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HEMATOLOGICAL PROFILE OF PRAGNANT WOMEN: A COMPARATIVE STUDY OF NORMAL PREGNANCY AND MISCARRIAGE

Original Research

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ABSTRACT

Background: Pregnancy is a physiological state marked by extensive hematological adaptations that support fetal development. These changes are generally well-tolerated; however, deviations beyond normal ranges may predispose women to complications, including early pregnancy loss. Monitoring hematological parameters provides critical insight into maternal health, as variations in red cell indices, leukocyte profiles, and platelet counts reflect underlying physiological or pathological processes. Understanding these changes is essential for establishing reference values and improving clinical assessment during early gestation.

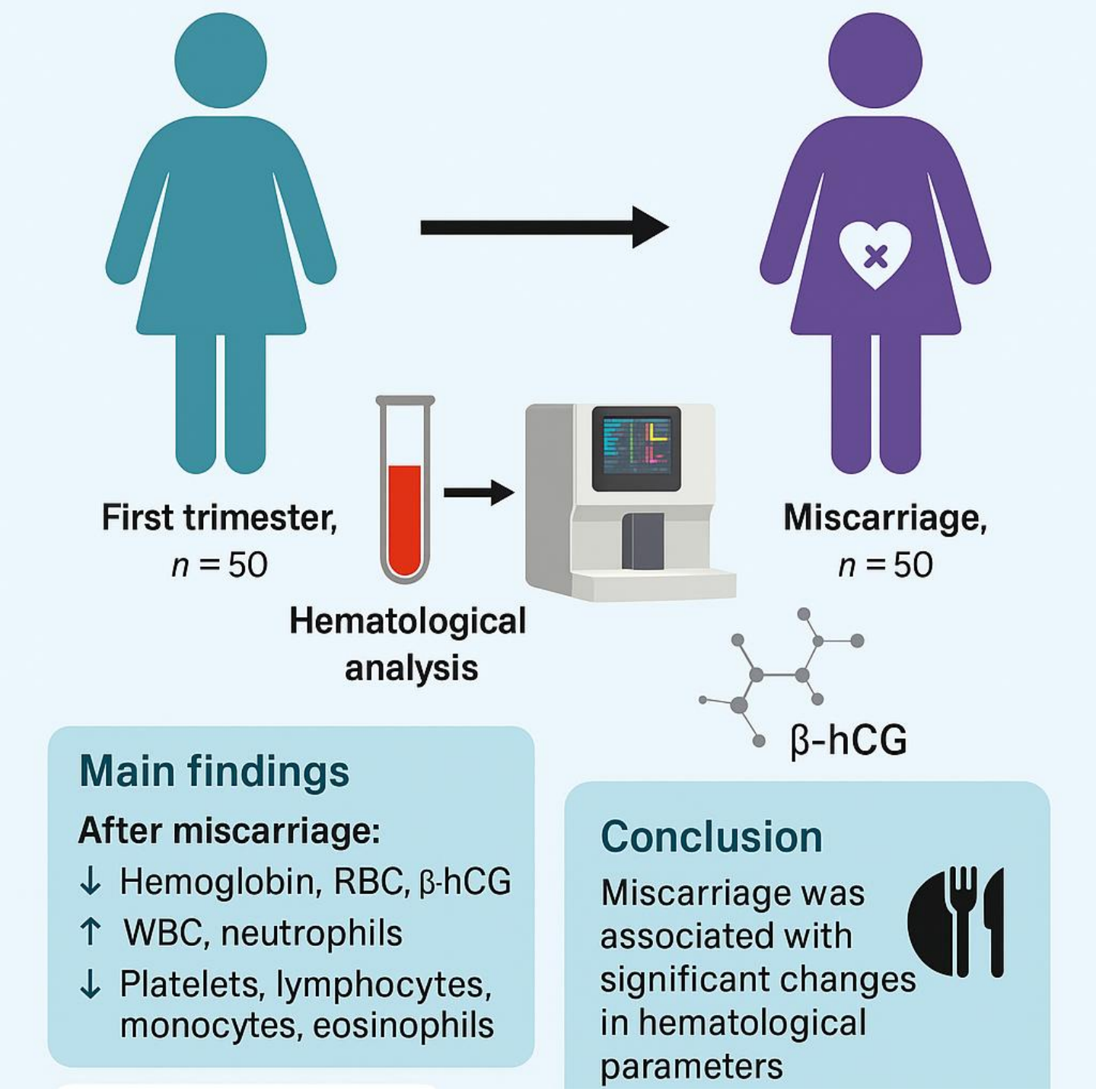
Objective: To evaluate and compare hematological parameters and β-hCG levels in women during the first trimester of pregnancy and after miscarriage, and to establish reference profiles supportive of early clinical decision-making.

