ORIGINAL RESEARCH

Blood Pressure Variability as a predictor of maternal and neonatal outcomes in preeclampsia

Ryan Saktika Mulyana[1]*, Tjokorda Gede Astawa Pemayun[1], Ida Ayu Narayani[1], I Putu Gede Danika Adikarya[1], I Gusti Bagus Mulia Agung Pradnyaandara[1], I Gusti Ayu Cintya Paramyta[2]
[1]Department of Obstetrics and Gynecology, Prof. dr. I.G.N.G Ngoerah General Hospital, Denpasar, Bali, Indonesia.
[2]Faculty of Medicine, Udayana University, Denpasar, Bali, Indonesia.

Article Info
Received Jan 5, 2025
Revised May 19, 2025
Accepted Jun 13, 2025
Published Dec 1, 2025

***Corresponding author:**
Ryan Saktika Mulyana
ryan@unud.ac.id

Keywords:
Blood Pressure Variability
Maternal health
Maternal outcomes
Neonatal outcomes
Preeclampsia

ABSTRACT

Objective: Preeclampsia remains a major cause of maternal and perinatal morbidity and mortality worldwide. This study aimed to evaluate the impact of blood pressure variability (BPV) on maternal and neonatal outcomes in preeclamptic patients, emphasizing its potential role in clinical management.

Materials and Methods: A retrospective cohort study was conducted on 40 preeclamptic patients treated at Prof. Dr. I.G.N.G Ngoerah Hospital, Denpasar, Bali, between January 2020 and December 2022. BPV was determined from serial systolic and diastolic blood pressure measurements during antenatal care. Maternal outcomes included length of hospitalization, preterm birth, premature rupture of membranes, eclampsia, postpartum hemorrhage, ICU admission, and composite adverse events. Neonatal outcomes included birth weight, Apgar scores, NICU admission, stillbirth, congenital anomalies, and neonatal death. Statistical analyses were performed using bivariate and multivariate logistic regression methods, with variables of $p < 0.25$ included in final models.

Results: High BPV was significantly associated with increased maternal adverse events (adjusted OR 13.66; 95% CI 2.26–82.43; $p = 0.004$) and neonatal adverse outcomes ($p = 0.011$). Specifically, it correlated with low birth weight ($p < 0.001$), shorter birth length ($p = 0.003$), preterm birth ($p = 0.003$), and higher NICU admission rates ($p = 0.005$). No significant association was observed with fetal distress, intrauterine growth restriction, or neonatal death. The study achieved a statistical power of 86.7%.

Conclusion: Increased BPV in preeclampsia is strongly linked to adverse maternal and neonatal outcomes. Routine BPV monitoring may serve as an important tool for early risk identification and improved obstetric management.

How to cite: Mulyana RS, Pemayun TGA, Narayani IA, et al. Blood Pressure Variability as a predictor of maternal and neonatal outcomes in preeclampsia. Majalah Obstetri & Ginekologi (Journal of Obstetrics & Gynecology Science). 2025;33(3):180-187. doi: 10.20473/mog.V33I32025.180-187.

Highlights:

1. Increased blood pressure variability (BPV) in preeclampsia is associated with a higher risk of maternal complications, such as prolonged hospitalization and eclampsia, as well as neonatal complications, including low birth weight and the need for NICU admission.
2. Incorporating BPV monitoring into routine prenatal care may improve early detection of high-risk cases, allowing for timely interventions to reduce adverse maternal and neonatal outcomes.

INTRODUCTION

Preeclampsia remains a primary contributor to maternal and perinatal mortality worldwide, posing significant health challenges during pregnancy. This condition is marked by elevated blood pressure, proteinuria, and edema, with clinical manifestations ranging from mild to severe. Complications associated with preeclampsia include maternal renal impairment, intrauterine fetal hypoxia, low birth weight, and preterm birth. In 2013, maternal mortality was recorded at 289,000 cases globally, with preeclampsia accounting for 24% of maternal deaths in Indonesia. Perinatal complications frequently linked to preeclampsia include neonatal asphyxia (44%), low birth weight (35.3%), preterm birth (15–67%), intrauterine growth restriction (10–25%), and perinatal mortality (1–2%).[1,2]

