# Prediction and Prevention of Pre-eclampsia by Measuring Mean Platelet Volume and Uterine Artery Doppler Indices in High-Risk Pregnant Women

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## ABSTRACT

**Background:** Pre-eclampsia (PE) is a multisystem disorder of unknown cause that is unique to human pregnancy.
**Objective:** This work aimed to evaluate platelet volume and its significance in the prediction of preeclampsia.
**Methods:** This is a prospective cohort study that was carried out in the Obstetrics and Gynecology Department (High-risk unit) at Zagazig University Hospitals. Sixty high-risk pregnant women were involved during the period from July 2021 to February 2022. Ultrasound scanning was done to evaluate fetal biometric parameters according to fetal morphology and localization of the placenta. The uterine arteries were identified, and the pulsatility index and resistive index were measured bilaterally. Ultrasound examinations were performed by one observer only.
**Results:** Platelet (PLT) was significantly higher among control and unaffected groups at all times but MPV and PDW were significantly higher among cases at all times. The first, second, third, fourth, and fifth visits were at 12, 14, 16, 18, and 20 weeks gestation respectively
**Conclusions** Abnormal platelet indices and uterine artery Doppler indices can be considered as an early, economical, and rapid procedure for the assessment of PE.
**Keywords:** Pre-eclampsia, Mean platelet volume (MPV), Platelet indices, Prediction.

## INTRODUCTION

Pre-eclampsia is a multisystem disorder of unknown cause that is unique to human pregnancy. It is characterized by an abnormal vascular response to placentation that is associated with increased systemic vascular resistance, enhanced platelet aggregation, activation of the coagulation system, and endothelial cell dysfunction[(1)].

The clinical findings of pre-eclampsia can manifest as either a maternal syndrome (hypertension and proteinuria with or without other multisystem abnormalities with or without body edema) after 20 weeks of gestation or fetal syndrome (fetal growth restriction, reduced amniotic fluid, and abnormal oxygenation). Preeclampsia resolves by 6-12 weeks postpartum in previously normotensive women[(2)].

Pre-eclampsia is the most commonest medical disorder during pregnancy, it complicates about 5 to 10% of pregnancies and continues to be a major cause of maternal and perinatal morbidity and mortality[(3)].

The early identification of patients with an increased risk for preeclampsia is therefore one of the most important goals in obstetrics.

Thrombocytopenia is probably due to consumption during low-grade intravascular coagulation[(4)].

Mean platelet volume (MPV) is significantly higher in patients with pre-eclampsia compared to those with normal pregnancy. The physiological changes in pregnancy normally show decreasing platelet count with increasing gestational age. However, in patients with pregnancy-induced hypertension (PIH), the effect on platelets is increased significantly leading to many complications in mother and fetus[(5)].

Accurate prediction of PE is essential for the initiation of preventive therapy and this also aids in targeting the group which would need increased antenatal surveillance. Extensive research over the past 35 years has evaluated the use of uterine artery Doppler for the prediction of PE[(6)].

The aim of this study is the prevention and prediction of pre-eclampsia by measuring mean platelet volume and uterine artery Doppler indices in high-risk pregnant women.

## PATIENTS AND METHODS

This is a prospective cohort study of pregnant women. The study was carried out on 60 pregnant women in the Obstetrics and Gynecology Outpatient Clinic at Zagazig University Hospitals. The participants were divided into two equal groups with matched ages. Group A included pregnant women with a history of high-risk factors, while the others who had no history of risk factors, were included in Group (B).

### Ethical consent:

**Written informed consent was obtained from all participants, the study was approved by the research ethics committee of the Faculty of Medicine, Zagazig University. The work was carried out for studies involving humans following the World Medical Association's Code of Ethics (Helsinki Declaration) IRB number.**

### Inclusion criteria:

High-risk patients with singleton pregnancy seen between 11 and 13 + 6 weeks with confirmed viable intrauterine pregnancy with no active bleeding or evidence of subchorionic hematoma. Gestational age was ascertained based on the first day of the last reliable menstrual period unless the difference from the first-trimester ultrasound was greater than 5 days.



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**Exclusion criteria:** Multifetal pregnancy. Fetal malformations. Uterine malformation or fibroids that could interfere with volume measurement.

