/cu.mm), Mean ± S.D.	2.6 ± 0.8
Total bilirubin (gm/dL), Mean ± S.D.	0.7 ± 0.3
AST (IU/L), Mean ± S.D.	24 ± 9
ALT (IU/L), Mean ± S.D.	22 ± 11
Total protein (gm/dL), Mean ± S.D.	6.6 ± 1.9
Serum albumin (gm/dL), Mean ± S.D.	3.7 ± 0.6
Urea (mg/dL), Mean ± S.D.	23 ± 5
Creatinine (mg/dL), Mean ± S.D.	0.5 ± 0.2
Uric acid (mg/dL), Median (IQR)	3 (3,4)
LDH (IU/L), Mean ± S.D.	413 ± 126
Urine albumin (Dipstick)	
0	109 (79%)
1+	26 (19%)
2+	3 (2%)

ALT: Alanine Transaminase, AST: Aspartate Transaminase, BMI: Body Mass Index, DBP: Diastolic Blood Pressure, IQR: Interquartile Range, LDH: Lactate Dehydrogenase, MAP: Mean Arterial Pressure, SBP: Systolic Blood Pressure, S.D.: Standard Deviation

Table 2A: Pre-eclampsia vs. MAP

Pre-eclampsia/ MAP > 100mm Hg	Yes	No	Total
Yes	29	1	30
No	16	92	108
Total	45	93	Odd's Ratio = 167 (p<0.01)

Table 2B: Logistic regression analysis

	Regression coefficient (B)	Standard Error	Wald Chi-Square	p-value	Odds ratio
MAP	.341	0.061	31.804	<0.01	1.4
Constant	-32.607	5.732	32.355	<0.01	(1.2, 1.6)

Where n= 138
Cox & Snell 5 square = 0.535
Nagelkerke R square = 0.746

Table 2C: ROC analysis

AUROC	0.958
The best cut-off for MAP	94mmHg
Sensitivity	89%
Specificity	98%

AUROC: Area Under the Receiver Operating Characteristic, MAP: Mean Arterial Pressure, ROC: Receiver Operating Characteristic

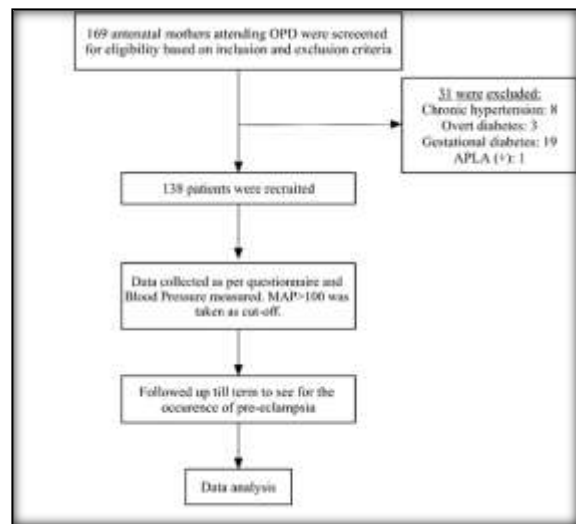


Figure 1: Study procedure

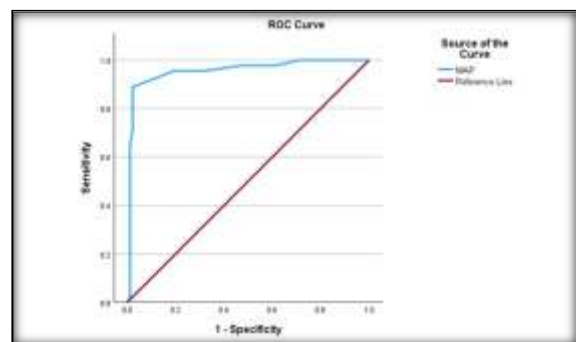


Figure 2: ROC analysis

MAP: Mean Arterial Pressure, ROC: Receiver Operating Characteristic

DISCUSSION

The logistic regression analysis yielded a Nagelkerke R-squared value of 0.746, indicating that MAP is a strong predictor of preeclampsia. ROC analysis

showed that a MAP of 94 mmHg was the best cut-off for predicting preeclampsia. The area under the receiver operating characteristic (ROC) curve (AUROC) was 0.958, with a sensitivity of 89% and a specificity of 98%. This result is consistent with previous studies using a MAP of 100 mmHg as the cut-off for predicting preeclampsia.^[8-20]

Pre-eclampsia remains a significant contributor to maternal morbidity and mortality globally. This study showed a prevalence of 33 % of preeclampsia. This could be because this study was conducted in a tertiary hospital, where more high-risk patients were examined and admitted. Since the aetiology of pre-eclampsia is not established, effective primary prevention strategies remain limited. Mean arterial blood pressure reflects systemic vascular resistance, which increases in preeclampsia due to abnormal placentation. So, measuring mean arterial pressure offers early diagnosis and treatment to prevent further complications.^[21-29]

This study had the advantages of being a prospective observational study conducted in a real-world outpatient setting. This study has limitations, including a single-centre design, a small sample size, and a convenience sampling technique. This study excluded all the associated comorbidities and prothrombotic states. However, obesity was not excluded. Multiple parameters, including pathological biochemical and biophysical abnormalities, are more likely to be captured and beneficial in a screening setting. But these were not captured. Future study designs can combine multiple risk factors into an algorithm to provide an individualised risk assessment.^[30-36]

However, this study found a substantial correlation between the development of preeclampsia later in pregnancy and MAP during the second trimester. The 94 mmHg cut-off is a potentially useful metric for predicting preeclampsia. Accordingly, women who have MAP levels greater than 94 mmHg must be

regarded as high-risk patients and require strict monitoring.^[37-43]

CONCLUSION

Second-trimester mean arterial pressure predicts preeclampsia very well. This method is inexpensive, non-invasive and more feasible than laboratory-based screening approaches, particularly in low-resource settings.

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