Methods: An experimental study was conducted among 100 women aged 21–42 years, divided into two groups of 50: first-trimester pregnant women and women who had experienced miscarriage. Venous blood samples were collected and analyzed for hemoglobin, RBCs, WBCs, hematocrit, MCV, MCH, MCHC, platelets, and differential leukocyte counts using a Mindray BC-6000 analyzer. β-hCG levels were assessed using a biochemistry analyzer. Demographic and clinical information was obtained through structured questionnaires. Statistical comparisons were performed to evaluate group differences, with significance set at $p < 0.05$.

Results: Hemoglobin decreased from 12.014 g/dl in the first trimester to 9.412 g/dl after miscarriage ($p < 0.01$), while RBCs declined from 4.376 $\times 10^{12}$/L to 4.011 $\times 10^{12}$/L ($p < 0.01$). WBCs increased significantly to 9.476 ± 2.89 $\times 10^{9}$/L ($p \leq 0.03$), accompanied by higher neutrophil levels (72.462 ± 8.70%). Lymphocytes, monocytes, and eosinophils decreased ($p \leq 0.02$), whereas platelets showed a slight reduction from 297 to 287 $\times 10^{9}$/L. MCV, MCH, and MCHC were also lower after miscarriage ($p < 0.05$). β-hCG levels markedly declined following pregnancy loss ($p < 0.001$).

Conclusion: Significant hematological and hormonal alterations were observed following miscarriage, demonstrating the clinical value of routine hematological monitoring in early pregnancy. These findings contribute reference points for evaluating maternal health and emphasize the need for nutritional counseling and consistent antenatal assessment.

Keywords: Anemia; Beta-hCG, Hematologic Tests, Leukocytes, Miscarriage, Pregnancy Trimester, First; Reference Values.



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INTRODUCTION

Pregnancy is a complex physiological state in which a complete offspring develops from the fertilized ovum, accompanied by profound maternal adaptations that support fetal growth and survival (1). Although considered a normal condition, gestation induces significant physiological, hormonal, hematological, and biochemical modifications that help the woman adjust to pregnancy demands while maintaining fetal well-being (2). Among these changes, hematological alterations are particularly important, as they reflect maternal adaptation to increased metabolic needs. The complete blood count (CBC), an accessible and cost-effective investigation, is routinely employed to monitor red blood cells, hemoglobin, hematocrit, erythrocyte indices, leukocyte subsets, and platelets, providing a reliable picture of maternal health (3). During early pregnancy, plasma volume expansion coupled with hemodilution leads to a fall in hematocrit and may result in physiological anemia, with these changes beginning as early as six weeks of gestation and extending into the postpartum period (4). Understanding these shifting hematological profiles is essential, not only for interpreting laboratory values but also for identifying women at risk of adverse maternal or fetal outcomes (5). A growing body of evidence highlights that several maternal factors predispose a seemingly normal pregnancy to early loss. Increasing maternal age, elevated pre-pregnancy body mass index, and low progesterone levels are well-established contributors, while lifestyle exposures—such as caffeine, smoking, alcohol, stress, and vigorous physical activity—have also emerged as significant risks (6). Miscarriage, defined as spontaneous pregnancy loss before 12 weeks (early miscarriage) or between 12 and 24 weeks (late miscarriage), affects nearly one in five pregnancies and carries substantial emotional, physical, and economic burdens (7). First-trimester vaginal bleeding is a frequent presenting symptom, occurring in approximately 25% of pregnancies and signaling a spectrum of possibilities ranging from threatened abortion to ectopic pregnancy (8). Although threatened abortion is diagnosed when cardiac activity is present in a closed-cervix pregnancy, the presence of subchorionic hematoma significantly increases the probability of pregnancy loss (9). The pathogenesis of early miscarriage is multifactorial; chromosomal anomalies account for a major proportion, while hormonal dysregulation and immunological disturbances further contribute to early pregnancy failure (10).

