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Original Paper

Influence of Hemoglobin and Platelet Levels on Maternal Health Across Trimesters in Pregnant Women in Ramadi City, Iraq

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ABSTRACT

Background: Anemia in pregnancy is one of the health problems in developing countries. This problem is exacerbated in conflict affected areas such as Ramadi City, Iraq where access to healthcare and nutrition is limited. However, data from Anbar Governorate remain limited

Objectives: To evaluate the hemoglobin and platelets of pregnant women in the three trimesters of pregnancy, and to assess its relationship with maternal symptoms, and to assess the factors that are associated with anemia in Ramadi City, Iraq.

Methods: A cross-sectional study was carried out on 114 pregnant women attending prenatal clinics in Ramadi City between January and April 2025. Blood samples were analyzed for hemoglobin and platelet counts using an automated hematology analyzer. Data were collected through structured questionnaires and analyzed using SPSS version 26.

Results: Hemoglobin declined significantly from 12.12 ± 1.40 g/dL in the first trimester to 10.45 ± 1.45 g/dL in the third ($F(2,111) = 9.60$; $p < 0.001$). Platelet counts showed no significant variation across trimesters ($p = 0.798$). Women with prior anemia history had significantly lower hemoglobin (9.86 vs. 11.76 g/dL; $p < 0.001$). Women receiving iron supplementation showed a statistically significant difference in hemoglobin compared to those not supplemented (10.48 vs. 11.54 g/dL; $t(112) = -3.82$; $p < 0.001$). Hemoglobin correlated negatively with fatigue ($r = -0.239$; $p = 0.011$), shortness of breath ($r = -0.187$; $p = 0.047$), and pallor ($r = -0.257$; $p = 0.006$).

Conclusion: Hemoglobin levels fall significantly as pregnancy advances in Ramadi City and are linked to worse maternal symptoms. Platelet counts stay within normal limits. Women receiving iron supplementation had lower hemoglobin levels, most likely because supplementation was prescribed in response to pre-existing anemia. Routine screening, iron supplementation, and better prenatal care are needed to reduce anemia in this population.

KEYWORDS: *Maternal anaemia; platelet count; haemoglobin; pregnancy trimester; Ramadi city; Iraq; parental care; iron deficiency.*

1-INTRODUCTION

Anemia during pregnancy is one of the most serious health problems affecting women in low- and middle-income countries, with an estimated global prevalence of around 40% [1, 2]. The condition is linked to a range of poor outcomes for both mother and baby, including preterm birth, low birth weight, postpartum bleeding, and maternal death [3, 4]. Iron deficiency is the main cause, accounting for roughly half of all anemia cases during pregnancy worldwide [5]. The physiological changes of pregnancy partly explain the fall in hemoglobin. Plasma volume rises by about 40–50%, which dilutes the blood and reduces hemoglobin concentration even when iron stores are adequate [6]. When this normal change is combined with iron deficiency or poor nutrition — common in areas with limited healthcare — hemoglobin can fall to levels that are clinically harmful [7]. The WHO defines anemia in pregnancy as hemoglobin below 11 g/dL in the first and third trimesters, and below 10.5 g/dL in the second trimester [8].

Platelet count is another useful marker in prenatal care. Unlike hemoglobin, platelets generally stay within the normal range of 150,000–450,000/µL throughout a healthy pregnancy [9]. A significant drop in platelets can point to serious conditions such as preeclampsia or HELLP syndrome, which need urgent medical attention [10, 11]. Monitoring both parameters together therefore gives a more complete picture of maternal hematological health. In Iraq, anemia affects about 31% of women of reproductive age [12], but the actual burden is likely higher in provinces that have suffered from conflict and disrupted services. Studies from Baghdad showed a clear drop in hemoglobin as pregnancy progressed [13, 14], while work from the Kurdistan Region confirmed that women not taking iron supplements had significantly worse hemoglobin levels than those who did [15]. These findings point to a widespread and persistent problem across the country. Anbar Governorate, where Ramadi City is

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located, is among the most affected areas in Iraq. Years of military conflict damaged hospitals and health centers, cut off supplies of iron and nutritional supplements, and forced many families to leave their homes [16]. Despite this, no published study has examined hemoglobin and platelet trends across the three trimesters of pregnancy specifically in Ramadi City. This absence of local evidence makes it difficult for health planners to design appropriate programs or set screening priorities for this vulnerable population.