In preeclampsia, high blood pressure compromises placental perfusion, leading to insufficient oxygen and nutrient supply to the fetus. This study can develop a fetal growth restriction, intrauterine hypoxia, and also placental abruption.[3] Proper antenatal care is vital for detecting early signs of preeclampsia to prevent progression to severe preeclampsia or eclampsia. Early diagnosis and timely intervention are crucial to minimizing maternal and neonatal morbidity and mortality. Ineffective antenatal care can lead to undiagnosed complications and increased health risks during pregnancy.[4,5]

Blood pressure variability (BPV) refers to the dynamic changes in blood pressure levels over a period of time, reflecting fluctuations influenced by physiological and pathological factors.[6] These fluctuations result from complex interactions between environmental factors (e.g., seasons, stress), physical conditions (e.g., posture, blood volume), and emotional states, as well as the cardiovascular regulatory mechanisms aiming to maintain blood pressure homeostasis.[7] BPV is a physiological phenomenon unique to each individual, reflecting their cardiovascular system's responsiveness to daily challenges. From a clinical perspective, BPV can complicate blood pressure assessment and is considered an independent predictor of cardiovascular risk.[8]

Despite its significance, the role of BPV in predicting adverse maternal and neonatal outcomes in pre-eclampsia remains unclear. Therefore, this study examines the relationship between BPV and maternal and neonatal outcomes in preeclampsia patients treated at Prof. Dr. I.G.N.G Ngoerah Hospital, Denpasar, Bali. The aim is to provide further insight into BPV as a potential prognostic factor in managing preeclampsia and improving patient outcomes.

MATERIALS AND METHODS

This retrospective cohort study examined medical records of 40 patients diagnosed with preeclampsia who received treatment at the fetomaternal clinic of Prof. Dr. I.G.N.G Ngoerah Hospital, Denpasar, Bali, between January 2020 and December 2022. The study included patients with a confirmed preeclampsia diagnosis based on established international criteria and a minimum of two antenatal visits. Patients with incomplete medical records, significant comorbidities, or those who delivered outside the hospital were excluded from the analysis. Ethical approval was obtained from the ethical committee of Udayana University (1302/UN14.2.2.VII. 14/LT/2024).

Blood pressure variability (BPV) was assessed using systolic and diastolic blood pressure measurements obtained during antenatal visits, following standardized calculation methods. Maternal outcomes evaluated included length of hospital stay, incidence of preterm birth, premature rupture of membranes, occurrence of eclampsia, postpartum hemorrhage, and other severe maternal complications. Neonatal outcomes analyzed comprised birth weight, birth length, Apgar scores at one and five minutes, NICU admission, stillbirth, neonatal mortality, and congenital anomalies. Statistical analysis was performed using SPSS version 26.0, incorporating descriptive statistics, normality assessments, homogeneity tests, comparative analyses (independent t-tests, chi-square tests), and multivariate logistic regression models. Normality of continuous variables was assessed using the Shapiro-Wilk test, and homogeneity of variance was evaluated using Levene's test. Independent t-tests were applied for the comparison of normally distributed continuous variables, while the Mann-Whitney U test was used for non-normally distributed data. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate.

Multivariate logistic regression analyses were conducted to identify factors associated with BPV, maternal adverse outcomes, and neonatal adverse outcomes. Variables with a p-value < 0.25 in bivariate analysis were included in the multivariate models. For BPV, a history of preeclampsia/hypertensive disorders of pregnancy was analyzed (OR 0.6, 95% CI 0.143–2.511; p = 0.484), although no significant association was found. Regarding maternal adverse events, multi-variate analysis identified low gravida as a protective factor (OR 0.16, 95% CI 0.029–0.874; p = 0.034) and high BPV as a strong risk factor (OR 13.658, 95% CI 2.263–82.425; p = 0.004). For neonatal adverse events, high BPV (OR 1.857, 95% CI 0.741–4.655; p = 0.187) and a history of cardiac disease (OR 0.2, 95% CI 0.023–

1.712; p = 0.142) were analyzed; however, neither was found to be statistically significant. Statistical significance was set at a p-value < 0.05. A post hoc power analysis demonstrated that the sample size was adequate, with a calculated power of 86.7% for detecting differences in maternal adverse events between high and low BPV groups.

