

Evaluating Platelet Parameters in Diagnosis and Prediction of Preeclampsia among Pregnant Women

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Despite the awareness and follow-up of pregnant women in modern obstetrics, preeclampsia (PE) remains a threat to the life of the mother and their fetus. The aim is to assess the platelet indices (MPV, PDW and PCT) in diagnosis and prediction of preeclamptic women. It is a retrospective case-control study was done in Sakaka, Aljof region, Saudi Arabia; the data was taken from the patient's records during the period of September – December 2023. In this study, we recruited 88 women with PE and equal controls. The data collected was analyzed using SPSS program version 20. The $p < 0.05$ was set as statistical significance. The result showed that the MPV, and PDW were significantly higher in cases when compared with the healthy group (MPV 10.1 ± 2.4 fl versus 8.6 ± 1.3 fl, $p < 0.001$, and PDW $15.8 \pm 1.4\%$ versus $13.8 \pm 2.3\%$ $p < 0.001$), while the platelet count (PC) and plateletcrit (PCT) were significantly lower than that of the healthy group (PC $178.1 \pm 60.7 \times 10^9/L$ versus $282.2 \pm 77.0 \times 10^9/L$, $p < 0.001$ and PCT $0.14 \pm 0.04\%$ versus $0.22 \pm 0.5\%$ $p < 0.001$). The ROC curve analysis of platelet parameters indicated that the PC had the highest area under the curve, which was 0.92 (95% CI 0.88-0.97), followed by MPV 0.83 (95% CI 0.75-0.90). The study concludes that the $PC \leq 175.0 \times 10^9/L$ and MPV value ≥ 10.7 fl are reliable predictors of PE.

Keywords: Preeclampsia, Pregnancy, Platelets parameters, Sakaka, Saudi Arabia.

Preeclampsia is a hypertensive disorder associated with pregnancy, characterized by elevated blood pressure (systolic blood pressure ≥ 140 mmHg, or a diastolic blood pressure ≥ 90 mm Hg), measured on at least two occasions four hours apart, following 20 weeks of pregnancy in a woman whose blood pressure and proteinuria were previously normal. The criteria for proteinuria consist of a protein excretion of 300 mg or above in a 24-hour urine collection or a reading of 2+ dipstick.¹ Preeclampsia is considered as one of the most serious health conditions during pregnancy. It

affects 3%–8% of pregnant women and produces a significant increase in maternal and neonatal morbidity and mortality.² Preeclampsia and other hypertensive diseases during pregnancy are responsible for around 7% of all maternal deaths, according to the Centers for Disease Control.³ Studies in Saudi Arabia suggest that hypertensive disorders of pregnancy afflict 2.4% of pregnant ladies, with 55% diagnosed with PE. These findings highlight the significance of early investigation to identify the conditions in mitigating the hazards linked to PE.⁴ In PE

the malfunction of placenta and immunologic alterations causing inadequate perfusion of the uteroplacental. ⁵ In terms of the processes that lead to vascular dysfunction, PE is comparable to atherosclerotic and cardiovascular diseases in individuals who are not pregnant. During a typical pregnancy, cytotrophoblasts traverse spiral arteries and the uterine myometrium to supply blood to the placenta and the growing baby. This intricate network of vascular anastomoses ensures that everything stays nourished. ^{6,7} Preeclamptic women have less extensive endovascular invasion of their spiral arteries because their cytotrophoblasts lack the invasive phenotype necessary to form these strong anastomoses. ⁸ This can lead to placental ischemia and inadequate oxygen transport to fetus. ⁹ Complicated by maternal endothelial dysfunction, and increased vascular permeability ⁸, these changes injure the endothelium, activating the coagulation system and consuming platelets. ¹⁰ Increased platelet consumption due to alterations in the coagulation system causes thrombocytopenia, which in turn activates the bone marrow to compensate and release young platelets into the peripheral circulation. ¹¹ Researchers have studied various screening tests in an effort to predict PE and pinpoint those most at risk of adverse events. These screening tests include ultrasound imaging and laboratory investigations. ¹²⁻¹⁵ This study aims to ascertain the platelet count and platelet indices used in the prediction of preeclampsia.