Hematological abnormalities, particularly anemia, remain a major global concern during pregnancy. Affecting nearly 42% of pregnant women worldwide and substantially higher proportions in low-resource settings, anemia is strongly associated with maternal mortality, preterm birth, low birth weight, and fetal growth restriction (11). Despite extensive literature comparing hematological profiles between pregnant and non-pregnant populations, limited research specifically evaluates CBC-related alterations in women who experience spontaneous miscarriage versus those with healthy early pregnancies (12). Pregnancy itself modulates leukocyte dynamics, with marked neutrophilia, stable eosinophil and lymphocyte counts, reduced basophils, and suppressed cell-mediated immunity, increasing susceptibility to viral and parasitic infections (13). Red cell indices may also be influenced by iron deficiency or folate deficiency, complicating the interpretation of hemoglobin levels in early gestation (14). Alongside hematological changes, biochemical markers such as human chorionic gonadotropin (hCG) serve as critical determinants of early pregnancy viability. Serial hCG trends, rather than absolute values, guide clinicians in distinguishing a viable pregnancy from miscarriage, ectopic pregnancy, or molar gestation. Transvaginal ultrasound, used in tandem with hCG thresholds, provides early visualization of gestational structures, cardiac activity, and embryonic development milestones (15–17). Despite these diagnostic tools, predicting early pregnancy loss remains challenging, underscoring the need to identify additional early biomarkers. Given the substantial burden of miscarriage, its multifactorial origins, and the limited emphasis on hematological predictors, this study aims to evaluate changes in routine blood parameters during early pregnancy and their association with early pregnancy loss. The objective is to determine whether specific hematological alterations can serve as early indicators of miscarriage, thereby supporting timely diagnosis and informed clinical decision-making.

METHODS

This experimental study was carried out over six months and enrolled a total of 100 pregnant women aged 21 to 42 years. Participants were recruited from the Pathology Research Laboratory of Riphah International University, Lahore, and the gynecology departments of various public sector hospitals in Faisalabad. Ethical approval for the study was granted by the Institutional Review Board of Riphah International University. Written informed consent was obtained from every participant before inclusion, and confidentiality of all data was ensured throughout the study. The study population consisted of two distinct groups: pregnant women with ongoing viable pregnancies beyond the first trimester and women who had experienced spontaneous miscarriage. Importantly, the study did not classify all participants as “completely healthy pregnant women.” Instead, it included both clinically healthy pregnant women and those who had undergone pregnancy loss, acknowledging that women who experienced miscarriage may have had underlying physiological

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changes preceding the loss. To maintain methodological rigor, the inclusion criteria targeted women without underlying systemic illnesses, while the exclusion criteria ruled out individuals with infectious diseases such as hepatitis. This approach aimed to minimize confounding factors and ensure that variations in hematological parameters were attributable primarily to pregnancy status rather than unrelated medical conditions. A structured questionnaire was administered to each participant to collect detailed demographic and clinical information, including age, weight, BMI, dietary habits, lifestyle factors, medication use, previous miscarriage history, stress levels, and overall health status. This standardized data collection allowed for consistent evaluation of potential contributors to hematological variability during early pregnancy.