After an explanation of the whole procedure, taking women's consent, all women included were subjected to complete history taking, complete general examination; blood pressure was measured while the patient was in the sitting position with the cuff of a mercury sphygmomanometer placed on the patient's right arm at the level of the heart. The Korotkoff IV sound (the point at which the sound becomes muffled) was used for the diastolic blood pressure. Obstetric examinations during follow-up visits included fundal level, fundal grip, umbilical grip, and pelvic grips. Laboratory investigations included urine analysis. Complete blood count, and platelet volume. Random blood sugar levels liver function tests (protein, albumin, bilirubin, enzymes), and kidney function tests (urea and creatinine). Ultrasonography was performed with a Voluson 730 pro V (General Electric Medical Systems, Austria) and a volumetric multi-frequency abdominal probe (2.2–6.5 MHz).

The following procedures were applied to each case: ultrasound scanning, evaluating fetal biometric parameters according to fetal morphology, and localization of the placenta. The uterine arteries were identified and the pulsatility index and resistive index were measured bilaterally. Ultrasound examinations were performed by one observer only.

**Assessment of uterine artery Doppler:**

For the uterine artery Doppler studies, a sagittal section of the uterus was obtained, and the cervical canal and internal cervical os were identified. Subsequently, the transducer was gently tilted from side to side and color flow mapping was used to identify each uterine artery along the side of the cervix and uterus at the level of the internal os. Pulsed wave Doppler imaging was used with the sampling rate set at 2 mm to cover the whole vessel and care was taken to ensure that the angle of insonation was less than 30◦. When three similar consecutive waveforms had been obtained the PI and RI was measured on both sides and the mean values of the left and right arteries were calculated.

**Follow up:**

All cases were followed up regularly until delivery platelet volume and uterine artery doppler will be done at 12, 14 .16,18, and 20 weeks gestation then follow up (once monthly for the first six months of pregnancy, twice monthly during the seventh and eighth month and then once weekly till delivery).

**Outcome measures:**

The primary outcome data were whether patients developed preeclampsia or not. The type of delivery whether vaginal delivery or caesarian section for each patient, the gestational age at the time of delivery, neonatal outcome, and birth weight for each case was recorded.

***Statistical Analysis***

Data collected throughout history, basic clinical examination, laboratory investigations, and outcome measures were coded, entered, and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) (Statistical Package for the Social Sciences) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represented by mean ± SD, the following tests were used to test differences for significance; difference and association of qualitative variable by Chi-square test ($X^2$). Differences between quantitative independent groups by t-test or Mann Whitney, agreement by Kappa, predictors by logistic regression. P-value was set at <0.05 for significant results &<0.001 for highly significant results.

**RESULTS**

**Table 1:** age was distributed as 27.07±3.44, 27.55, and 27.0±3.45 respectively in the Pre-eclampsia group. The unaffected and control groups without significant difference and GA at the start of the study were 16.01±1.49, 16.22, and 26.11±1.40 respectively with no significant difference

**Table (1): Age and gestational age distribution among studied groups**

| | Pre-eclampsia Group (N=15) | Unaffected Group (N=15) | Control group (N=30) | T | P |
|---|---|---|---|---|---|
| **Age (years)** | **27.07±3.44** | **27.55** | **27.0±3.45** | **0.112** | **0.911** |
| **GA at examination time(weeks)** | **16.01±1.49** | **16.22±1.49** | **16.11±1.40** | **-0.331** | **0.741** |

**GA:** Gestational age.
Probability p-value > 0.05 was considered insignificant
Student T-test: to test whether the means are different

**Table 2:** systolic blood pressure (SBP) and diastolic blood pressure (DBP) were significantly higher among the Pre-eclampsia group.

**Table (2): Systolic blood pressure and diastolic blood pressure distribution among studied groups**

| | Pre-eclampsia Group (N=15) | Unaffected Group (N=15) | Control group (N=30) | T | P |
|---|---|---|---|---|---|
| **SBP(mm/hg)** | **152.96±7.3** | **125.09±7.36** | **128.09±7.36** | **16.291** | **0.00**** |
| **DBP(mm/hg)** | **100.18±6.29** | **85.48±5.79** | **86.48±5.79** | **14.359** | **0.00**** |