MATERIALS AND METHODS

Study design

Our study is a retrospective case-control study that was carried out at the Maternity & Children Hospital in Sakaka, Al Jouf, Saudi Arabia, from September to December 2023. The hospital is considered as one of the reference centers in the Sakaka region and serves all residents of the Al-Jouf region. The study included the medical records of 88 preeclamptic women as cases (incomplete records were excluded); the data included age, occupation, gestational weeks, gravity, parity, blood pressure (systole and diastole), platelet count, mean platelet volume, platelet distribution width, hematocrit, hemoglobin, and white blood cell count. The complete blood count was analyzed by full hematology analyzer machine (5-Part Sysmex

XN-330). The 88 healthy pregnant ladies who came to the hospital for antenatal care or follow-up were recruited in this study as controls after verbal consent. Any records of women with preeclampsia according to the case definition were included in the study and those of women with diabetes mellitus, hypertension, thyroid disorders, liver disorders, and renal problems were not allowed to participate in this study. In this study we applied convenience sampling because the criterias were very narrow, so this study included the records of 88 patients who met the selection criteria and the control group number was selected equivalent to the number of cases. A nurse collected the samples from the control group as instructed. She had no knowledge of the results of the study group records to avoid bias.

Data analysis

The collected data was analyzed, using SPSS program version 20. The $p < 0.05$ was set as statistical significance.

Ethical approval

This research was authorized by Research Ethical Committee, Ministry of Health, Aljouf, Saudi Arabia (No.2023-107) on 10 September 2023.

RESULTS

Socio-clinical characteristics of study groups

The study included 88 preeclamptic ladies as cases and 88 apparently healthy pregnant women (who came for prenatal follow-up) as a control at the Maternity and Children Hospital in Sakaka, Al Jouf, Saudi Arabia. The hospital is one of the reference centers in Al Aljouf province. The mean age of cases was 33.4 ± 8.1 years and 32.1 ± 6.7 years for the control group, with no significant differences ($P = 0.249$). Table 1. In our study, the majority of the cases and control group were housewives (50% and 51%), public employees (21% and 19%), and private employees (18% and 17%), respectively, with no significant differences. Table 1. The mean gestational age in weeks of cases was 32.9 ± 8.2 and 33.1 ± 5.2 for the healthy group, with no significant difference ($P = 0.009$). Table 1. Our result showed no significant differences in gravidity and parity between cases and controls, with the mean 3.9 ± 3.2 and 2.3 ± 3.0 for cases and 3.6 ± 2.8 and 2.1 ± 2.8 for controls (P -value 0.587 and 0.539, respectively;

Table 1). Our results indicated that the systolic blood pressure of cases was 156.5±8.7 and 115±5.8 for the control group, with a significant difference ($p < 0.001$), and the diastolic blood pressure was 107.3±7.5 for cases and 72.6±7.2 for the healthy group, with a significant difference (Table 1).

Some hematological parameters among groups of the study

Some hematological parameters among study participants exhibited significant differences, like white blood cell count (WBCs), PC, MPV, PDW, and PCT, when comparing between cases and the control group, while other parameters, like hemoglobin and hematocrit, exhibited no significant differences when comparing between cases and the healthy group, as shown in Table 2. The white blood cell count, MPV, and PDW were significantly higher among cases when compared with the control group ($p < 0.001$) (WBC 10.2±5.0

$\times 10^9/L$ versus 7.6±1.80 $\times 10^9/L$, MPV 10.1±2.4 fl versus 8.6±1.3 fl, and PDW 15.8±1.4% versus 13.8±2.3%), while the platelet count (PC) and plateletcrit (PCT) were significantly lower than that of the control group ($p < 0.001$) (PC 178.1±60.7 $\times 10^9/L$ versus 282.2±77.0 $\times 10^9/L$ and PCT 0.14±0.04% versus 0.22±0.5%) (Table 2).

