**Alqalam Journal of Medical and Applied Sciences**. 2026;9(2):509-515
https://doi.org/10.54361/ajmas.269231

*Original article*

# Diagnostic Value of Platelet Indices in Predicting Pre-eclampsia

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**Abstract**
Platelet indices, including platelet count (PC), mean platelet volume (MPV), platelet distribution width (PDW), and plateletcrit (PCT), have been proposed as potential markers for the early prediction of pre-eclampsia. This study aimed to investigate the diagnostic value of PC, MPV, the PC/MPV ratio, and PDW in predicting pre-eclampsia. A prospective cohort study was conducted on 100 pregnant women in their first trimester attending the Obstetric Outpatient Clinic at Al-Bayda Medical Centre for routine care. At each visit, a complete blood count (CBC) was performed to assess platelet indices. The comparison between the pre-eclampsia group (Group I) and the non-pre-eclampsia group (Group II) revealed no significant differences in age or parity (P = 0.426 and 0.812, respectively). However, gestational age was significantly lower in Group I. Hemoglobin levels and total leukocyte counts showed no significant differences between groups. In contrast, PC was significantly decreased in Group I compared to Group II. At a PC ≤214, the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and area under the curve (AUC) for predicting pre-eclampsia were 77.78%, 76.92%, 25.0%, 97.2%, and 0.748, respectively. MPV and PDW were significantly higher in Group I, while the PC/MPV ratio was significantly reduced. In conclusion, platelet indices—including PC, MPV, PC/MPV ratio, and PDW—are significant predictors of pre-eclampsia. These parameters demonstrated marked differences between pre-eclamptic and non-pre-eclamptic women, highlighting their potential utility for early detection and management of pre-eclampsia.
**Keywords**. Platelet Indices, Prediction, Pre-eclampsia.

## Introduction

Pre-eclampsia is an obstetric condition that affects "6–8%" of pregnancies globally. After the 20th week of pregnancy, it is characterized by hypertension (blood pressure ≥140/90 mmHg), proteinuria (≥0.3g/d), and other symptoms. It has high mortality and morbidity rates [1]. Pre-eclampsia has been linked to several variables, including inadequate trophoblastic invasion of the maternal vascular bed and consequent restriction of placental blood flow, even if the precise pathophysiology of the condition is still unclear [2, 3]. Placental under perfusion generates broad systemic, maternal endothelial dysfunction, and increased vascular permeability [4]. The coagulation system is activated when platelets meet injured endothelium, increasing bone marrow output and platelet production [5]. The main pathophysiological processes in pre-eclampsia include changes in the haemostatic system, such as endothelial cell damage, platelet activation, and increased intravascular thrombin production [6]. Various indices are used to measure platelet functions, for example, the platelet count (PC), mean platelet volume (MPV), the PC to MPV ratio, and platelet distribution width (PDW); PDW measures platelet size distribution [7].

In a pre-eclampsia patient, one of the systems most severely impacted by immunological dysfunction and inflammatory responses in mothers is the coagulation-fibrinolytic system [8]. The control of utero-placental circulation and organ perfusion in pregnant women depends on the equilibrium between coagulation and anticoagulation. For a typical pregnant lady, a suitable increase in blood coagulation is necessary to minimize postpartum hemorrhage and associated problems [9]. When this balance is upset in pre-eclampsia patients, the pathogenesis of pre-eclampsia occurs in the form of spasm of the blood vessels, and in turn, the bloodstream of the placenta and many organs is blocked by micro-thrombosis [10]. In addition to various organ dysfunction and systemic metabolic problems, the hypercoagulable state of pre-eclamptic women may even endanger the lives of the mother and foetus [11]. Since pregnancy termination is now the only effective treatment for pre-eclampsia, a trustworthy predictor of pre-eclampsia would be crucial for early prevention and management [12]. This work aims to investigate the diagnostic value of PC, MPV, the PC to MPV ratio, and PDW for the prediction of pre-eclampsia.

## Patients and methods

One hundred pregnant women in the first trimester of their pregnancies who were receiving standard obstetric care at the Al-Bayda Medical Center's Obstetric Outpatient Clinic were included in this prospective cohort research.

### *Ethical Consideration*

All women were informed before enrolment, and their written consent was acquired. Approval of the study was received from the ethics committee of the department, and agreement was gained from the pregnant women participating in the study.