This study was designed to fill that gap. We enrolled 114 pregnant women from prenatal clinics in Ramadi City and measured their hemoglobin and platelet levels across the three trimesters. We also examined how hemoglobin levels related to symptoms such as fatigue, dizziness, shortness of breath, and pallor, and looked at factors — including a history of anemia and use of iron supplements — that might explain differences between women. The results are intended to support better prenatal care and anemia prevention in Anbar Governorate.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

A cross-sectional study was conducted at prenatal clinics in Ramadi City, Anbar Governorate, Iraq, between January and April 2025. Ethical approval was obtained from Anbar Health Directorate, Ministry of Health, Iraq, and all participants gave informed consent before enrollment.

2.2 Study Population and Sample Size

The study included 114 pregnant women recruited from prenatal clinics by convenience sampling. The sample size was calculated based on a 95% confidence level, a 5% margin of error, and an estimated anemia prevalence of 31% among Iraqi pregnant women [12], giving a minimum required sample of 108 participants. Women were eligible if they were pregnant at any stage, aged 18 years or older, and had lived in Ramadi City for at least one year. Women with known chronic blood disorders unrelated to iron deficiency, or those taking part in another study, were excluded. Recruitment covered clinics from different parts of the city to ensure a reasonable mix of urban and rural participants.

2.3 Data Collection

A structured questionnaire was used to collect information on age, place of residence, education level, gestational trimester, history of anemia, use of iron supplements, and the presence of symptoms including fatigue, dizziness, shortness of breath, and pallor. The questionnaire was reviewed by specialists before use to check its clarity and relevance.

2.4 Laboratory Analysis

A venous blood sample of 3–5 mL was taken from each participant into an EDTA-coated tube. Hemoglobin concentration (g/dL) and platelet count (per µL) were measured using a calibrated automated hematology analyzer. The analyzer was checked with control samples each day to make sure the results were reliable.

2.5 Statistical Analysis

Data were entered and analyzed using IBM SPSS Statistics version 26. Frequencies and percentages were used for categorical variables. Means and standard deviations (SD) with 95% confidence intervals (CI) were calculated for continuous variables. Normality was checked with the Kolmogorov-Smirnov test. Anemia was defined using WHO trimester-specific hemoglobin thresholds: below 11 g/dL in the first and third trimesters, and below 10.5 g/dL in the second trimester [8]. One-way ANOVA with Tukey HSD post hoc testing compared hemoglobin and platelet levels across trimesters. An independent samples t-test compared hemoglobin between women with and without prior anemia. An independent samples t-test was also used to compare mean hemoglobin concentrations between women taking iron supplements and those not taking them. Pearson correlation coefficients measured the relationship between hemoglobin and symptoms. Chi-square tests examined associations between trimester and symptom prevalence, and between iron supplementation status and anemia history. A p-value below 0.05 was considered statistically significant.

3. RESULTS

3.1 Participant Characteristics

Table 1 shows the characteristics of the 114 women included in the study. Their mean age was 28.07 ± 6.04 years, with ages ranging from 17 to 42 years. Most participants were over 25 years old (61.4%) and lived in urban areas (59.6%). Educational level varied: primary education was most common (34.2%), followed by university level (33.3%). More than half of the women were in their second trimester (47.4%). A notable proportion — 42.1% — reported a past history of anemia, and 46.5% were not taking iron supplements at the time of the study.

Table 1. Characteristics of study participants.

Characteristic	N	%
Age ≤25 years	44	38.6
Age >25 years	70	61.4
Urban residence	68	59.6
Rural residence	46	40.4
Primary education	39	34.2
Intermediate education	24	21.1
Preparatory education	13	11.4
University education	38	33.3
1st Trimester	22	19.3
2nd Trimester	54	47.4
3rd Trimester	38	33.3
History of anemia (Yes)	48	42.1
Taking iron supplements (Yes)	61	53.5

3.2 Hemoglobin and Platelet Levels

The mean hemoglobin for the whole group was 10.96 ± 1.55 g/dL, with values ranging from 7.30 to 16.30 g/dL (Table 2). The WHO defines anemia in pregnancy using trimester-specific thresholds: below 11 g/dL in the first and third trimesters, and below 10.5 g/dL in the second trimester [8]. Applying these cutoffs, the overall mean hemoglobin of 10.96 g/dL falls below the 11 g/dL threshold for the first and third trimesters, suggesting that anemia was common across the group. The mean platelet count was 245.63 ± 84.54 × 10^3/µL, which is within the accepted normal range.