Venous blood collection was performed using sterile techniques. Five milliliters of blood were drawn from each participant and transferred into EDTA-containing tubes. Samples were accurately labeled with the participant's name, age, and laboratory identification number. All samples were stored at room temperature and analyzed within 24 hours to ensure the validity of cellular measurements. Fasting was not required, as the hematological parameters assessed are not significantly altered by short-term dietary intake. Laboratory evaluation focused on complete blood count (CBC) parameters known to fluctuate during pregnancy, including hemoglobin (Hb), red blood cells (RBCs), white blood cells (WBCs), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), platelet count, and leukocyte differential counts (neutrophils, lymphocytes, monocytes, eosinophils, and basophils). Hemoglobin levels below 110 g/L were classified as anemia, and low platelet counts were interpreted as thrombocytopenia. Following miscarriage, β-hCG levels were also assessed using a biochemistry analyzer to confirm hormonal decline and validate pregnancy loss. All hematological analyses were performed using the Mindray BC-6000 seven-part differential hematology analyzer. This analyzer utilized six essential reagents (DS-Diluent, LH Lyse, LD Lyse, LN Lyse, FD Dye, and FN Dye) and required only 25 µL of anticoagulated blood per sample. It allowed simultaneous processing of up to 50 samples with a throughput of approximately 110 tests per hour. For CBC+DIFF analysis, the system required 80 µL of whole blood or 35 µL of capillary blood, supporting efficient, cost-effective, and reliable laboratory evaluation. Although the description of the data analysis process did not specify the exact statistical tests used, standard analytical procedures for such studies would typically include descriptive statistics, group comparisons using independent t-tests or Mann–Whitney U tests, and correlation analyses to explore associations between hematological alterations and pregnancy outcomes. Clarifying these statistical details would enhance analytical transparency and reproducibility.

RESULTS

A total of 100 pregnant women aged 21 to 42 years were included in the study, divided equally between women in their first trimester and those who had experienced miscarriage. The age distribution indicated that 47 women were between 21 and 30 years, 33 were between 31 and 35 years, and 20 were between 36 and 42 years. Hematological assessments were performed for all participants, and findings were compared between the two groups. In the first trimester group, hemoglobin averaged 12.01 g/dl, and red blood cell count measured 4.37 $\times 10^{12}$/L. Hematocrit was 36.7%, while mean corpuscular volume and mean corpuscular hemoglobin were 82.16 ± 8.60 fl and 27.22 ± 3.45 pg, respectively. The mean corpuscular hemoglobin concentration was 32.634 ± 3.41 g/dl, and platelet count averaged 297 $\times 10^{9}$/L. Leukocyte distribution showed comparatively lower white blood cell and neutrophil counts, whereas lymphocytes, monocytes, and eosinophils remained slightly higher. After miscarriage, marked reductions in erythrocyte parameters were observed. Hemoglobin decreased to 9.476 ± 1.40 g/dl, RBCs to 4.011 ± 0.69 $\times 10^{12}$/L, and hematocrit to 30.88 ± 4.86%. Mean corpuscular volume dropped to 77.988 ± 10.32 fl, mean corpuscular hemoglobin to 23.542 ± 3.79 pg, and mean corpuscular hemoglobin concentration to 29.914 ± 3.23 g/dl. Platelets declined mildly to 287 $\times 10^{9}$/L. White blood cell levels increased significantly to 9.476 ± 2.89 $\times 10^{9}$/L, with neutrophils rising to 72.462 ± 8.70%. Conversely, lymphocytes (20.784 ± 7.61%), monocytes (4.365 ± 2.10%), and eosinophils (2.1 ± 1.40%) were reduced compared to first-trimester values.

Overall comparison showed that hemoglobin, red blood cells, hematocrit, MCV, MCH, and MCHC consistently declined after miscarriage, while WBCs and neutrophils rose significantly. Platelet reduction was minimal and statistically nonsignificant. These trends indicate substantial hematological shifts associated with pregnancy loss, particularly within red cell indices and leukocyte distribution. Statistical analysis demonstrated significant differences across most parameters, including hemoglobin ($p < 0.01$), RBCs ($p < 0.01$), hematocrit ($p < 0.05$), MCV ($p = 0.05$), MCH ($p < 0.006$), MCHC ($p < 0.04$), WBCs ($p \leq 0.03$), neutrophils ($p \leq 0.03$), lymphocytes ($p \leq 0.02$), monocytes ($p \leq 0.02$), and eosinophils ($p \leq 0.02$). The evaluation of β-hCG levels demonstrated a pronounced decline following miscarriage, reflecting cessation of placental hormonal activity. The decrease was uniform across all age groups and showed strong statistical significance ($p < 0.001$), supporting β-hCG as a reliable indicator of pregnancy viability and early pregnancy loss. Analysis

