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Socio-Demographics, Hematological Assessments, and a Correlation Between Platelet Indices in Preeclampsia in Sulaimani Governorate, Iraq

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Abstract

Preeclampsia (PE), a serious disorder during pregnancy, is most commonly defined as blood pressure≥140/90 mmHg and protein in urine>300 mg/24-hour after 20 weeks of gestation. This study aimed to identify the hematological characteristics, to examine the influence of social and demographic factors on their prevalence, and to assess the correlation between platelet indices and red blood cell indices with relevant variables. A total of 80 pregnant women who were recruited at 20 weeks or later with complete blood counts analyzed by Coulter counter, were included in this study. The largest percentage of preeclampsia cases were found in primigravida women aged 30-39 years, living outside urban areas, who were obese and had blood type O. It was discovered that the values of erythrocyte distribution width (RDW%) and granulocytes% (GRA%) exhibited statistically significant differences between patients with preeclampsia and those without. Moreover, the mean platelet volume (MPV), platelet larger cell ratio (P-LCR%), platelet distribution width (PDW%), and platelet larger cell count(P-LCC) of these women were higher than those in normal pregnant women. Still, their platelet counts (PLT) decreased significantly.A noteworthy negative association emerged between RDW and PLT. At the same time, positive correlations were identified between RDW and both hemoglobin (Hb) and mean corpuscular hemoglobin concentration (MCHC). Recognized risk factors for PE include obesity and blood group O. This study concludes that indicators of RDW and platelet indices could serve as predictive markers for anticipating this serious pregnancy-related condition.

Keywords: Preeclampsia. Hypertension. Granulocyte. platelet indices.

التقييم الاجتماعي والديموغرافي والدموي وعلاقته مع مؤشرات الصفيحات الدموية في تسمم الحمل في محافظة السليمانية، العراق

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الخلاصة

يعد تسمم الحمل حالة حرجة في الحمل ، وهو محور هذه الدراسة، التي تهدف إلى تحليل صفات الدم ، واستكشاف تأثير العوامل الاجتماعية والديموغرافية على انتشاره، وتحديد الارتباطات بين مؤشرات الصفائح الدموية و كريات الدم الحمر مع المتغيرات ذات الصلة. شاركت ثمانون امرأة حامل في هذه الدراسة ، وتم تسجيلهن في الأسبوع العشرين أو أكثر من الحمل، مع تحليل تعداد الدم الكامل باستخدام عداد كولتر. حدثت غالبية حالات تسمم الحمل لدى النساء الحوامل لأول مرة في عمر 30–39 عامًا، والمقيمات خارج المناطق الحضرية، ويتميزن بالسمنة، وفصيلة الدم O. اظهرت النتائج ارتفاع معنوي عالي في نسبة الخلايا الحبيبية (GRA%) وعرض توزيع و كريات الدم الحمر (RDW%) في مجموعة تسمم الحمل. بالإضافة إلى ذلك، أظهرت هذه المجموعة ارتفاعًا في معدل حجم الصفيحة الدموية (MPV)، ونسبة الخلية اكبر–الصفيحة (P–LCR)، وعرض توزيع الصفيحة الدموية (PDW%)، وعدد الخلية اكبر –الصفيحة (P–LCC) مقارنة بالأفراد ذوي ضغط الدم الطبيعي، على الرغم من انخفاض معنوي عدد الصفيحة الدموية (PLT) بشكل كبير. وقد ظهرت علاقة سلبية جديرة بالملاحظة بين RDW وPLT، في حين تم تحديد ارتباطات إيجابية بين RDW وكل من الهيموغلوبين (Hb) ومعدل تركيز هيموغلوبين الكريات (MCHC). وشملت عوامل الخطر المحددة لتسمم الحمل السمنة وفصيلة الدم O. وخلصت هذه الدراسة أن مؤشرات RDW ومؤشرات الصفائح الدموية يمكن أن تكون بمثابة علامات تنبؤية لتوقع هذه الحالة الخطيرة المرتبطة بالحمل.