Table 2. Hemoglobin and platelet counts for all participants.

Parameter	N	Mean ± SD	Min	Max
Hemoglobin (g/dL)	114	10.96 ± 1.55	7.30	16.30
Platelet Count (×10^3/µL)	114	245.63 ± 84.54	110.0	484.0

3.3 Changes Across Trimesters

Hemoglobin fell steadily from the first to the third trimester (Table 3). The mean was 12.12 ± 1.40 g/dL in the first trimester, 10.85 ± 1.46 g/dL in the second, and 10.45 ± 1.45 g/dL in the third. One-way ANOVA showed this decline was statistically significant ($F(2, 111) = 9.60$; $p < 0.001$). Post hoc Tukey HSD testing found significant differences between the first and second trimesters (mean difference 1.27 g/dL; $p = 0.002$) and between the first and third trimesters (mean difference 1.67 g/dL; $p < 0.001$). The difference between the second and third trimesters was not significant ($p = 0.403$).

Platelet counts did not change significantly across trimesters ($F(2, 111) = 0.23$; $p = 0.798$), with means ranging from 242.96 to 253.18 × 10^3/µL, all within normal limits.

Table 3. Hemoglobin and platelet levels by trimester.

Trimester	N	Hb Mean ± SD (g/dL)	95% CI	Platelets Mean ± SD (×10^3/µL)
1st Trimester	22	12.12 ± 1.40	11.50 – 12.74	253.18 ± 79.12
2nd Trimester	54	10.85 ± 1.46	10.45 – 11.25	242.96 ± 86.31
3rd Trimester	38	10.45 ± 1.45	9.98 – 10.93	246.74 ± 84.20

One-way ANOVA confirmed that the decline in hemoglobin was statistically significant (Table 4), while platelet counts showed no significant variation across trimesters.

Table 4. One-way ANOVA results for hemoglobin and platelet counts across trimesters.

Variable	Sum of Squares	df	Mean Square	F	p-value
Hemoglobin (g/dL)	39.98	2	19.99	9.60	< 0.001*
Platelet Count (×10³/μL)	3280.92	2	1640.46	0.23	0.798

**p < 0.05.*

Post hoc Tukey HSD testing identified where the significant differences in hemoglobin occurred (Table 5).

Table 5. Post hoc Tukey HSD comparisons for hemoglobin levels across trimesters.

Comparison	Mean Difference (g/dL)	Std. Error	p-value	95% CI
1st vs. 2nd Trimester	1.27	0.37	0.002*	0.40 – 2.14
1st vs. 3rd Trimester	1.67	0.39	< 0.001*	0.75 – 2.58
2nd vs. 3rd Trimester	0.39	0.31	0.403	−0.33 – 1.12

**Statistically significant (p < 0.05).*

Figure 1 shows the distribution of hemoglobin values across the three trimesters, with reference lines marking the WHO diagnostic thresholds for each trimester.