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of leukocyte distribution revealed clear numerical differences between the first trimester and post-miscarriage period. Based on the plotted averages in the comparative chart, first-trimester WBC levels were approximately 8.0 ×10⁹/L, with neutrophils comprising about 67%, lymphocytes around 27%, monocytes approximately 5%, and eosinophils close to 1%. When compared with post-miscarriage values—WBCs 9.476 ± 2.89 ×10⁹/L, neutrophils 72.462 ± 8.70%, lymphocytes 20.784 ± 7.61%, monocytes 4.365 ± 2.10%, and eosinophils 2.1 ± 1.40%—the results demonstrated a clear rise in total leukocyte count and neutrophil proportion following pregnancy loss. Conversely, lymphocyte, monocyte, and eosinophil percentages showed notable reductions after miscarriage.

Table 1: Age Distribution of Pregnant Women Included in the Study

AGE	FEMALE
21-30 YEAR	47
30-35 YEAR	33
36-42 YEAR	20

Table 2: Comparison of Hematological Parameters Between First-Trimester Pregnancies and Post-Miscarriage Women

Parameter	First Trimester (Mean ± SD)	After Miscarriage (Mean ± SD)	P-value / Significance
Hemoglobin (Hb, g/dl)	12.01	9.476 ± 1.40	P < 0.01
Red Blood Cells (RBCs, x10^12/L)	4.37	4.011 ± 0.69	P < 0.01
Hematocrit (HCT, %)	36.7	30.88 ± 4.86	P < 0.05
Mean Corpuscular Volume (MCV, fl)	82.16 ± 8.60	77.988 ± 10.32	P = 0.05
Mean Corpuscular Hemoglobin (MCH, pg)	27.22 ± 3.45	23.542 ± 3.79	P < 0.006
Mean Corpuscular Hemoglobin Concentration (MCHC, g/dl)	32.634 ± 3.41	29.914 ± 3.23	P < 0.04
White Blood Cells (WBCs, x10^9/L)	Lower than post-miscarriage	9.476 ± 2.89	P ≤ 0.03
Neutrophils (%)	Lower than post-miscarriage	72.462 ± 8.70	P ≤ 0.03
Lymphocytes (%)	Higher than post-miscarriage	20.784 ± 7.61	P ≤ 0.02
Monocytes (%)	Higher than post-miscarriage	4.365 ± 2.1	P ≤ 0.02
Eosinophils (%)	Higher than post-miscarriage	2.1 ± 1.40	P ≤ 0.02
Platelets (x10^9/L)	297	287	Not significant

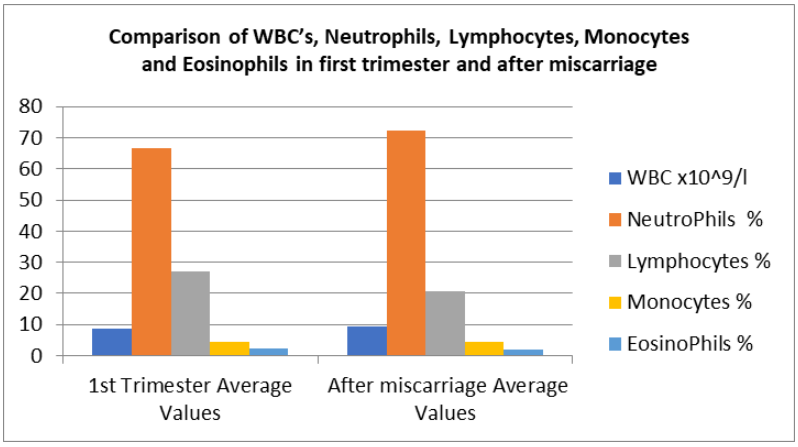

Figure 1 Comparison of WBCs, Neutrophils, Lymphocytes, Monocytes and Eosinophils in First Trimester and After Miscarriage