RESULTS AND DISCUSSION

The study was conducted at Prof. Dr. I.G.N.G Ngoerah Hospital, Denpasar, from March to May 2024. A total of 40 preeclampsia cases from patients visiting the fetomaternal clinic between 2020 and 2022 were selected as the sample. The collected data were then analyzed accordingly.

General characteristics

The general characteristics of the study sample were analyzed based on maternal age at delivery, gravida, primiparity, education level, and medical histories, including preeclampsia or hypertensive disorders of pregnancy (PE/HDK), hypertension, diabetes mellitus (DM), cardiovascular disease (CVD), malignancy, and kidney disease (Table 1). Both the high BPV and low BPV groups shared similar characteristics, with no significant differences in most variables except for PE/HDK and cardiac history. Maternal age displayed no significant difference between groups (p = 0.066), with the high BPV group having a mean age of 34.15 years and the low BPV group averaging 33.8 years. Similarly, no significant differences were observed in gravida status or education level across groups (p = 1.000). A notable finding was the significant difference in PE/HDK history (p = 0.043), where 63% of the high BPV group had no prior history, compared to an equal distribution (50%) of patients with and without such a history in the low BPV group.

Table 1. General characteristics based on BPV groups

Variables	High BPV	Low BPV	P-Value
Maternal age (years), mean±SD	34.15±6.67	33.8±3.63	0.066
Gravida, n (%)			
≥3	10 (50)	10 (50)	1.000
<3	10 (50)	10 (50)	
Primiparity, n (%)			
Yes	7 (63.6)	4 (36.4)	0.479
No	13 (44.8)	16 (55.2)	
Education level, n (%)			
Low	14 (50)	14 (50)	1.000
High	6 (50)	6 (50)	
History of preeclampsia and hypertension in pregnancy, n (%)			
Yes	3 (23.1)	10 (76.9)	0.043*
No	17 (63)	10 (37)	
History of hypertension, n (%)			
Yes	8 (40)	12 (60)	0.343
No	12 (60)	8 (40)	
History of diabetes mellitus, n (%)			
Yes	5 (62.5)	3 (37.5)	0.695
No	15 (46.9)	17 (53.1)	
History of heart disease, n (%)			
Yes	0 (0)	6 (100)	0.020*
No	20 (58.8)	14 (41.2)	
History of CVD, n (%)			
Yes	0 (0)	0 (0)	-
No	20 (50)	20 (50)	
History of malignancies, n (%)			
Yes	2 (66.7)	1 (33.3)	1.000
No	18 (48.6)	19 (51.4)	
History of kidney disease, n (%)			
Yes	0 (0)	0 (0)	-
No	20 (50)	20 (50)	

*A significant difference (p < 0.05) was found in the data, analyzed using the Chi-Square Test.

Although a numerical difference was noted in the history of hypertension—wherein most participants in the high BPV group (12 individuals) had no prior history, while the majority in the low BPV group (12 individuals) had a history of hypertension. This variation was not statistically significant (p = 0.343). Likewise, there were no significant differences in the history of diabetes mellitus (p = 0.695) or malignancies (p = 1.000). Additionally, none of the participants had a history of cardiovascular disease or kidney disease.

The relationship between blood pressure variability and maternal outcomes

A significant correlation (p < 0.05) was identified between BPV and multiple maternal outcomes, including length of hospital stay (p = 0.001), preterm birth (p < 0.001), premature rupture of membranes (p = 0.005), and other maternal complications (p = 0.002) (Table 2). However, BPV was not significantly associated (p > 0.05) with postpartum infection (p = 0.605), eclampsia (p = 1.000), postpartum hemorrhage (p = 1.000), maternal mortality, or ICU admission (p = 0.235). These studies demonstrates that BPV influences specific maternal outcomes in preeclampsia, such as hospital stay duration, preterm birth, and premature rupture of membranes.