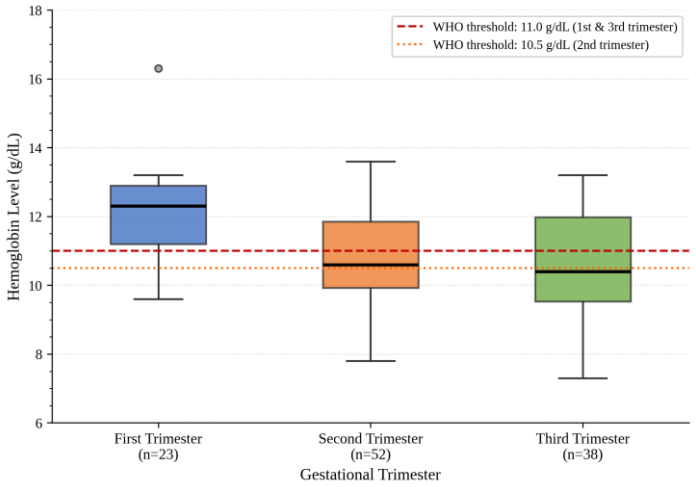

Figure 1. Box plots of hemoglobin concentrations (g/dL) by gestational trimester. Horizontal lines indicate WHO diagnostic thresholds: 11.0 g/dL for the first and third trimesters (red dashed line) and 10.5 g/dL for the second trimester (orange dotted line). Boxes represent interquartile range; horizontal black lines show medians; whiskers extend to 1.5 × IQR; circles indicate outliers.

3.4 Effect of Prior Anemia History and Iron Supplementation on Hemoglobin

Women who had a previous history of anemia (n = 48) had a mean hemoglobin of 9.86 ± 1.22 g/dL, compared to 11.76 ± 1.25 g/dL in those without such a history (n = 66). This difference of nearly 1.9 g/dL was statistically significant ($t(112) = -8.71$; $p < 0.001$), as shown in Table 6.

Table 6. Hemoglobin levels by anemia history.

Group	N	Mean Hb (g/dL)	SD	95% CI
With history of anemia	48	9.86	1.22	9.50 – 10.22
Without history of anemia	66	11.76	1.25	11.45 – 12.07

Independent samples t-test: $t(112) = -8.71$, $p < 0.001$.

In addition to prior anemia history, iron supplementation status was also examined as a related factor influencing hemoglobin levels. Women taking iron supplements (n = 61) had a mean hemoglobin of 10.48 ±

1.54 g/dL compared to 11.54 ± 1.39 g/dL in those not taking supplements (n = 53). This difference was statistically significant ($t(112) = -3.82$; $p < 0.001$) (Table 6a).

Table 6a. Hemoglobin levels by iron supplementation status.

Group	N	Mean Hb (g/dL)	SD	95% CI
Taking iron supplements	61	10.48	1.54	10.08 – 10.87
Not taking iron supplements	53	11.54	1.39	11.15 – 11.93

Independent samples t-test: $t(112) = -3.82$, $p < 0.001$.

3.5 Maternal Symptoms

Fatigue was the most commonly reported symptom (76.3%), followed by dizziness (63.2%), shortness of breath (29.8%), and pallor (16.7%) (Table 7). Both fatigue and dizziness became more frequent as pregnancy advanced, with the highest rates in the third trimester (81.6% and 76.3%, respectively). Shortness of breath increased gradually from 18.2% in the first to 36.8% in the third trimester. Pallor showed little change across trimesters. Chi-square tests for each symptom across trimesters yielded the following results: fatigue ($\chi^2 = 1.428$; df = 2; $p = 0.490$), dizziness ($\chi^2 = 7.508$; df = 2; $p = 0.023$), shortness of breath ($\chi^2 = 2.318$; df = 2; $p = 0.314$), and pallor ($\chi^2 = 0.128$; df = 2; $p = 0.938$). Only the association between trimester and dizziness was statistically significant.

Table 7. Maternal symptoms by gestational trimester.

Symptom	Overall (%)	1st Trimester	2nd Trimester	3rd Trimester
Fatigue	76.3%	81.8%	70.4%	81.6%
Dizziness	63.2%	40.9%	63.0%	76.3%
Shortness of Breath	29.8%	18.2%	29.6%	36.8%
Pallor	16.7%	18.2%	16.7%	15.8%

3.6 Hemoglobin and Symptoms

Table 8 shows the correlation between hemoglobin levels and maternal symptoms. Hemoglobin was significantly and negatively correlated with fatigue ($r = -0.239$; $p = 0.011$), shortness of breath ($r = -0.187$; $p = 0.047$), and pallor ($r = -0.257$; $p = 0.006$). The correlation with dizziness did not reach significance ($r = -0.158$; $p = 0.093$). These results indicate that women with lower hemoglobin levels tended to report more symptoms.

Table 8. Pearson correlations between hemoglobin and maternal symptoms (N = 114).