1.Introduction

Preeclampsia (PE) is a medical condition that only affects pregnant women and is characterized by multiorgan dysfunction, increased systemic vascular resistance, activation of the clotting system, endothelial cell malfunction, and constrained fetal growth [1]. A woman who was previously normotensive and nonproteinuric but develops new-onset proteinuria after 20 weeks of pregnancy is diagnosed with hypertension (defined as systolic blood pressure (SBP) ≥140 and/or diastolic blood pressure (DBP) ≥90 mmHg at two measurements 4 hours apart) [2,3]. PE is the leading cause of perinatal mortality and morbidity worldwide and is the second most significant factor contributing to maternal mortality [4]. Every year, PE causes 76,000 maternal deaths and 500,000 perinatal deaths, and complicates 3–5% of pregnancies [5]. The World Health Organization (WHO) states that developing countries experience a higher rate of PE compared to developed nations [6]. The cause of PE is unknown, although it has been established that certain risk factors, including obesity, diabetes mellitus (DM) [7], autoimmune illnesses, repeated pregnancies, genetic predisposition, nutritional deficiencies, primigravidity, teenage pregnancy, and age above 35, increase the likelihood of developing the condition. The pathogenesis of PE is a deficiency in remodeling of the spiral arteries caused by total or partial failure of trophoblastic invasion of the spiral artery myometrial segments between 12 and 20 weeks [8]. The fetoplacental unit experiences inadequate blood flow due to the narrow bore, low capacitance, and high resistance of spiral arteries. This leads to placental hypoperfusion and the generation of oxidative stress, causing damage to endothelial cells in multiple organs [8]. The most frequent hemostatic anomaly in PE is thrombocytopenia, which is caused by endothelial dysfunction, increased platelet consumption, uncontrolled intravascular platelet activation with peripheral destruction, and a decrease in platelet count [9- 11]. The goal of this study is to demonstrate how blood parameters may be used as a low-cost method to predict the risk and severity of preeclampsia in the Sulaimani governorate, where there is a hematological variance linked with the condition.

2. Methodology

From January to May 2023, 80 pregnant women were sequentially recruited at a Sulaimani City maternity teaching hospital for a cross-sectional comparative study. After matching for

gestational age, 40 cases of preeclampsia and 40 normotensive pregnancies formed separate groups. Participants, meeting inclusion criteria, answered questions on age, pregnancy, chronic illness, hemopoietic issues, blood type, and socio-demographic characteristics. Data also included weight and height for Body Mass Index (BMI) calculation. During regular check-ups, skilled gynecologists diagnosed preeclampsia or normal based on clinical history, blood pressure, and urine protein levels.

2.1. Definition of clinical variable

Blood pressure of less than (140/90 mmHg) and gestational age of 20 weeks or less indicates a normotensive pregnancy [12]. Pre-eclampsia: Pregnancy at a gestational age of 20 weeks with blood pressure (140/90 mmHg) and (0.3 g) protein in 24-hour urine. The lab investigation involved taking 2.5 milliliters of venous blood from each participant and placing it in a K3-EDTA anticoagulated container to analyze the full blood count. The samples were then kept at room temperature until processing within four hours of collection. Coulter was used to automate the full blood count. BMI was calculated by dividing a person's height in meters squared by their weight in kilograms. The following weight categories were screened using this technique: underweight <18.5, healthy weight (18.5-24.9), overweight (15.0-29.9), and obesity >30.0.

3. Statistical Analysis

Data were analyzed with IBM SPSS version 29, represented as (mean ± standard deviation). A p-value < 0.05 was considered statistically significant. Spearman's rank correlation coefficient (r) was calculated, with p-values derived from (r). A $p < 0.01$ was deemed significant.

4. Institutional Review Board Approval

This study was approved by the Institutional Review Board under exempt status (UoS-Sci-Bio, reference number: 008).