***Received****: 22-12-2025 -* ***Accepted****: 20-02-2026 -* ***Published****: 26-02-2026*

### *Data collection*

According to the study protocol, a complete blood count (CBC) was performed at each visit, and platelet indices were recorded, including platelet count (PC), mean platelet volume (MPV), platelet distribution width (PDW), and the PC/MPV ratio. PDW was used to assess platelet size distribution.

### *Eligibility criteria*

Eligible participants were women with singleton, viable pregnancies in the first trimester, calculated either from the first day of the last menstrual period or confirmed by ultrasonographic estimation. Women were excluded if they had idiopathic thrombocytopenic purpura (ITP) or any other hematological disorder, hepatic or renal disease, a history of anticoagulant drug use, or long-term use of oral contraceptive pills.
This design allowed for the prospective monitoring of platelet indices throughout early pregnancy, enabling comparison between women who later developed pre-eclampsia and those who did not, thereby assessing the diagnostic value of these hematological parameters in predicting the condition.

### *Statistical analysis*

A coding sheet was created when the data was gathered. Analysis of data was performed by SPSS v25 (IBM®, Chicago, USA). The unpaired student t test was used to compare quantitative parametric data, which were displayed as mean and standard deviation (SD). The Mann-Whitney U test was used to compare quantitative non-parametric data, which were displayed as median and range. The Chi-square test was used to compare categorical data that were displayed as numbers and percentages.

## Results

This prospective cohort study included 100 pregnant women in the first trimester of pregnancy, attending Al-Bayda Medical Centre, Obstetric Outpatient Clinic, for routine obstetric care. Patients were classified into two groups: Group 1 included 9 pre-eclamptic patients, and Group II included 91 non-pre-eclamptic patients. Table 1 shows that the age ranged from 20 to 38 years, with a mean of 27.11 ± 6.13 years in group I and from 20 to 40 years, with a mean of 28.89 ± 6.39 years in group II. Parity ranged from 0-4 with a median value of 2 in group I and ranged from 0-4 with a median value of 2 in group II. Gestational age ranged from 28-37 weeks, with a mean value 32.67±3.43 weeks in group 1 and ranged from 31-40 weeks, with a mean value of 35.29 ±2.88 weeks in group II. The comparison between the two groups showed no significant differences in age or parity (P = 0.426 and 0.812), but gestational age was significantly lower in group I than in group II (P = 0.012).

***Table 1. Patients' characteristics of both groups***

| Patients' characteristics | | Group I (n=9) | Group II (n=91) | P value |
|---|---|---|---|---|
| Age (years) | Mean ± SD | 27.11 ± 6.13 | 28.89 ± 6.39 | 0.426 |
| | Range | 20-38 | 20-40 | |
| Parity | Median | 2 | 2 | 0.812 |
| | Range | 0-4 | 0-4 | |
| Gestational age (weeks) | Mean ± SD | 32.57 ± 3.43 | 35.29 ± 2.88 | 0.012* |
| | Range | 28-37 | 31-40 | |

**Significant as P value <0.05*

Table 2 shows that there was no significant difference between the two groups at any time point of measurement with respect to hemoglobin levels.

***Table 2. Hemoglobin (gm/dL) of both groups***

| Weeks | Group I (n=9) | | Group II (n=91) | | P value |
|---|---|---|---|---|---|
| | Mean | ±SD | Mean | ±SD | |
| 4 w | 12.61 | 1.13 | 12.55 | 0.99 | 0.873 |
| 8 w | 12.61 | 1.13 | 12.28 | 1.04 | 0.368 |
| 12 w | 12.42 | 1.08 | 12.04 | 1.06 | 0.303 |
| 16 w | 12.14 | 1.03 | 11.77 | 1.05 | 0.311 |
| 20 w | 11.94 | 1.00 | 11.54 | 1.08 | 0.283 |
| 24 w | 11.68 | 0.99 | 11.26 | 1.08 | 0.275 |
| 28 w | 11.51 | 1.00 | 11.02 | 1.09 | 0.202 |
| 32 w | 10.88 | 0.98 | 10.76 | 1.14 | 0.822 |
| 34 w | 10.75 | 0.83 | 11.93 | 1.08 | 0.515 |
| 36 w | 10.40 | 0.95 | 10.10 | 0.97 | 0.601 |
| 37 w | 10.20 | 0.99 | 9.79 | 0.96 | 0.561 |
| 38 w | --- | --- | 9.73 | 0.88 | --- |
| 39 w | --- | --- | 9.65 | 0.92 | --- |
| 40 w | --- | --- | 9.83 | 0.64 | --- |


***Received****: 22-12-2025 -* ***Accepted****: 20-02-2026 -* ***Published****: 26-02-2026*

https://doi.org/10.54361/ajmas.269231

Table 3 shows that there was no significant difference between the two groups at any time point of measurement with respect to total leukocyte count (TLC).