Symptom	Pearson r	p-value	Significance
Fatigue	−0.239	0.011	*
Shortness of Breath	−0.187	0.047	*
Pallor	−0.257	0.006	**
Dizziness	−0.158	0.093	NS

**p < 0.05; **p < 0.01; NS = Not significant.*

3.7 Symptoms by Anemia History

Women with a prior history of anemia reported higher rates of all symptoms compared to those without such a history. Fatigue was present in 87.5% of women with anemia history versus 68.2% of those without ($\chi^2 = 5.145$; df = 1; $p = 0.023$), and dizziness was reported by 72.9% versus 57.6% ($\chi^2 = 2.782$; df = 1; $p = 0.095$), respectively. Shortness of breath was seen in 39.6% of women with prior anemia versus 22.7% of those without ($\chi^2 = 3.731$; df = 1; $p = 0.053$), and pallor in 25.0% versus 10.6% ($\chi^2 = 4.200$; df = 1; $p = 0.040$). These differences suggest that pre-existing iron deficiency not only lowers hemoglobin but also amplifies the symptom burden during pregnancy (Table 9).

Table 9. Prevalence of maternal symptoms by anemia history.

Symptom	With Anemia History (%)	Without Anemia History (%)
Fatigue	87.5%	68.2%
Dizziness	72.9%	57.6%
Shortness of Breath	39.6%	22.7%
Pallor	25.0%	10.6%

4. DISCUSSION

This study examined hemoglobin and platelet levels in pregnant women in Ramadi City across the three trimesters and explored how these levels relate to maternal symptoms and risk factors. The findings add important local evidence to a field where data from Anbar Governorate have been almost entirely absent.

4.1 Hemoglobin Decline During Pregnancy

The fall in hemoglobin from 12.12 g/dL in the first trimester to 10.45 g/dL in the third was both statistically significant and clinically meaningful. Trimester-specific WHO diagnostic thresholds were applied when interpreting anemia prevalence: hemoglobin below 11 g/dL in the first and third trimesters and below 10.5 g/dL in the second trimester [8]. Using these cutoffs, mean hemoglobin in the second trimester (10.85 g/dL) remained above the second-trimester threshold of 10.5 g/dL, whereas mean values in the third trimester (10.45 g/dL) fell below the 11 g/dL threshold, indicating that the burden of anemia was greatest in late pregnancy. Part of this decline is expected during normal pregnancy, as plasma volume expands faster than red blood cell mass, causing a dilutional fall in hemoglobin [6, 17]. However, the magnitude of the drop seen here — nearly 1.67 g/dL — goes beyond what physiological hemodilution alone would explain, and most likely reflects inadequate iron stores in a significant proportion of participants [5]. The post-conflict environment of Anbar Governorate, where many health facilities were damaged and supply chains for nutritional supplements disrupted, provides an important backdrop for understanding why iron deficiency is so prevalent in this population [16].

Similar patterns have been documented elsewhere in Iraq. Khalil [13] found that anemia was common among pregnant women in Baghdad with comparable hemoglobin values, and Mohammed [14] showed a progressive fall in hemoglobin and related blood parameters across all three trimesters in the same city. Kadhim Jasim et al. [18] reported an anemia prevalence of 84.84% in a Baghdad tertiary center, with clear links to neonatal complications. Rashid et al. [19] confirmed the widespread nature of iron deficiency anemia across different regions of Iraq, including the Kurdistan area. Taken together, these findings suggest that the pattern seen in Ramadi is not an isolated phenomenon but part of a broader national problem rooted in nutritional deficiency and inadequate prenatal support.

4.2 Platelet Stability

Platelet counts showed no significant change across trimesters in this study, with mean values remaining well within the normal range throughout. This is consistent with the general understanding that platelet production is maintained during uncomplicated pregnancies [9, 20]. Sibai et al. [10] noted that meaningful drops in platelets are usually associated with conditions such as preeclampsia or HELLP syndrome, which were not apparently prevalent in this cohort. Pishko and Marshall [21] and Mushahary et al. [22] further clarified that stable platelet counts in a cross-sectional community sample suggest the absence of major obstetric complications at the population level. For this group, anemia rather than platelet disorders represented the main hematological concern.