5. Results

The participants were separated into three age groups, as shown below: 35 of them were between the ages of 20 and 29, with preeclampsia affecting 45%. The percentage increased to 35% for those aged from (30 to 39) and decreased to 20% for those aged between (40 to 50). The association between residence and preeclampsia is quite minimal. Additionally, primigravidas comprised 74.1% of the participants. Table 1 includes the individuals' blood group and BMI status. Blood group O comprised 42.5% of preeclampsia cases, with AB types at 5%. 60% of preeclampsia cases and 54.3% of all participants were obese. Additionally, 50% of preeclampsia cases occurred between 28 and 33 weeks of gestation, as shown in Table 1.

Table 1: Socio-demographic profiles and hematological indicators of normotensive pregnant women and those with preeclampsia

Socio-demographic status		Preeclampsia group n=40(%)	Normal group n=40(%)	Totals n=80 (%)	P-value
Age (Year)	20-29	18 (45%)	17 (43.8%)	35 (44.4%)	
	30-39	14 (35%)	18 (44%)	32 (39.5%)	0.554
	40-50	8 (20%)	5 (12.2%)	13 (16%)	
	Mean ± SD	31.3 ± 7.03	30.6 ± 6.41		0.681
Residency	Inside city	18 (45%)	23 (58.5%)	41 (51.9%)	
	Outside city	22 (55%)	17 (41.5%)	39 (48.1%)	0.223
Gravidity	Primigravida	23 (57.5%)	36 (90.2%)	59 (74.1%)	0.01
	Multigravida	17 (42.5%)	4 (9.8%)	21 (25.9%)	
	Mean ± SD	2.8 ± 2.08	3.29 ± 1.6		0.228
Blood Groups	A	11 (27.5%)	8 (19.5%)	19 (23.5%)	
	B	10 (25%)	14 (34.1%)	24 (29.6%)	0.459
	AB	2 (5%)	1 (2.4%)	3 (3.7%)	
	O	17 (42.5%)	17 (43.9%)	34 (43.2%)	
BMI Status	Underweight	0 (0%)	1 (2.4%)	1 (1.2%)	
	Normal	5 (12.5%)	6 (14.6%)	11 (13.6%)	0.614
	Overweight	11 (27.5%)	14 (34.1%)	25 (30.9%)	
	Obesity	24 (60%)	19 (48.8%)	43 (54.3%)	
	Mean ± SD	30.7 ± 4.53	29.23 ± 4.42		0.14
Gestational Age (Week)	20-27 weeks	6 (15%)	4 (12.2%)	10 (13.6%)	
	28-33 weeks	20 (50%)	16 (39%)	36 (44.4%)	0.452
	34-38 weeks	14 (35%)	20 (48.8%)	34 (42%)	
	Mean ± SD	31.56 ± 4.08	32.35 ± 4.47		0.347
Total		40 (100%)	40 (100%)	80 (100%)	

The chi-square test of independence was used to compare proportions across categories between two groups. A p-value < 0.05 was considered statistically significant.

Except for the GRA%, which significantly increased in the preeclampsia group (P-value 0.05), there was no significant change in white blood cells or other subtypes in either the preeclampsia or normal groups, as shown in Table 2.

Table 2: Comparison of WBC count and differential leukocytes in preeclampsia and the control group

Variables	Preeclampsia group (n=40) Mean ± SD	Normal group (n=40) Mean ± SD	P-value
WBCs 10^9/L	10.64 ± 2.77	10.26 ± 3.14	0.572
LYM 10^9/L	2.29 ± 0.95	2.29 ± 0.53	0.981
LYM %	22.3 ± 7.94	24.5 ± 7.2	0.187
MID 10^9/L	0.56 ± 0.75	0.48 ± 0.37	0.527
MID %	5.34 ± 4.7	5.08 ± 3.8	0.787
GRA 10^9/L	7.95 ± 2.51	7.26 ± 2.94	0.254
GRA %	73.13 ± 8.81	68.783 ± 9.98	0.041

Independent Samples t-test has been used, with P<0.05 considered statistically significant.