***Table 3. TLC (×10³/µL) of both groups***

| Weeks | Group I (n=9) | | Group II (n=91) | | P value |
|---|---|---|---|---|---|
| | Mean | ±SD | Mean | ±SD | |
| 4 w | 7.41 | 1.75 | 7.55 | 1.95 | 0.841 |
| 8 w | 8.29 | 2.36 | 7.99 | 2.02 | 0.673 |
| 12 w | 8.71 | 2.53 | 8.39 | 2.03 | 0.657 |
| 16 w | 9.18 | 2.50 | 8.82 | 2.02 | 0.618 |
| 20 w | 9.60 | 2.41 | 9.20 | 1.98 | 0.575 |
| 24 w | 10.00 | 2.47 | 9.58 | 2.02 | 0.564 |
| 28 w | 10.31 | 2.49 | 9.95 | 2.01 | 0.615 |
| 32 w | 10.54 | 1.87 | 10.39 | 2.13 | 0.878 |
| 34 w | 10.35 | 1.48 | 10.39 | 2.18 | 0.681 |
| 36 w | 10.50 | 1.42 | 11.00 | 2.46 | 0.734 |
| 37 w | 11.00 | 0.14 | 11.16 | 2.42 | 0.926 |
| 38 w | --- | --- | 11.55 | 2.63 | --- |
| 39 w | --- | --- | 11.81 | 2.74 | --- |
| 40 w | --- | --- | 11.83 | 2.46 | --- |

**Significant as P value <0.05*

Table 4 shows that there were no significant differences in platelet count between the two groups at 4, 8, 12, 16, and 20 weeks of gestation (P = 0.801, 0.587, 0.442, 0.300, and 0.208, respectively). However, a significant decrease in platelet count was observed in Group I compared to Group II at 24, 28, 32, 36, and 37 weeks (P = 0.017, 0.006, 0.028, 0.009, 0.001, and 0.015, respectively).

**Table 4. Platelet count (×10³/µL) of both groups**

| Weeks | Group I (n=9) | | Group II (n=91) | | P value |
|---|---|---|---|---|---|
| | Mean | ±SD | Mean | ±SD | |
| 4 w | 277.78 | 69.87 | 284.18 | 72.50 | 0.801 |
| 8 w | 268.56 | 70.43 | 282.38 | 72.84 | 0.587 |
| 12 w | 261.44 | 72.15 | 281.00 | 72.61 | 0.442 |
| 16 w | 253.00 | 71.91 | 279.40 | 72.48 | 0.300 |
| 20 w | 246.56 | 71.09 | 278.74 | 72.74 | 0.208 |
| 24 w | 215.78 | 61.61 | 276.97 | 72.83 | 0.017* |
| 28 w | 206.00 | 50.22 | 276.10 | 73.51 | 0.006* |
| 32 w | 202.20 | 68.78 | 279.16 | 74.77 | 0.028* |
| 34 w | 168.00 | 59.06 | 273.22 | 75.95 | 0.009* |
| 36 w | 115.00 | 54.37 | 275.10 | 72.40 | 0.001* |
| 37 w | 133.00 | 49.50 | 267.50 | 72.54 | 0.015* |
| 38 w | --- | --- | 257.80 | 78.91 | --- |
| 39 w | --- | --- | 256.06 | 75.13 | --- |
| 40 w | --- | --- | 262.14 | 86.94 | --- |

**Significant as P value <0.05*

Table 5 shows that there were no significant differences in mean platelet volume (MPV) between the two groups at 4, 8, 12, and 16 weeks of gestation (P = 0.067, 0.731, 0.168, and 0.019, respectively). However, a significant increase in MPV was observed in Group I compared to Group II at 20, 24, 28, 32, 36, and 37 weeks (P < 0.001).