Multivariate analysis was performed using logistic regression. Variables with a p-value <0.25 in the bivariate analysis were included in the model. Based on the results shown in Table 3, the variables eligible for inclusion in the logistic regression analysis for risk factors associated with maternal adverse events were gravida, primiparity, history of heart disease, and BPV.

Table 2. Maternal outcome based on BPV groups

Variables	High BPV	Low BPV	P-Value
LOS (day), median (IQR)	6 (3.5)	4 (1.75)	0.001[a]
Preterm birth, n (%)			
Yes	16 (80)	4 (20)	<0.001*
No	4 (20)	16 (80)	
Partus prematurus imminens, n (%)			
Yes	3 (75)	1 (25)	0.479
No	17 (47.2)	19 (52.8)	
Premature ruptures of membranes, n (%)			
Yes	10 (90.9)	1 (9.1)	0.005*
No	10 (34.5)	19 (65.5)	
Eclampsia, n (%)			
Yes	1 (100)	0 (0)	1.000
No	19 (48.7)	20 (51.3)	
PPH, n (%)			
Yes	1 (100)	0 (0)	1.000
No	19 (48.7)	20 (51.3)	
Maternal death, n (%)			
Yes	0 (0)	0 (0)	-
No	20 (50	20 (50)	
ICU hospitalization, n (%)			
Yes	6 (75)	2 (25)	0.235
No	14 (43.8)	18 (56.3)	
Maternal adverse events, n (%)			
Yes	16 (76.2)	5 (23.8)	0.002*
No	4 (21.1)	15 (78.9)	

aData is not normally distributed, significantly different (p < 0.05) analyzed using the Mann-Whitney Test
*A significant difference (p < 0.05) was found in the data, analyzed using the Chi-Square Test.

Table 3. Multivariate analysis of risk factors associated with maternal adverse events

Variables	P-Value	Adjusted PR	95% CI
Gravida	0.034*	0.16	0.029-0.874
Primiparity	0.691	0.707	0.128-3.905
History of heart disease	0.596	0.526	0.049-5.651
BPV	0.004*	13.658	2.263-82.425

*Statistically significant (p < 0.05), analyzed using Logistic Regression.

Table 4. Neonatal outcome based on BPV groups

Variables	High BPV	Low BPV	P-Value
Birth weight (cm), median (IQR)	1.745 (1.473)	2.926 (1.377)	<0.001[a]
Birth length (cm), median (IQR)	43.5 (9.75)	47.5 (4.75)	0.003[a]
Abortus, n (%)			
Yes	0 (0)	0 (0)	-
No	20 (50)	20 (50)	
Fetal distress, n (%)			
Yes	4 (80)	1 (20)	0.342
No	16 (45.7)	19 (54.3)	
IUGR, n (%)			
Yes	9 (75)	3 (25)	0.084
No	11 (39.3)	17 (60.7)	
NICU Hospitalization. n (%)			
Yes	10 (90.9)	1 (9.1)	0.005*
No	10 (34.5)	19 (65.5)	
Anomaly, n (%)			
Yes	2 (100)	0 (0)	0.487
No	18 (47.4)	20 (52.6)	
Neonatal death, n (%)			
Yes	1 (100)	0 (0)	1.000
No	19 (48.7)	20 (51.3)	
Maternal adverse events, n (%)			
Yes	13 (76.5)	4 (23.5)	0.011*
No	7 (30.4)	16 (69.9)	

[a]Data is not normally distributed, significantly different ($p < 0.05$) analyzed using the Mann-Whitney Test
*A significant difference ($p < 0.05$) was found in the data, analyzed using the Chi-Square Test.

Table 5. Multivariate analysis of risk factors associated with neonatal adverse events

Variables	P-Value	Adjusted PR	95% CI
History of heart disease	0.142	0.2	0.023-1.712
BPV	0.187	1.857	0.741-4.655

The relationship between blood pressure variability and neonatal outcomes

Similarly, BPV demonstrated a significant association ($p < 0.05$) with multiple neonatal outcomes, including low birth weight ($p < 0.001$), preterm birth ($p = 0.003$), NICU admission ($p = 0.005$), and other maternal complications ($p = 0.011$). However, BPV was not significantly linked ($p > 0.05$) to neonatal outcomes such as abortion, fetal distress ($p = 0.342$), intrauterine growth restriction ($p = 0.084$), stillbirth/intrauterine fetal death ($p = 0.487$), congenital anomalies ($p = 0.487$), or neonatal mortality ($p = 1.000$) (Table 4). These numbers refers that BPV perform a significant part in determining specific neonatal outcomes in preeclampsia, particularly low birth weight, preterm birth, and NICU admission.