**SBP(mm/hg):** Systolic Blood Pressure **DBP(mm/hg):** Diastolic Blood Pressure
**: Hightly insignificant

**Table 3:** there was no significant difference between cases or control regarding any parameters. NB 1st first visit at 12-week gestation, 2nd visit at 14-week gestation, 3rd visit at 16-week gestation, 4th visit at 18-week gestation, and 5th visit at 20-week gestation

**Table (3): Hemoglobin and white blood cells distribution at different times between the studied groups**

| | Pre-eclampsia group (N=15) | Unaffected Group (N=15) | Control group (N=30) | t | P |
|---|---|---|---|---|---|
| **HB1st (m±sd)** | **11.26±1.05** | **11.88±0.97** | **11.08±0.97** | **0.892** | **0.375** |
| **WBCs1st (m±sd)** | **8.31±1.39** | **8.99±1.41** | **8.09±1.41** | **0.820** | **0.414** |
| **HB 2nd (m±sd)** | **11.03±1.03** | **11.78±0.95** | **11.18±0.95** | **-0.791** | **0.430** |
| **WBCs2nd(m±sd)** | **7.31±1.39** | **7.55±1.41** | **7.95±1.41** | **-1.150** | **0.287** |
| **HB 3rd (m±sd)** | **10.92±0.93** | **11.33±0.94** | **11.13±0.94** | **-1.845** | **0.061** |
| **WBCs 3rd (m±sd)** | **6.55±1.47** | **7.43±1.42** | **7.41±1.42** | **-1.625** | **0.095** |
| **HB 4th (m±sd)** | **10.97±0.91** | **11.25±0.94** | **11.21±0.94** | **-1.248** | **0.215** |
| **WBCs 4th (m±sd)** | **5.93±1.62** | **6.77±1.68** | **6.67±1.68** | **-1.903** | **0.058** |
| **HB 5th (m±sd)** | **10.97±0.91** | **11.33±0.94** | **11.21±0.94** | **-1.248** | **0.215** |
| **WBCs 5th (m±sd)** | **5.93±1.62** | **6.57±1.68** | **6.67±1.68** | **-1.903** | **0.058** |

**HB**: Hemoglobin **WBCs:** White blood cells

**Table 4:** showed that PLT was significantly higher among the control and unaffected groups at all times but MPV and PDW were significantly higher among cases at all the times NB 1st first visit at 12-week gestation, 2nd visit at 14-week gestation, 3rd visit at 16-week gestation, 4th visit at 18-week gestation and 5th visit at 20-week gestation.

**Table (4): Platelet indices distribution at different times among the studied groups**

| | Pre-eclampsia Group (N=15) | Unaffected Group (N=15) | Control group (N=30) | t | P |
|---|---|---|---|---|---|
| **PLT 1st** | **204.9±26.9** | **271.64±37.8** | **270.64±37.83** | **-10.404** | **0.00**** |
| **MPV 1st** | **11.52±1.14** | **10.23±1.04** | **10.21±1.04** | **6.179** | **0.00**** |
| **PDW 1st** | **15.11±1.33** | **12.63±1.44** | **12.61±1.44** | **9.330** | **0.00**** |
| **PLT 2nd** | **199.35±28.83** | **277.87±37.9** | **278.87±37.96** | **-12.258** | **0.00**** |
| **MPV 2nd** | **11.92±1.14** | **11.22±1.08** | **11.12±1.08** | **3.725** | **0.00**** |
| **PDW 2nd** | **15.41±1.33** | **12.43±1.44** | **12.41±1.44** | **11.196** | **0.00**** |
| **PLT 3rd** | **189.11±26.81** | **286.5±37.45** | **287.5±37.45** | **-15.696** | **0.00**** |
| **MPV 3rd** | **12.33±1.36** | **11.87±1.17** | **11.84±1.17** | **2.008** | **0.046*** |
| **PDW 3rd** | **15.94±1.27** | **12.24±1.45** | **12.29±1.45** | **13.886** | **0.00**** |
| **PLT 4th** | **186.64±26.77** | **286.61±41.9** | **287.61±41.93** | **-13.882** | **0.00**** |
| **MPV 4th** | **12.47±1.31** | **11.93±1.44** | **11.91±1.44** | **2.005** | **0.048*** |
| **PDW 4th** | **15.99±1.07** | **12.35±1.63** | **12.32±1.63** | **12.850** | **0.00**** |
| **PLT 5th** | **186.64±26.77** | **288.66±41.9** | **287.61±41.93** | **-13.882** | **0.00**** |
| **MPV 5th** | **12.47±1.31** | **11.91±1.44** | **11.91±1.44** | **2.005** | **0.048*** |
| **PDW 5th** | **15.99±1.07** | **12.38±1.68** | **12.32±1.63** | **12.850** | **0.00**** |