Area under the Curve

The ROC curve analysis of platelets indices showed that the platelets count had highest area under the curve, which was 0.92(95% CI 0.88- 0.97), followed by mean platelet volume 0.83 (95% CI 0.75 -0.90) and platelet distribution width 0.83 (95% CI 0.74-0.91), while the plateletcrit showed the lowest area under curve, which was 0.57 (95% CI 0.45-0.68). The platelets count can predict the preeclampsia at cu-off value $\leq 175.0 \times 10^9/L$ (sensitivity 88% and specificity 90%), followed by mean platelet volume at cu-off value

Table 1. Socio-clinical characteristics of study groups

Type of variable	Cases	Control	P-value
Age/yrs (mean±SD)	33.4±8.1	32.1±6.7	0.249
Occupation %			
housewife (%)	50	51	0.652
Public employee %	21	19	0.568
Private (%)employee	17	18	0.653
Gestational age/weeks	32.9± 8.2	33.1 ±5.2	0.092
Gravity	3.9±3.2	3.6±2.8	0.587
Parity	2.3 ±3.0	2.1±2.8	0.539
Blood pressureSystole mm/hg	156.5±8.7	115±5.8	< 0.001
Diastole mm/hg	107.3±7.5	72.6±7.2	< 0.001

*SD= standard deviation

Table 2. Some hematological parameters among groups of the study

Variables	Cases	Control	P-value
WBCs	10.2±5.0	7.6±1.8	< 0.001
Hb	11.1±1.0	11.7±1.3	0.372
Hct	35.1	35.3	0.753
PC	178.1±60.7	282.2±77.0	< 0.001
MPV	10.1±2.4	8.6±1.3	< 0.001
PDW	15.8±1.4	13.8±2.3	< 0.001
PCT	0.14±0.04	0.22±0.5	< 0.001

WBCs=White blood cell count, Hct= Hematocrit, PC=Platelet count, MPV=Mean platelet volume, PDW=Platelet distribution width, PCT = plateletcrit

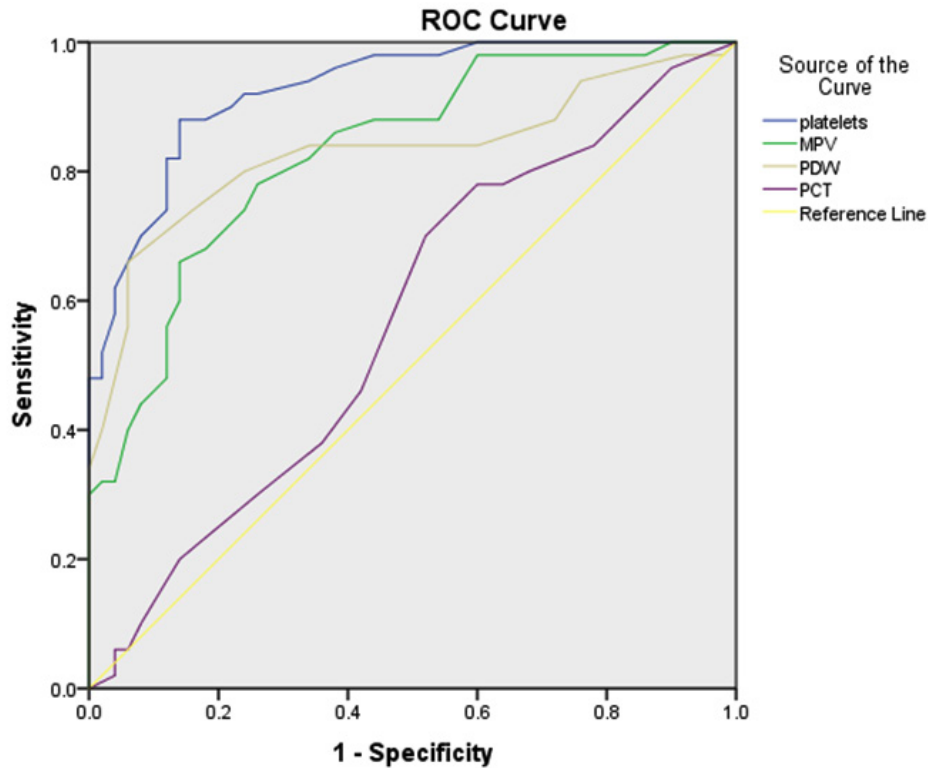
e^{10.7} fl (sensitivity 74% and specificity 84%), Platelet distribution width at cut-off value e^{16.6} fl (sensitivity 48.7 and specificity 76%) and plateletcrit at cut-off value d^{0.13}% (sensitivity 43.5 and specificity 74.7%) figure 1.