Multivariate analysis was performed using logistic regression. Variables with a p-value <0.25 in the bivariate analysis were included in the model. Based on the results shown in Table 5, the variables eligible for inclusion in the logistic regression analysis for risk factors associated with neonatal adverse events were history of heart disease and BPV.

This retrospective cohort study identified a significant association between blood pressure variability (BPV) and adverse maternal outcomes in individuals with preeclampsia. High BPV was associated with longer hospital stays and increased maternal complications, which aligns with current theories suggesting BPV results from complex interactions between intrinsic and extrinsic factors. Intrinsic factors include cardiovascular conditions such as excessive sympathetic nerve activity and impaired vascular regulation, while extrinsic factors like drastic seasonal changes can also influence BPV. High BPV leads to endothelial dysfunction and organ damage, causing hemodynamic instability in pregnant women, which delays recovery and increases maternal complications. This is aligned with evidences that 16.8% of patients with high BPV experienced maternal and/or neonatal complications.[9,10]

Preeclampsia mechanisms, including endothelial dysfunction and oxidative stress, are linked to BPV, with BPV serving as a predictor of preeclampsia severity.[6]

BPV may contribute to preterm birth through uterine vascular dysfunction and 0.001).[11,12]

This study also discovered a notable correlation was observed between BPV and the incidence of premature rupture of membranes (PROM). This association may be attributed to increased intrauterine pressure resulting from BPV, which heightens the risk of membrane rupture. These evidences arrange in line with the study conducted by Liu et al.,[8] which reported similar outcomes where gestational hypertension and preeclampsia themselves increased the risk ratio for the occurrence of premature rupture of membranes (RR = 4.21, 95% CI 3.77– 4.70). High BPV can activate inflammatory mediators, which in impaired blood supply to the placenta. Additionally, high BPV can increase the risk of preterm birth by affecting vaso-dilation and causing disruptions in uterine contractility.[14] This finding is also consistent with the results obtained by Gu et al. in 2022, where the incidence of preterm birth significantly increased with high BPV in preeclampsia patients (OR: 3.25, 95% CI 2.24–4.72, p < turn weaken the fetal membranes, leading to PROM.[15,16] The evidence studies also support existing research on the association between preeclampsia and PROM.

However, BPV did not emerge as a significant risk factor for maternal complications such as postpartum infection (PPI), eclampsia, postpartum hemorrhage (PPH), maternal mortality, or ICU admission. These evidence of studies contrast with previous findings, which may be attributed to the limited sample size and the low incidence of these complications, potentially reducing the statistical power of the analysis.

This retrospective cohort study identified a strong correlation between BPV and adverse neonatal outcomes in preeclampsia, including low birth weight, prematurity, NICU admission, and other maternal complications. BPV is known to contribute to increased vascular pressure, which can compromise placental circulation, thereby reducing oxygen and nutrient supply to the fetus.[17] This physiological impairment increases the risk of fetal distress, growth restriction, and preterm delivery, consequently elevating NICU admission rates. Supporting this hypothesis, Gu et al.[11] reported a higher incidence of prematurity, fetal distress, and low Apgar scores in neonates from mothers with elevated BPV. Similarly, Jieyu et al.[18] demonstrated an association between high BPV and an increased likelihood of low BW. However, this study did not demonstrate a significant correlation between BPV and adverse neonatal outcomes such as abortion, fetal distress, intrauterine growth restriction (IUGR), stillbirth, congenital anomalies, or neonatal death. In contrast, Magee et al.,[19] which suggested that greater BPV heightens the risk of maternal mortality, severe maternal complications, and perinatal morbidity. The divergence in findings may be due to differences in sample size and the incidence rates of these neonatal complications across studies.[20]