4.3 Role of Prior Anemia History and Iron Supplementation

Women who had anemia before this pregnancy had hemoglobin levels nearly 2 g/dL lower than those without such a history, and reported higher rates of all four symptoms. Fatigue was present in 87.5% of women with prior anemia compared to 68.2% of those without, and dizziness in 72.9% versus 57.6%. This pattern suggests that anemia tends to persist and worsen across pregnancies when not adequately treated, as women who enter pregnancy with low iron stores face increasing demands from the growing fetus in the second and third trimesters [23]. Untreated anemia during pregnancy also raises the risk of preterm birth [27].

Women taking iron supplements had lower hemoglobin than those not taking them (10.48 vs. 11.54 g/dL; $t(112) = -3.82$; $p < 0.001$). This is explained by the fact that women with pre-existing anemia were more likely to be prescribed supplements ($\chi^2 = 38.15$; $p < 0.001$), so the lower hemoglobin reflects their condition before starting supplements, not a result of taking them [15]. Since this is a cross-sectional study, it captures a single point in time and cannot show whether hemoglobin improved after supplementation began — a question that requires a longitudinal design to answer properly.

Despite this, iron supplementation remains an important intervention during pregnancy. Nearly half the participants (46.5%) were not taking supplements, which is concerning given the limited access to healthcare in conflict-affected Anbar [16]. Evidence from Iraq and other low-resource settings confirms that iron and folate supplementation, combined with nutrition education, can meaningfully reduce anemia during pregnancy [15, 24, 28].

4.4 Hemoglobin and Maternal Symptoms

The negative correlations between hemoglobin and fatigue, shortness of breath, and pallor confirm that as hemoglobin falls, women experience a greater symptom burden. Fatigue and breathlessness during pregnancy can limit daily activity, affect sleep, and reduce a woman's ability to care for herself and her family. Milman [25] and Kharate and Choudhari [26] have both documented that symptomatic anemia during pregnancy is an important and often under-recognized clinical problem. The steady increase in dizziness across trimesters (40.9% in the first to 76.3% in the third; $\chi^2 = 7.508$; $p = 0.023$) likely reflects the multifactorial nature of this symptom during pregnancy, including hormonal changes, reduced blood pressure, and physiological adaptations, rather than hemoglobin decline alone, as the correlation between dizziness and hemoglobin did not reach statistical significance in this study ($r = -0.158$; $p = 0.093$) [29, 30]. In settings where laboratory tests are not always available — as is often the case in rural Anbar — tracking these symptoms during routine antenatal visits could serve as a practical early warning sign. The urban predominance of participants (59.6%) in this study also suggests that rural women, who face greater barriers to clinic attendance, may carry an even higher symptom burden than captured here.

This study has some limitations worth noting. The cross-sectional design allows description of associations but not causal inference. Convenience sampling from urban clinics may underrepresent rural women, and the absence of ferritin and MCV measurements limits precise characterization of iron status. Nonetheless, this study provides the first systematic hematological data from pregnant women in Ramadi City, and the findings are directly relevant to prenatal care planning in Anbar Governorate.

5. CONCLUSION

Hemoglobin levels fall significantly across the three trimesters of pregnancy in Ramadi City and are closely linked to increasing maternal symptoms, while platelet counts remain stable throughout. Women who had anemia before pregnancy are more likely to have low hemoglobin levels during pregnancy, especially by the third trimester, and should receive closer monitoring and early treatment. Women receiving iron supplements had lower hemoglobin levels, which reflects the fact that supplements were prescribed because of pre-existing anemia rather than causing the low hemoglobin. These findings highlight the need for routine hemoglobin screening at each antenatal visit, universal iron and folic acid supplementation, and targeted nutritional education for pregnant women in Anbar Governorate. Future studies should include measurements of serum ferritin and MCV, use longitudinal designs, and extend to rural areas to provide a fuller picture of maternal anemia in this region.

DECLARATIONS

Ethical Approval: This study was approved by Anbar Health Directorate, Ministry of Health, Iraq. All participants provided informed consent prior to enrollment.

Conflict of Interest: The author declares no conflict of interest.

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Data Availability: Data are available from the corresponding author upon reasonable request.

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