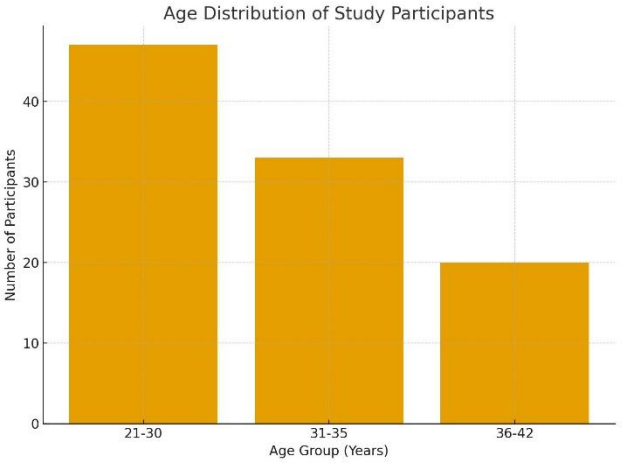

Figure 1 Age Distribution of Study Participants

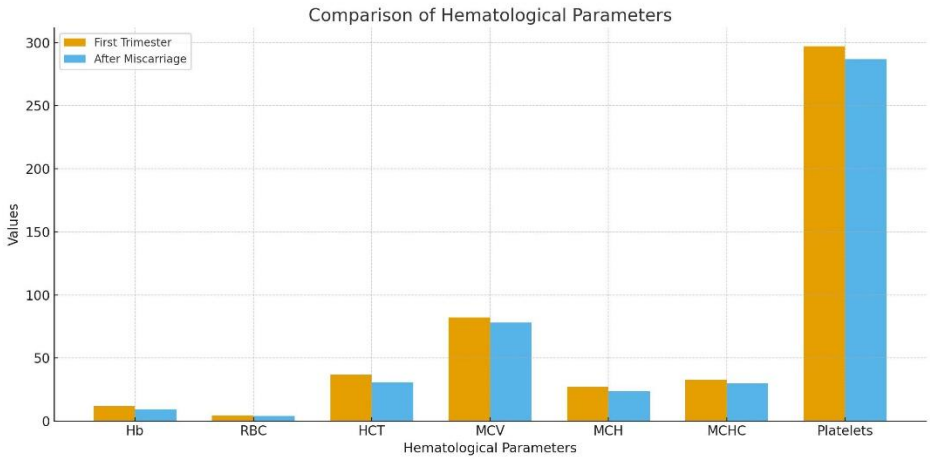

Figure 3 Comparison of hematological Parameters

DISCUSSION

The present study evaluated hematological variations in pregnant women and identified distinct differences between normal early gestation and the period following miscarriage. The observed decline in hemoglobin concentration after pregnancy loss aligned with long-established evidence indicating that pregnancy is accompanied by expanded plasma volume and physiological hemodilution, which naturally decreases hemoglobin values (18). In this study, hemoglobin decreased from an early-gestational mean of 12.014 g/dl to 9.412 g/dl after miscarriage, while RBC indices showed similar downward trends. These findings support previous research demonstrating that red cell parameters are sensitive to changes in pregnancy physiology and respond markedly to disruptions such as pregnancy loss. Declines in RBC count, hematocrit, MCV, MCH, and MCHC further reflected impaired erythropoietic balance and possible nutritional or hormonal influences associated with early pregnancy failure. Leukocyte dynamics demonstrated a contrasting pattern, with significant elevations in total WBCs and neutrophils after miscarriage. This response is consistent with reports describing leukocytosis as a marker of physiological stress and inflammatory activation during pregnancy complications (19). The increase in neutrophils, coupled with reductions in lymphocytes, monocytes, and eosinophils, indicated a shift toward innate immune predominance following pregnancy loss. Similar patterns have been documented, where neutrophil activation is attributed to delayed apoptosis, oxidative stress, and increased presence of toxic granules, while lymphocyte suppression reflects transient immune modulation during and after early gestational disruption (20). These hematological shifts provide insight into the immunophysiological stress associated with miscarriage and highlight the sensitivity of leukocyte subsets to pregnancy outcomes. The marked decline in β-hCG levels after miscarriage served

as a robust biochemical confirmation of pregnancy loss and supported its clinical utility as an early indicator of non-viable gestation. This pattern is well-established in the literature, where falling hCG levels reliably correspond to cessation of placental activity and are routinely used to differentiate viable pregnancies from early pregnancy failure. The findings reinforced the diagnostic value of integrating β-hCG trends with hematological markers to improve early identification of pregnancy loss.