***Table 5. MPV (fL) of both groups***

| Weeks | Group I (n=9) | | Group II (n=91) | | P value |
|---|---|---|---|---|---|
| | Mean | ±SD | Mean | ±SD | |
| 4 w | 8.01 | 0.98 | 7.51 | 0.76 | 0.067 |
| 8 w | 7.40 | 1.09 | 7.50 | 0.83 | 0.731 |
| 12 w | 7.90 | 1.01 | 7.47 | 0.87 | 0.168 |
| 16 w | 8.29 | 1.14 | 7.45 | 0.99 | 0.019 |
| 20 w | 9.48 | 1.00 | 7.52 | 1.01 | <0.001* |
| 24 w | 9.92 | 1.06 | 7.56 | 1.02 | <0.001* |


***Received****: 22-12-2025 -* ***Accepted****: 20-02-2026 -* ***Published****: 26-02-2026*

| | | | | | |
|---|---|---|---|---|---|
| 28 w | 10.41 | 0.96 | 7.54 | 1.08 | <0.001* |
| 32 w | 10.28 | 0.96 | 7.51 | 1.18 | <0.001* |
| 34 w | 10.95 | 0.70 | 7.49 | 1.20 | <0.001* |
| 36 w | 12.43 | 0.81 | 7.51 | 1.14 | <0.001* |
| 37 w | 12.50 | 1.56 | 7.39 | 0.97 | <0.001* |
| 38 w | --- | --- | 7.70 | 0.99 | --- |
| 39 w | --- | --- | 7.99 | 0.91 | --- |
| 40 w | --- | --- | 8.06 | 0.91 | --- |

**Significant as P value <0.05*

Table 6 shows that there were no significant differences in the PC/MPV ratio between the two groups at 4, 8, 12, and 16 weeks of gestation (P = 0.462, 0.849, 0.251, and 0.077, respectively). However, a significant decrease in the PC/MPV ratio was observed in Group I compared to Group II at 20, 24, 28, 32, 36, and 37 weeks (P = 0.003, <0.001, <0.001, 0.001, 0.001, <0.001, and 0.007, respectively).

***Table 6. PC/MPV of both groups***

| **Weeks** | **Group I (n=9)** | | **Group II (n=91)** | | **P value** |
|---|---|---|---|---|---|
| | Mean | ±SD | Mean | ±SD | |
| 4 w | 35.53 | 11.14 | 38.23 | 10.42 | 0.462 |
| 8 w | 37.34 | 12.00 | 38.04 | 10.40 | 0.849 |
| 12 w | 33.81 | 10.67 | 38.16 | 10.79 | 0.251 |
| 16 w | 31.31 | 10.22 | 38.12 | 10.94 | 0.077 |
| 20 w | 26.37 | 8.12 | 37.75 | 11.05 | 0.003* |
| 24 w | 21.77 | 5.55 | 37.31 | 10.99 | <0.001* |
| 28 w | 19.93 | 5.34 | 37.39 | 11.20 | <0.001* |
| 32 w | 19.78 | 6.77 | 37.88 | 11.92 | 0.001* |
| 34 w | 15.19 | 4.52 | 37.46 | 12.07 | 0.001* |
| 36 w | 9.25 | 4.20 | 37.76 | 12.31 | <0.001* |
| 37 w | 10.47 | 2.66 | 37.39 | 13.10 | 0.007 |
| 38 w | --- | --- | 34.51 | 12.66 | --- |
| 39 w | --- | --- | 32.74 | 11.40 | --- |
| 40 w | --- | --- | 33.57 | 13.78 | --- |

**Significant as P value <0.05*

Table 7 shows that there were no significant differences in platelet distribution width (PDW) between the two groups at 4, 8, 12, and 16 weeks of gestation (P = 0.557, 0.780, 0.388, and 0.273, respectively). However, a significant increase in PDW was observed in Group I compared to Group II at 20, 24, 28, 32, 36, and 37 weeks (P = 0.023, 0.007, 0.001, <0.001, 0.001, 0.001, and <0.001, respectively).