Limitation

This study has several limitations that should be taken into consideration for future research. The relatively small sample size may reduce the statistical power, potentially limiting the generalizability of the studies to a broader occupants. Additionally, the retrospective design may introduce selection and confounding biases, which could affect the observed associations between BPV and maternal as well as neonatal outcomes. A further limitation is the absence of a standardized protocol for BPV measurement, which may result in inconsistencies in blood pressure assessments. Variability in visit frequency, intervals between measurements, and follow-up duration could contribute to measurement bias, potentially impacting the accuracy of BPV assessment. Furthermore, the study population was drawn from a general hospital setting rather than a controlled clinical trial, which may affect the transferability of the evidences. Additionally, the analysis included other maternal risk factors that could act as confounders, further complicating the interpretation of BPV's impact on maternal and neonatal outcomes. Future studies with larger, multi-center cohorts and a standardized BPV measurement protocol are needed to validate these findings and enhance the clinical applicability of BPV monitoring in obstetric care.[21]

CONCLUSION

Based on the results of the study on 40 pregnant women with preeclampsia who visited the fetomaternal clinic at RSUP Prof. Dr. I.G.N.G. Ngoerah from 2020 to 2022, it can be concluded that there is a relationship between BPV and maternal outcomes in preeclampsia patients, including the length of hospitalization, prematurity, PROM, and other maternal side effects. BPV is also associated with neonatal outcomes, including birth weight, preterm birth, the need for NICU care, and other maternal side effects at RSUP Prof. Dr. I.G.N.G. Ngoerah.

DISCLOSURES

Acknowledgment

The authors sincerely appreciate all individuals and institutions that contributed to the development of this manuscript. The final version has undergone rigorous review, and all authors have provided their formal approval for publication. The figures presented in this manuscript are entirely original.

Conflict of interest

The authors affirm that there are no conflicts of interest related to this study.

Funding

This study did not receive financial support from any public, private, or commercial funding agencies.

Author contribution

All authors played an integral role in every stage of this research, including study design, data collection, statistical analysis, manuscript drafting, and final approval for submission.