**PLT:** Platelet **MPV**: Mean Platelets Volume **PDW:** Platelets Distribution Width

**Table 5:** showed that uterine artery Doppler PI and RI were significantly higher in pre-eclampsia patients.

**Table (5): Uterine artery Doppler at the first trimester among the studied groups (n=60)**

| uterine artery | Un affected | Affected | Control | T | P |
|---|---|---|---|---|---|
| **PI -mean±SD<br>-range** | 0.76±0.14<br>0.6-0.9 | 1.13±4<br>0.9-1.5 | 0.74±0.37<br>.07-1.2 | 11.9 | <0.001 |
| **RI -mean±SD<br>-range** | 0.49±0.1<br>0.42-0.55 | 0.57±0.5<br>0.52-0.72 | 0.50±0.13<br>0.54-0.8 | 4.9 | <0.001 |

**PI**: Pulsatility Index **SD:** Standard Deviation **RI**: Resistance Index

**Table 6:** showed that low APGAR1, preterm, CS delivery type, and PPH were significantly associated with the pre-eclampsia group.

**Table (6): Maternal and neonatal outcome distribution between the studied groups**

| | | | Pre-eclampsia Group (N=15) | Unaffected Group (N=15) | Control group (N=30) | t/ $X^2$ | P |
|---|---|---|---|---|---|---|---|
| **APGAR1** | | | **5.72±0.89** | **6.69±1.6** | **6.68±1.6** | **-4.993** | **0.00**** |
| **APGAR2** | | | **7.88±0.95** | **9.77±0.4** | **9.18±0.4** | **-1.723** | **0.088** |
| **Term** | **Preterm** | **N** | **4** | **2** | **2** | | |
| | | **%** | **26.6%** | **13.3** | **6.7%** | | |
| | **Full-term** | **N** | **11** | **13** | **28** | **5.11** | **0.026*** |
| | | **%** | **73.4%** | **86.7** | **93.3%** | | |
| **Delivery** | **CS** | **N** | **9** | **3** | **4** | | |
| | | **%** | **60 %** | **20** | **13.3%** | | |
| | **VD** | **N** | **6** | **12** | **26** | **9.83** | **0.003*** |
| | | **%** | **40%** | **80%** | **86.7%** | | |
| **PPH** | **No** | **N** | **8** | **14** | **29** | | |
| | | **%** | **53.3%** | **93.3** | **96.6%** | | |
| | **Yes** | **N** | **7** | **1** | **1** | **5.84** | **0.022*** |
| | | **%** | **46.6%** | **6.7** | **3.4%** | | |
| **NICU** | **No** | **N** | **4** | **11** | **28** | | |
| | | **%** | **26.6%** | **73.3%** | **84%** | | |
| | **Yes** | **N** | **11** | **4** | **2** | **2.31** | **0.12** |
| | | **%** | **73.3%** | **26.6%** | **16%** | | |
| **IUGR** | **No** | **N** | **13** | **14** | **28** | | |
| | | **%** | **86.6%** | **93.3** | **84%** | | |
| | **Yes** | **N** | **2** | **1** | **2** | **2.07** | **0.15** |
| | | **%** | **13.4%** | **6.7** | **16%** | | |
| **Total** | | **N** | **15** | **15** | **30** | | |
| | | **%** | **100.0%** | **100.0%** | **100.0%** | | |

**CS:** Ceaserian Section **VD:** Vaginal Delivery
**PPH:** Post Partum Hemorrhage **NICU:** Neonatal Intensive Care Unit
**IUGR:** Intrauterine growth restriction

## DISCUSSION

In the present study: maternal age was distributed as 27.07±3.44, 27.55, and 27.0±3.45 respectively in the pre-eclampsia, unaffected, and Control groups without significant difference, and GA at the start of the study was 16.01±1.49,16.22 and 26.11±1.40 respectively with no significant difference

In agreement with the study done by **Tesfay *et al.*** [7] where the characteristics of pre-eclamptic and normotensive pregnant women are presented. While a significant difference was not found among the mean ages of mild PE, severe PE, and control groups ($p>0.05$), the gestational age of preeclamptic patients was found to be lower than the normotensive pregnant women ($p< 0.05$).