***Table 7. PDW (%) of both groups***

| **Weeks** | **Group I (n=9)** | | **Group II (n=91)** | | **P value** |
|---|---|---|---|---|---|
| | Mean | ±SD | Mean | ±SD | |
| 4 w | 9,82 | 0.95 | 10.05 | 1.14 | 0.557 |
| 8 w | 9.97 | 0,72 | 10.08 | 1.19 | 0.780 |
| 12 w | 10.41 | 0.78 | 10.06 | 1.20 | 0.388 |
| 16 w | 10.51 | 1.00 | 10.04 | 10.23 | 0.273 |
| 20 w | 11.07 | 0.82 | 10.10 | 1.22 | 0.023* |
| 24 w | 11.38 | 0.99 | 10.14 | 1.30 | 0.007* |
| 28 w | 11.74 | 1.11 | 10.16 | 1.31 | 0.001* |
| 32 w | 12.58 | 1.38 | 10.22 | 1.38 | <0.001* |
| 34 w | 12.95 | 1.66 | 10.37 | 1.37 | 0.001* |
| 36 w | 12.90 | 0.96 | 10.37 | 1.23 | 0.001* |
| 37 w | 14.20 | 0.00 | 10.22 | 1.24 | <0.001* |
| 38 w | --- | --- | 10.25 | 1.25 | --- |
| 39 w | --- | --- | 10.18 | 1.21 | --- |
| 40 w | --- | --- | 10.53 | 1.27 | --- |

**Significant as P value <0.05*

At cut-off ≤214 of platelet count to predict pre-eclampsia, sensitivity was 77.78, specificity was 76.92, PPV was 25.0, NPV was 97.2, AUC was 0.748, and P value was 0.003.


***Received****: 22-12-2025 -* ***Accepted****: 20-02-2026 -* ***Published****: 26-02-2026*

https://doi.org/10.54361/ajmas.269231

***Table 8. ROC curve of PC to predict pre-eclampsia***

| Cut-off | Sensitivity | Specificity | PPV | NPV | AUC | P value |
|---|---|---|---|---|---|---|
| ≤214 | 77.78 | 76.92 | 25.0 | 97.2 | 0.748 | 0.003* |

**Significant as P value <0.05*

At a cut-off >9.7 of MPV to predict pre-eclampsia, sensitivity was 77.78, specificity was 100.00, PPV was 100.0, NPV was 97.8, AUC was 0.936, and P value was <0.001 (Table 9).

***Table 9. ROC curve of PC to predict pre-eclampsia***

| Cut-off | Sensitivity | Specificity | PPV | NPV | AUC | P value |
|---|---|---|---|---|---|---|
| <9.7 | 77.78 | 100.00 | 100.00 | 97.8 | 0.936 | <0.001* |

**Significant as P value <0.05*

At a cut-off ≤26.89 of PC-MPV to predict pre-eclampsia, sensitivity was 88.89, specificity was 78.02, PPV was 28.6, NPV was 98.6, AUC was 0.894, and P value was <0.001 (Table 10).

***Table 10. ROC curve of PC/MPV to predict pre-eclampsia***

| Cut-off | Sensitivity | Specificity | PPV | NPV | AUC | P value |
|---|---|---|---|---|---|---|
| ≤26.89 | 88.89 | 78.02 | 28.6 | 98.6 | 0.894 | <0.001* |

**Significant as P value <0.05*

At cut-off >10.4 of PDW to predict pre-eclampsia, sensitivity was88.89, specificity was 54.95, PPV was 16.3, NPV was 98.0, AUC was 0.764, and P (Table 11).

***Table 11. ROC curve of PDW to predict pre-eclampsia***

| Cut-off | Sensitivity | Specificity | PPV | NPV | AUC | P value |
|---|---|---|---|---|---|---|
| >10.4 | 88.89 | 54.95 | 16.3 | 98.0 | 0.764 | 0.002* |

**Significant as P value <0.05*

## Discussion

Three to eight percent of pregnancies are complicated by pre-eclampsia, which is one of the primary health conditions that contribute to maternal morbidity and mortality [13]. It is defined as de novo hypertension, occurring after 20 weeks of pregnancy [14]. It has also been claimed that the abnormalities in coagulation and fibrinolysis play a role in the pathophysiology of pre-eclampsia [15]. PC, PDW, MPV, and PCT are indicators of platelet activation [16]. The purpose of this work is to explore the diagnostic usefulness of PC, MPV, the PC to MPV ratio, and PDW for the prediction of pre-eclampsia. One hundred pregnant women who were attending Al-Beyda Medical Center throughout the first trimester of their pregnancies participated in this prospective cohort study. Routine obstetric follow-up consists of monthly visits until the 32$^{nd}$ week of pregnancy, biweekly visits between the 32$^{nd}$ and 36$^{th}$ gestational week, and weekly thereafter. Patients were divided into two groups: group I comprised pre-eclamptic patients, and group II comprised non-pre-eclamptic patients.