REFERENCES

1. Organization WH. Di balik angka: pengkajian kematian maternal dan komplikasi untuk mendapatkan kehamilan yang lebih aman [Internet]. WHO; 2015 [cited 2025 Jan 5]. Available from: https://lib.fkm.ui.ac.id
2. Das S, Das R, Bajracharya R, Baral G, Jabegu B, Odland J et al. 2019. Incidence and Risk Factors of Pre-Eclampsia in the Paropakar Maternity and Women's Hospital, Nepal: A Retrospective Study. International Journal of Environmental Research and Public Health;16(19):3571.
3. Hashemi A. Hubungan Paritas Pada Penderita Pre-eklampsia Berat terhadap Kejadian Asfiksia Neonatorum Di RSD Dr. Soebandi Kabupaten Jember. 2015 [cited 2025 Jan 5];68–74. Available from: https://repository.unej.ac.id/xmlui/handle/123456789/71473
4. Jumiatun. Hubungan antara Preeklampsia dalam persalinan dengan kejadian asfeksia di RSUD Kab. Batang. J Kebidanan STIKes Widya Husada. 2013;11:1–17.
5. Brown MA, Magee LA, Kenny LC, Karumanchi SA, McCarthy FP, Saito S, et al. The hypertensive disorders of pregnancy: ISSHP classification, diagnosis & management recommendations for international practice. Pregnancy Hypertens. 2018;13(May):291–310.
6. Stevens SL, Wood S, Koshiaris C, Law K, Glasziou P, Stevens RJ, et al. Blood pressure variability and cardiovascular disease: systematic review and meta-analysis. BMJ [Internet]. 2016 [cited 2025 Jan 5];354. Available from: https://pubmed.ncbi.nlm.nih.gov/27511067/
7. Schutte AE, Kollias A, Stergiou GS. Blood pressure and its variability: classic and novel measurement techniques. Nat Rev Cardiol. 2022;19(10):643–54.
8. Bellamy L, Casas JP, Hingorani AD, Williams DJ. Pre-eclampsia and risk of cardiovascular disease and cancer in later life: Systematic review and meta-analysis. Br Med J. 2007;335(7627):974–7.
9. Kim SA, Lee JD, Park JB. Differences in visit-to-visit blood pressure variability between normotensive and hypertensive pregnant women. Hypertens Res [Internet]. 2019 Jan 1 [cited 2025 Jan 5];42(1):67–74. Available from: https://pubmed.ncbi.nlm.nih.gov/30315199/
10. Wang J, Shi X, Ma C, et al. 2017. Visit-to-visit blood pressure variability is a risk factor for all-cause mortality and cardiovascular disease. J Hypertens; 35: 10- 17.
11. Gu Y, Shi H, Zeng W, Zheng Y, Yang M, Sun M, et al. Association between gestational visit?to?visit blood pressure variability and adverse neonatal outcomes. J Clin Hypertens [Internet]. 2022 Jun 1 [cited 2025 Jan 5];24(6):779. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC9180330/
12. English FA, and Kenny LC, and McCarthy FP. 2015. Risk factors and effective management of preeclampsia. Integrated Blood Pressure Control; 8: 7-12. ?1.
13. Liu J, Yang L, Teng H, Cao Y, Wang J, Han B, et al. Visit-to-visit blood pressure variability and risk of adverse birth outcomes in pregnancies in East China. Hypertens Res [Internet]. 2021 Feb 1 [cited 2025 Jan 5];44(2):239–49. Available from: https://pubmed.ncbi.nlm.nih.gov/32895496/
14. Subedi S, Hazel EA, Mohan D, Zeger S, Mullany LC, Tielsch JM, et al. Prevalence and predictors of spontaneous preterm births in Nepal: Findings from a prospective, population-based pregnancy cohort in rural Nepal-a secondary data analysis. BMJ Open. 2022 Dec 1;12(12).
15. Sheikh J, Allotey J, Kew T, Khalil H, Galadanci H, Hofmeyr GJ, et al. Vulnerabilities and reparative strategies during pregnancy, childbirth, and the postpartum period: moving from rhetoric to action. eClinicalMedicine [Internet]. 2023 Jan 1 [cited 2025 Jan 5];67:102264. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC10837549/

16. Lin D, Hu B, Xiu Y, Ji R, Zeng H, Chen H, et al. Risk factors for premature rupture of membranes in pregnant women: a systematic review and meta-analysis. BMJ Open [Internet]. 2024 Mar 1 [cited 2025 Jan 5];14(3):e077727. Available from: https://bmjopen.bmj.com/content/14/3/e077727
17. Fung R, Villar J, Dashti A, Cheikh Ismail L, Staines-Urias E, Ohuma EO, et al. Achieving accurate estimates of fetal gestational age and personalised predictions of fetal growth based on data from an international prospective cohort study: a population-based machine learning study. Lancet Digit Heal. 2020;2(7):e368–75.
18. Jieyu L, Yingying C, Tian G, Jiaxiang W, Jiawen L, Yingjie G, et al. Visit-to-visit blood pressure variability is associated with gestational hypertension and pre-eclampsia. Pregnancy Hypertens [Internet]. 2019 Oct 1 [cited 2025 Jan 5];18:126–31. Available from: https://pubmed.ncbi.nlm.nih.gov/31610398/
19. Magee LA, Singer J, Lee T, McManus RJ, Lay-Flurrie S, Rey E, et al. Are blood pressure level and variability related to pregnancy outcome? Analysis of control of hypertension in pregnancy study data. Pregnancy Hypertens [Internet]. 2020 Jan 1 [cited 2025 Jan 5];19:87–93. Available from: https://pubmed.ncbi.nlm.nih.gov/31927325
20. Leeman L, Dresang LT, Fontaine P. 2016. Hypertensive Disorders of Pregnancy. Am Fam Physician. Jan 15;93(2):121-7. PMID: 26926408
21. Krielessi V, Papantoniou N, Papageorgiou I, Chatzipapas I, Manios E, Zakopoulos N, et al. Placental Pathology and Blood Pressure's Level in Women with Hypertensive Disorders in Pregnancy. Obstet Gynecol Int. 2012;2012:1–6.