As shown in Table 3, there were no significant differences in RBC count, hemoglobin (HGB), hematocrit (HCT%), MCV, MCH, or MCHC levels between the control and preeclampsia groups. However, RDW% was significantly elevated (P-value < 0.05) in the preeclampsia group compared to normotensive pregnant women.

Table 3: Comparison of red blood corpuscle (RBCs) parameters and RBC indices in preeclampsia, and normal groups

Parameters	Preeclampsia Groups (n=40) Mean ± SD	Normal Groups (n=40) Mean ± SD	P-value
RBC (10^12/L)	4.118 ± 0.487	4.1522 ± 0.5105	0.7587
HGB (g/dl)	11.8275 ± 1.1769	11.927 ± 1.1983	0.708
HCT %	35.565 ± 3.4149	36.307 ± 3.9995	0.3714
MCV (fl)	86.5075 ± 7.8174	86.124 ± 6.8740	0.815
MCH (pg)	28.825 ± 2.871	28.778 ± 2.7353	0.9401
MCHC (g/dl)	33.295 ± 1.0429	33.083 ± 1.2108	0.401
RDWa (fl)	57.6175 ± 6.3081	56.322 ± 5.6880	0.3344
RDW %	13.3875 ± 1.3288	12.559 ± 1.2432	0.005

Independent Samples t-test has been used, with P<0.05 considered statistically significant.

The preeclampsia group showed a significantly increased value (P-value = 0.0001) when compared to normal pregnant women in terms of MPV and P-LCR, as shown in Table 4. Preeclampsia was associated with a significant drop in PLT but a significant increase in PDWa and P-LCC (P-value 0.05). Table 4 shows that there were no statistically significant changes in either the PCT% or PDW% (P-value > 0.05).

Table 4: Comparison of platelet count, platelet indices in preeclampsia and normal groups

Parameters	Preeclampsia **Group** (n=40) Mean ±SD	Normal **Group** (n=40) Mean ± SD	P-value
PLT (10^9/L)	187.825 ± 67.104	230.805 ± 63.978	0.0042
MPV (fl)	10.34 ± 1.138	9.168 ± 1.2491	0.000
PDWa (fl)	13.185 ± 1.703	12.171 ± 1.7065	0.0090
PDW %	43.223 ± 7.7145	42.9975 ± 3.56640	0.866
PCT %	0.187 ± 0.0654	0.19768 ± 0.045882	0.3964
P-LCR %	30.06 ± 7.7648	22.656 ± 8.0642	0.000
P-LCC (10^9/L)	53.65 ± 19.345	45.732 ± 12.0914	0.0296

Independent Samples t-test has been used, with P<0.05 considered statistically significant.

PDWa and MPV had a positive correlation with mean arterial pressure (MAP), as illustrated in Table 5. MAP was negatively linked with PLT, P-LCR, and P-LCC; however, this correlation was not statistically significant (P-value > 0.05).

Table 5: Correlation of platelet parameters with mean arterial pressure (MAP)in preeclampsia group

Parameters	Correlation index	P-value
PLT	-0.247	0.125
MPV	0.213	0.187
PDWa	0.156	0.335
P-LCR	-0.137	0.401
P-LCC	-0.092	0.574

According to Table 6, there was a statistically significant positive association between RDW and Hb, as well as MCHC (P-value 0.01), and BMI (P-value 0.05). On the other hand, a substantial negative correlation was found between RDW and PLT (P-value 0.05).