DISCUSSION

Modern medicine focuses on predicting diseases before they occur to prevent them or reduce their complications, especially in obstetrics.¹⁶ The complications of PE can be reduced or prevented through regular checkups, including laboratory tests. The endothelial damage of preeclamptic pregnant ladies leads to activation of thrombocytes. The platelets’ activation and consumption can

simply be assessed by platelet count and their indices.¹⁷⁻²⁰ This retrospective case control study was nearly matched in age, gestational weeks, gravidity and parity.

Regarding the platelet count in our study showed that significantly decreased between cases and control (178.1±60.7 X10⁹/L versus 28.2.2±77.0 X10⁹/L). This finding agrees with previous reports observed by Sultana,R. *et al*¹¹, Walle M, *et al.* at University of Godor in Ethiopia¹³, Tesfay F. *et al.* in Tigray region, Ethiopia²¹, Woldeamanuel GG *et al.* in meat-analysis study included 56 studies.²² The decreased platelet count could be related to endothelial injury in women with PE, which leading to aggregation and increase turnover of thrombocytes. In contrast some studies exhibited



Diagonal segments are produced by ties.

Platelets 0.92 (95% CI 0.88- 0.97)	MPV 0.83 (95% CI 0.75 -0.90)	PDW 0.83 (95% CI 0.74-0.91)	PCT 0.57 (95% CI 0.45-0.68)
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ROC: receiver operating characteristic, MPV=mean platelet volume, PDW=platelet distribution width, PCT=plateletcrit, 95%CI = 95% Confidence interval

Fig. 1. Area Under the Curve

no significant differences between platelets count between preeclamptic ladies and healthy pregnant women.^{14, 23-25} Variations in disease severity and sample size could be the cause of the discrepancies between the researchers. Our study showed that the MPV is significantly higher among cases (10.1 ± 2.4 fl) and lower among healthy control group (8.6 ± 1.3 fl). The increase in MPV among preeclamptic ladies could be elucidated by the fact that the platelet consumption in peripheral circulation and compensation by bone marrow lead to the release of large thrombocytes in peripheral blood. Our finding agreed with other reports done by Walle M, *et al*¹³, Tesfay F. *et al*²¹, Thalor N. *et al*²⁴, Udeh, P.I *et al*.¹⁵ In contrast to a study reported by Amita K. *et al*²⁶, he exhibited no significant differences in MPV between study group and normotensive healthy pregnant group. This variation possibly because of the fact that the delaying measurement of complete blood count in EDTA sample, could lead to increase in MPV over time.²⁷

Our study findings showed increased PDW in women with PE comparing to normal control group (15.8 ± 1.4 fl versus 13.8 ± 2.3 fl) P-value less than 0.05. Our result was in keeping with many reports showed raised PDW among women with PE, Walle M, *et al*¹³, Tesfay F. *et al*²¹, Thalor N. *et al*²⁴, Udeh, P.I *et al*¹⁵, Zahir M. *et al*²⁸, who reported an elevated readings can assist the obstetrician in promptly managing the patients. Also, Singh A, *et al*²⁹, concludes that PDW can be used along with platelet count as a marker of PE and Tokgöz Çakır B. *et al*³⁰, who conclude the PDW may be used as a marker to forecast unfavorable newborn outcomes in cases of preeclampsia. The poikilocytosis in platelets due to endothelial injury and red bone marrow activation could cause raised PDW among cases.¹⁸ Inversely, our finding was consistent with report done by AlSheeha MA *et al*¹⁴, and Gogoi P. *et al*.³¹ These variations could be due to differences in techniques used automated analyzers. Our result revealed that the PCT is lower among cases with PE, where was normal in healthy pregnant women ($0.14 \pm 0.04\%$ versus $0.22 \pm 0.5\%$) respectively. Our result was in keeping with Kurtoglu E *et al*²⁵, and Singh A. *et al*²⁹, he stated the severity of PE can be assessed using PCT in conjunction with platelet count. However lower value in the PCT among women with PE was reported by Thalor N. *et al*²⁴, and he