In **Saeed *et al.*** [8] the I, II, and III groups gestational hypertension. Gestational hypertension superimposed pre-eclampsia, and showed poor outcome. The main maternal age of women in the PIH group was 25.67±4.11 and in the normotensive group was 25.87±4.05 revealing a significant difference in mean maternal age between the two groups whereas **Helseth *et al.*** [9] demonstrated that the mean maternal age for development of pre-eclampsia is 32.4±5.1 and normotensive is 32.5±5.5 age varies in my study than this study may be supported by other studies. This difference may be due to the early marriage trend in our area and the age of menarche**.**

**Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) distribution between groups:**

**In the present study**: SBP and DBP were significantly higher among the pre-eclampsia group, SBP and DBP were significantly negatively correlated with PLT count but significantly positively correlated with MPV and PDW.

**In the study done by Saleh *et al.*** [10] Out of 30 women in the PIH group, 22 (73.3%) were unbooked and only 8 (26.7%) were booked Mean systolic blood pressure of the PIH group was 156.5 ± 17.1 which was significantly higher than the mean of the normotensive group was 117.7± 5.04 ($p<0.001$). The mean diastolic blood pressure of the PIH group was 103.0 ±7.94 which was significantly higher than the mean diastolic blood pressure of 76.3 ±5.07 ($p<0.001$).

**Distribution of hemoglobin (HB) and white blood cells (WBCs) at different times among the studied groups:**

In the present study, there was no significant difference between the pre-eclampsia and control groups regarding HB and WBC distribution through visits.

In the study done by **Nasiri and associates** [11] the levels of hemoglobin can be used to predict pre-eclampsia and monitoring the pregnant women and its regular measure in 3 trimesters help us to identify women at risk for preeclampsia. **Phaloprakarn and Tangjitgamol** [12] showed that high hemoglobin in the first and third trimesters is associated with preeclampsia ($P < 0.01$).

**Distribution of platelet (PLT) indices at different times between the studied groups:**

In the present study, PLT was significantly higher among the control group at all times but MPV and PDW were significantly higher among the pre-eclampsia group at all times.

A study was done by **Sitotaw *et al.*** [13] in the northern part of Ethiopia enrolling 33 mild PE, 30 severe PE, and 63 healthy pregnant women revealed an increase in MPV, PDW, and P-LCR with the advancement of PE. Whereas, PC decreased with the severity of the disease.

**Doppler analysis of the uterine artery in predicting pre-eclampsia:**

The utility of Doppler analysis of the uterine artery in predicting pre-eclampsia has been extensively studied, initially in the mid-second trimester and more recently in early pregnancy. Ultrasonographic evidence of this resistance includes the presence of a diastolic 'notch' in the Doppler waveform of the uterine artery or an increase in that vessel's pulsatility index (PI). The results were variable in many studies due to heterogeneity of vascular impedance measures, gestational age at screening, and the prevalence and definition of preeclampsia.

Regarding the mean uterine artery pulsatility index (PI), the present study found that pre-eclamptic patients had significantly higher UADPI when compared with controls. This coincides with the findings of **Plasencia *et al.*** [14] who reported that Doppler studies of the uterine arteries at 11–13 weeks have demonstrated that impedance to flow is increased in pregnancies that subsequently develop hypertensive disorders and that the increase is particularly marked for early PE.

**Maternal and Neonatal outcome distribution between the studied groups**:

In the present study: APGAR1&2, preterm, CS mode, PPH, Stillbirth, and baby mortality were significantly associated with PE.

**Nair and Savitha** [15] there is a significant increase in perinatal mortality in severely pre-eclamptic patients with hyperuricemia, more so in the preterm group, compared to the control group. The mean gestational age of delivery decreased significantly with increasing MSUA concentration in preeclamptic patients. A significant increase in low birth weight, very low birth weight, extremely low birth weight babies with increasing MSUA concentration, with the highest MSUA level in very low birth weight babies. Perinatal morbidity (as an increase in RDS, IUGR) is significantly increased in preeclamptic patients with hyperuricemia compared to the control group.