Table 6: Correlation of Hb, MCHC, PLT, and BMI with RDW in preeclampsia group

Parameters	Correlation index	P-value
Hb	0.491	0.001
MCHC	0.959	<0.001
PLT	-0.387	0.014
BMI	0.316	0.047

Table 7: Correlation of MPV, PDWa, P-LCR, P-LCC with PLT in preeclampsia

Platelet Parameters	Normal	Preeclampsia	P-value
MPV	-0.648	-0.529	< 0.001
PDWa	-0.557	-0.601	< 0.001
P-LCR	-0.627	-0.104	0.523
P-LCC	0.047	0.676	< 0.001

Table 7 shows that there are statistically significant negative correlations between PLT and MPV, as seen in Figure 1, and between PLT and PDWa, as seen in Figure 2, with a P-value of less than 0.01. Furthermore, a non-significant negative correlation, with P-LCR as revealed in Figure 3. A statistically significant positive correlation has been found between PC and P-LCC with a P-value of less than 0.01, as revealed in Figure 4. Based on the graph, the city's first gravida had the highest percentage of gravidas, while the sixth, fifth, and eighth gravidas had the lowest percentages (Figure 5).

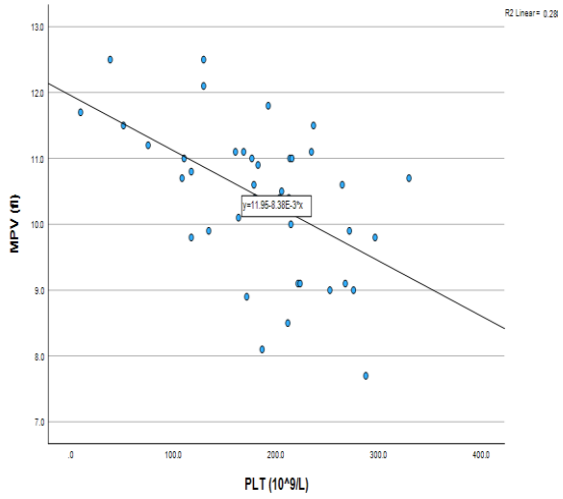

Figure 1: Correlation of PLT with MPV

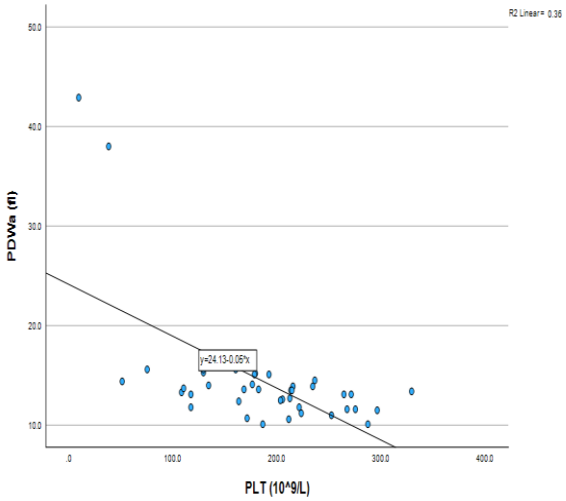

Figure 2: Correlation of PLT with PDWa

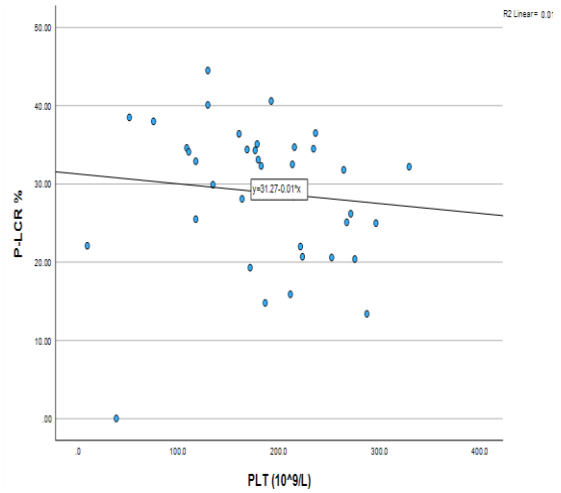

Figure 3: Correlation of PLT with P-LCR%