The comparison between the two groups showed an insignificant difference with regard to age and parity, but there was a significant decrease in gestational age in both groups. This was consistent with a study that found that while there was no discernible difference in the two study groups' fundamental characteristics (age, parity, and BMI), pre-eclamptic women had a considerably lower gestational age [2]. This was in line with another study that a significant difference was not found among the mean ages of pre-eclampsia and control groups, but the gestational age of preeclamptic patients was found to be lower than that of the control women [17]. There was also agreement with other observations that found that in the pre-eclampsia group, gestational age and birth weight were significantly lower compared to the control group [18, 19]. Hemoglobin and TLC were insignificantly different between the two groups at all times of measurement. This was in agreement with a study that showed there was no significant difference in TLC and hemoglobin [2]. However, this result disagreed with the study, which found that TLC was significantly higher in the pre-eclampsia group [17]. Current data found that PC showed a significant decrease in group I than group Il. This was in agreement with previous studies that reported decreased PC as the disease progressed, but normal counts in the initial stages [2, 17,18].

In terms of an at cut-off ≤214 of PC to predict pre-eclampsia, the P value was 0.003. This was in line with a study that found that PC can differentiate control from preeclamptic pregnant women at a cut-off value <233 x $10^9$/L [2, 17]. MPV was significantly increased in group I than in group II at 20 to 37 weeks. This was in agreement with studies that found that the MPV in pre-eclampsia and healthy females was elevated. The difference between pre-eclamptic patients and controls was statistically significant [19-22]. This agreed with the meta-analysis, which was based on outcomes reported from 50 studies that included 14,614 women [23]. However, this was in disagreement with other studies, which showed that there was no significant


***Received****: 22-12-2025 -* ***Accepted****: 20-02-2026 -* ***Published****: 26-02-2026*

difference in MPV between the two groups [2, 16]. At a cut-off >9.7 of MPV to predict pre-eclampsia, the P value was <0.001. This was in line with studies that found similar observations [17, 21].
PC/MPV was significantly decreased in group I than in group II at 20. 24, 28, 32, 36, and 37 weeks. This was in agreement with a study that showed that PC/MPV was significantly lower in the cases compared with the controls [2]. At the cut-off 26.89 of PC-MPV to predict pre-eclampsia, the P value was <0.001. PDW was significantly increased in group I than in group II. This was in line with observations showing that the PDW was higher in pre-eclampsia patients [17, 20-22]. This was in disagreement with other studies that showed that there was no significant difference in PDW between the two groups [2, 16]. At a cut-off >10.4 of PDW to predict pre-eclampsia, the P value was 0.002. This was in line with a report that found PDW can differentiate non-pregnant women from preeclamptic pregnant women [17]. However, this wasn't in line with Mahmoud *et al.*, who showed that the PDW was higher in pre-eclampsia patients and the cut-off value of PDW [21]. An active rotation of platelet synthesis in the bone marrow due to peripheral consumption is indicated by the increase in MPV and PDW, two markers of platelet activation. Together with elevated blood pressure, the rise in MPV and PDW levels further demonstrates that they are elevated in severe pre-eclampsia with higher blood pressure rises.

## Conclusion

Platelet indices, including PC, MPV, PC/MPV ratio, and PDW, are significant predictors of pre-eclampsia. The pre-eclampsia group showed marked differences in these indices compared to the non-pre-eclampsia group. These indices can be valuable for early detection and management of pre-eclampsia.

***Acknowledgments***

Heartily thankful to the Al-Beyda Medical Center Director for his encouragement and support. My thanks are conveyed to the patients who accept in participate in this research, also all staff and nurses of Al-Beyda Medical center in Al-Jabal Al-Akhdar in Al-Beyda City (Libya) for their great assistance.

***Conflicts of Interest***

The authors declare no conflicts of interest

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***Received****: 22-12-2025 -* ***Accepted****: 20-02-2026 -* ***Published****: 26-02-2026*

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***Received****: 22-12-2025 -* ***Accepted****: 20-02-2026 -* ***Published****: 26-02-2026*