The occurrence of pregnancy outcomes in the study done by **Tam *et al.*** [16] was: preterm birth rate (22.4%), IUGR (25.9%), Apgar score less than 7 (9.0%), fetal death (2.9%), and neonatal death (4.9%). Other studies have reported similarly, with preterm birth ranging from 15% to 67%, IUGR ranging from 10% to 25%, and fetal mortality ranging from 1% to 2%.2 Concerning individual fetal/neonatal complications.

## CONCLUSION

There is a positive association between the decrease in platelet count and the development of pre-eclampsia. Also increased mean platelet volume and platelet distribution width are significant predictors for pre-eclampsia in pregnancy. The estimation of platelet indices and uterine artery Doppler indices can be considered an early, economic, and rapid procedure for the assessment of PE.

Further studies on a large number of patients are needed to confirm the combined use of platelet indices and uterine artery Doppler indices to increase the sensitivity for the prediction of PE.

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## REFERENCES

1. **Sibai B, Morris M, Wyllie R (2019):** Genetic and familial predisposition to eclampsia and pre-eclampsia in a defined population. Br J Obstet Gynecol., 97: 762-66.
2. **Arudini D, Rizzo G, Romanini C *et al.* (2015):** Functional assessment of uteroplacental and fetal circulations by means of color Doppler ultrasonography: J. ultrasound Med.,9:249.
3. **Roberts J, Rizzo G, Romanini C (2020)**: The development of abnormal heart rate patterns after absent end-diastolic velocimetry in umbilical artery: Analysis of risk factors. AM J Obstet Gynecol., 168: 43-48.
4. **Dadhich S, Edwards C (2018):** Hypertension in pregnancy. J Nation Med Assoc., 86(4):289-93.
5. **August P, Lindheimer M (1995):** Pathophysiology of preeclampsia. In: Laragh JL, Brenner BM, eds. Hypertension 2nd ed. New York, NY: Raven Press; Pp. 2407-2426.
6. **Alfirevic Z, Neilson J (2015):** Doppler ultrasonography in high-risk pregnancies: Systematic review with meta-analysis. Am J Obstet Gynecol., 127: 1379-82.
7. **Tesfay F, Negash M, Alemu J *et al.* (2019)** Role of platelet parameters in early detection and prediction of severity of preeclampsia: A comparative cross-sectional study at Ayder comprehensive specialized and Mekelle general hospitals, Mekelle, Tigray, Ethiopia. PLoS ONE, 14(11): e0225536.
8. **Saeed G, Hamid R, Khattak N (2003):** Serum Uric Acid level as a marker for predicting progression of gestational hypertension to pre-eclampsia and fetal morbidity. Pak Armed Forces Med J., 53:136-41.
9. **August P, Helseth G, Cook E *et al.* (2004):** A prediction model for superimposed preeclampsia in women with chronic hypertension during pregnancy. Am J Obstet Gynecol., 191:1666-72.
10. **Saleh F, UD-Din S, Soomro N (2019):** Serum uric acid as predictor model for pre-eclampsia Pak J Surg., 26(3):246-251.
11. **Nasiri M, Faghihzadeh S, Majd H *et al.* (2015):** Longitudinal Discriminant Analysis of Hemoglobin Level for Predicting Preeclampsia. Iran Red Crescent Med J., 17(3): 489-93.
12. **Phaloprakarn C, Tangjitgamol S (2008):** Impact of high maternal hemoglobin at first antenatal visit on pregnancy outcomes: a cohort study. J Perinat Med., 36(2):115–9.
13. **Sitotaw C, Asrie F, Melku M (2018):** Evaluation of platelet and white cell parameters among pregnant women with Preeclampsia in Gondar, Northwest Ethiopia: A comparative cross-sectional study. Pregnancy Hypertension, 13: 242–247.
14. **Plasencia W, Maiz N, Bonio S *et al.* (2017):** Uterine artery Doppler at $11^{+}0$ to $13^{+}6$ weeks in the prediction of preeclampsia. Ultrasound Obstet Gynecol., 30: 742-9.
15. **Nair A, Savitha C (2017):** Estimation of serum uric acid as an indicator of the severity of preeclampsia and perinatal outcome. J Obst Gynecol India, 67(2):109-18.
16. **Tam M, Nguyen L, Nam L *et al.* (2018):** Maternal serum uric acid concentration and pregnancy outcomes in women with pre-eclampsia/ eclampsia. Int J Gynecol Obstet., 144; 21-26.