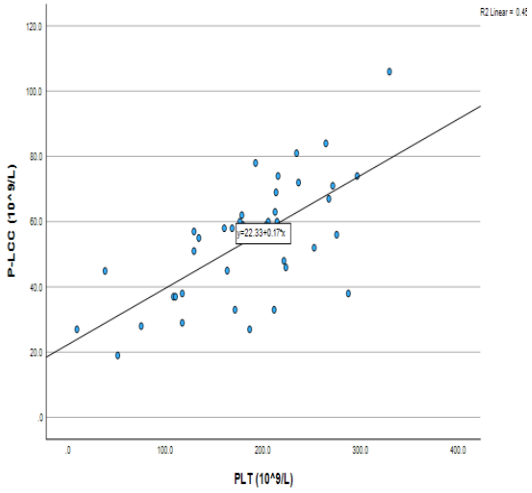

Figure 4: Correlation of PLT with P-LCC

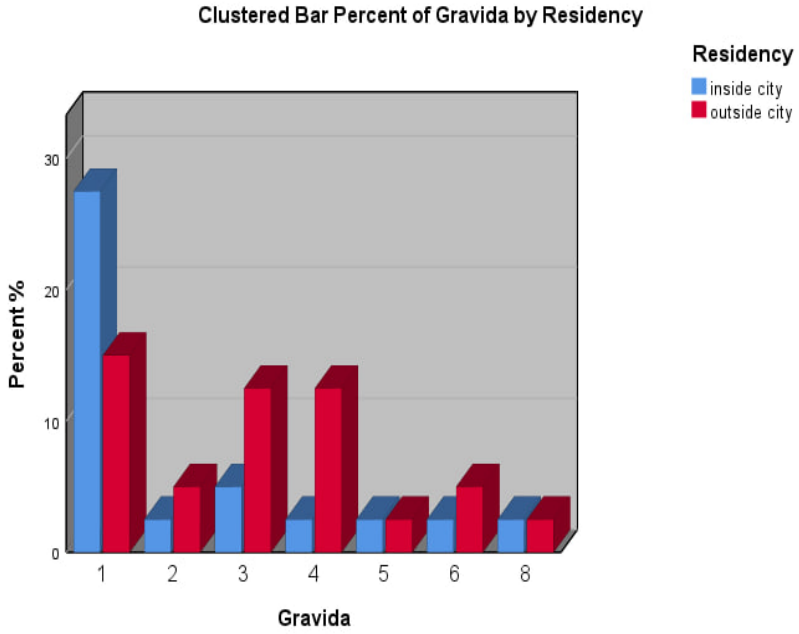

Figure 5: Percent of gravida by residency in preeclampsia group

Limitations: The greatest limitation of this study was the practical aspect, involving the use of the Coulter to automate the full blood count and other essential instruments in the hospital. This is why our sample size was limited to only 80 participants.

Discussion

According to this study, there were significant differences in the gravida and GRA%, RDW, PLT, PDW, MPV, P-LCR, and P-LCC between preeclampsia group and normal pregnant women. In contrast to the study conducted by Aziz *et al.,* [13], who discovered advanced maternal age as a risk factor for the incidence of preeclampsia in Bandung, younger women aged 20-29 were found to have a higher risk of developing preeclampsia compared to women with regular pregnancies. This risk decreased for women in the 30-39 age group. Preeclampsia was shown to be more common in primigravida when compared to multigravida. This difference is believed to be associated with a greater immune response and cytokine production (autoimmunity) in primigravida [14 and 15]. Similar to findings from the