observed the variation between the two groups was not statistically significant. In contrast our result was disagreeing with study done by Choudhary, P. *et al*³², and Wu J. *et al*³³, he reported that the PCT not differentiate between PE and normal pregnant women.

The receiver operational curve analysis exhibited that the platelet count had largest area under curve (0.92 (95% CI 0.88- 0.97), and could differentiate preeclamptic women from healthy at cut-off value $\geq 175.0 \times 10^9/L$ (sensitivity 88% and specificity 90%, our finding was in keeping with the studies done by Walle M, *et al*¹³, Tesfay F. *et al*²¹, and AlSheeha MA *et al*¹⁴, he stated that preeclampsia can be accurately predicted by platelets below $248.0 \times 10^3/iL$.

The MPV represent the second large AUC of platelets indices 0.83 (95% CI 0.75 -0.90), which could helping in prediction of PE at cut-off value ≥ 10.7 fl (sensitivity 74% and specificity 84%), our finding was in line with Bellos I. *et al*³⁴, he conclude that the mean platelet volume is a useful diagnostic for identifying and monitoring people who develop preeclampsia and Bhamri SS. *et al*³⁵, he stated that MPV >10.55 fL with 68.7% sensitivity and 55.9% specificity could predict the patients with PE. The PDW showed moderate AUC of platelet indices 0.83 (95% CI 0.74-0.91) and could helping in prediction of PE at cut-off value ≥ 16.6 fl (sensitivity 48.7 and specificity 76%), this finding is similar to the research done by Tokgöz Çakır B. *et al*³⁰, he draws attention to PDW's potential as a marker for forecasting unfavorable newborn outcomes in cases of PE and Walle M, *et al*¹³, he implies that PDW might be used as a marker to forecast PE and Udeh, P.I. *et al*¹⁵, he highlighted PE seems to be reliably predicted by PDW in the middle of the second trimester's weeks of gestation. Also, Bawore SG. *et al*³⁶, he found PCT to be a potential candidate marker for pregnant women's preeclampsia prediction. The PCT had the lowest AUC of 0.57 (95% CI 0.45-0.68), which is seen as a weak indicator for predicting PE at a cut-off value of $\leq 0.13\%$ (with a sensitivity of 43.5 and specificity of 74.7%). Our finding was in keeping with Freitas, L. G. *et al*³⁷, he stated that except for PCT, which is deemed unsuitable for this PE prediction, analysis of the ROC curve for variables showed that the parameters had regular diagnostic significance for PE.

CONCLUSION

Our results exhibited that the drop in PC, increased MPV, and PDW at cut-off value $\leq 175.0X 10^9/L$, ≥ 10.7 fl, and ≥ 16.6 fl respectively can help in the diagnosis and prediction of PE. The regular monitoring and interpreting full blood count (mainly platelet indices) could help the obstetricians in predicting PE besides well obstetric history and examination.

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Conflict of interest

The authors do not have any conflict of interest.

Data Availability

This statement does not apply to this article.

Ethics Statement

This research was authorized by Research Ethical Committee, Ministry of Health, Aljouf, Saudi Arabia (No.2023-107) on 10 September 2023.

Informed Consent Statement

This study did not involve human participants, and therefore, informed consent was not required.

Clinical Trial Registration

This research does not involve any clinical trials.

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Not Applicable.

Authors' Contribution

Albadawi Talha: Conceptualization, supervision, Project Administration, Methodology, Writing – Original Draft; Yara Albarrak: Data Collection; Norah Alruwaili: Data management and analysis; Hadeel Aldraan: Data Collection; Fai Al Shamari: Data Collection.

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