study on preeclampsia in Mexico, no statistically significant difference was identified in the occurrence of preeclampsia among various ABO blood groups. [16]. The prevalence of overweight and obesity in the preeclampsia group was higher than that in the normal pregnancy group, but there was no significant difference. It has been noted that the development of preeclampsia is associated with obesity through inflammation and oxidative stress [17]. In this study, early-onset preeclampsia with a gestational age of 28–33 weeks was closely related to a high risk of preeclampsia, which corresponds to the finding by Kumasawa [18]. The level of WBC, MID, and GRA% were all slightly higher in women with preeclampsia versus those who were healthy pregnant. This may be caused by the lower LYM% present in preeclampsia patients because the condition is associated with innate immune activation. The increasing WBC while decreasing LYM% suggests possible inflammation associated with preeclampsia [19]. We found that HB and HCT were lower, while MCV was higher in preeclampsia than in normal pregnant women. Changes in normal pregnancy are attributed to the rise in blood volume rather than to vitamin B12 deficiency anemia. Therefore, the differences in blood volume expansion could potentially be slightly larger in women with preeclampsia relative to those with normal pregnancies. The current study discovered higher MCV values and RDW% levels in preeclampsia compared to normal pregnant women, and a negative correlation between RDW% and MAP was discovered, suggesting that rising RDW% levels may not be related to rising blood pressure in preeclampsia. Additionally, a strong positive correlation between HB and MCHC and RDW% was discovered, suggesting that rising RDW% levels may not be related to iron deficiency anemia in preeclampsia, a microangiopathic hemolytic anemia observed in severe preeclampsia and hellp syndrome, may be suggested by an increasing RDW% along with MCHC and Hb levels, and a decreasing PLT count. Furthermore, we discovered a significant positive association between BMI and RDW% in preeclampsia, which is significantly connected with microangiopathic hemolytic anemia and inflammation. It has been found that higher BMI increases the production of more cytokines and promotes inflammation. It has also been found that obesity is a risk factor for microangiopathic hemolytic anemia. In contrast, Abdullahi *et al.* found no correlation between preeclampsia and RDW in Sudan [20]. On the other hand, Nori et al. demonstrated that red cell distribution width (RDW) exhibited a significant association with established predictors and severity indicators of preeclampsia, independent of gestational age and body mass index [20]. In contrast, Umezuluike *et al.* did not find a significant difference in procalcitonin levels between women with preeclampsia and those with normal pregnancies, which may be attributed to differences in gestational age [21,22]. Based on our research, MPV, PDW, P-LCC, and P-LCR, and platelet-larger cell count (P-LCC) were significantly higher in women with preeclampsia compared to those with normal pregnancies. Al-Sheeha *et al*. utilized a single gestation group and found no significant disparity in PDW and MPV between normal and preeclampsia groups in Saudi Arabia [23].Additionally, Martanti *et al.* concluded that there were no significant alterations in the hematological parameters of individuals with preeclampsia when compared to normotensive pregnant women [24]. By contrast, the present study comprised several gestation subgroups and demonstrated an elevated P-LCC value in preeclampsia compared with those of normal pregnant women. Negative correlations were found within the preeclampsia and normal groups between PLT and MPV, PDW and P-LCR. It indicates that preeclampsia can result in endothelial lesions, leading to increased platelet consumption and the generation of larger new platelets [25]. There was a positive correlation between PLT and P-LCC, suggesting that higher value of P-LCC might be associated with inflammation instead of stimulation of platelet generation. This is strengthened by the fact that P-LCC are positively correlated with granulocytes percentage. In preeclampsia, a positive correlation of MPV and PDW with MAP, as well as that of systolic blood pressure, was demonstrated. It

seems that an elevation in MPV and PDW might correlate with the severity of the disease. Lastly, there are also differences in gestational age, maternal demographics, and inflammatory scores of the pregnant population, which affect hematological parameters [26].

7. Conclusion

Preeclampsia heightens maternal risks. A significant negative association of RDW with PLT and a positive correlation of RDW with Hb, MCHC, and BMI were observed. PLC shows substantial negative associations with MPV, PWDa, and P-LCR, along with a significant positive correlation with P-LCC. Cost-effective platelet indices can aid in predicting preeclampsia.

Conflict of Interest: We declare that we do not have any conflict of interest

Implication: The statement stresses improving pregnant women's care quality, focusing on healthcare system aspects. It highlights enhancing individual performance, routinely investigating hematological parameters for preeclampsia, and addressing obstetrics' lack of validated measures. The goal is to boost patient safety.

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