Miscarriage results from a broad interplay of biological, genetic, maternal, and environmental factors. Earlier studies have shown that maternal age remains a significant determinant, with the risk rising sharply beyond 35 years and becoming markedly elevated after 40 (21). Chromosomal abnormalities remain the predominant cause of first-trimester pregnancy loss, while maternal comorbidities, hormonal imbalances, thrombophilic conditions, and lifestyle factors such as smoking, excessive caffeine intake, trauma, and poor nutrition further heighten susceptibility (22). The hematological changes observed in this study—particularly reductions in hemoglobin, RBC indices, and platelet trends—are consistent with previously documented physiological patterns. Platelet reduction during pregnancy and miscarriage may be influenced by hemodilution, platelet consumption at the placental interface, and enhanced destruction associated with placental pathology (23). Although platelet decline was mild and statistically non-significant, the trend aligns with earlier work describing mild gestational thrombocytopenia. The study offered several strengths, including direct comparison of hematological parameters before and after miscarriage within the same population and incorporation of β-hCG measurements to support diagnostic confirmation. The evaluation of multiple CBC components provided a comprehensive overview of hematological adaptation versus dysregulation. However, certain limitations were present. The study involved a relatively small sample size, which may restrict generalizability. Potential confounders such as nutritional status, iron supplementation, subclinical inflammation, or comorbidities other than infectious diseases were not extensively controlled. The study design did not include follow-up measurements beyond the immediate post-miscarriage period, limiting interpretation of temporal hematological recovery. Additionally, the lack of trimester-specific comparisons for parameters across the full course of gestation narrowed the scope of developmental interpretation. Future research may benefit from longitudinal designs tracking hematological trajectories throughout pregnancy and into the post-miscarriage recovery period. Incorporating biochemical markers of inflammation, iron studies, hormonal profiling, and chromosomal screening could further contextualize hematological shifts associated with pregnancy outcomes. Multicenter studies with larger sample sizes would strengthen the evidence and enhance applicability to broader populations. Despite its limitations, this study contributed valuable insight into the hematological and hormonal changes accompanying miscarriage and highlighted the importance of routine hematological evaluation as part of early pregnancy assessment and clinical decision-making.

CONCLUSION

This study demonstrated that hematological profiles undergo notable alterations during pregnancy and in the period following miscarriage, underscoring the importance of routine blood evaluation for early detection of complications. The findings established reference ranges for key hematological parameters in healthy pregnant women, providing a useful framework for clinical assessment and monitoring throughout gestation. These values support clinicians in distinguishing normal physiological changes from early indicators of adverse outcomes. The study also emphasized the critical role of maternal nutrition, highlighting the need for continuous education and guidance to ensure dietary adequacy during pregnancy. Overall, the research contributes meaningful insight into the hematological dynamics of early pregnancy and reinforces the value of proactive maternal health monitoring to promote safer pregnancy outcomes.

AUTHOR CONTRIBUTION

Author	Contribution
Muhammad Noman*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Usman	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing

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Author	Contribution
	Has given Final Approval of the version to be published
Gul Rana Ahmad	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Muhammad Sohail Hanif	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Mukhtiar Ali	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Khizar Farooq	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Fariha Kousar	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Zia ur Rehman	Writing - Review & Editing, Assistance with Data Curation

REFERENCES

1. Humadi EH, Maki H. White blood cell Indices to predict first trimester missed miscarriage. J Pak Med Assoc. 2024;74(10 (Supple-8)):S156-s9.

2. Gunenc O, Sarikaya S, Korez MK. The value of hematological parameters measured at first presentation in patients diagnosed with pregnancy in predicting early pregnancy loss; can NLPR be a new predictive value? A case-control study. J Matern Fetal Neonatal Med. 2025;38(1):2525399.

3. Soysal C, Sarı H, Işıkalan MM, Özkaya EB, Ulaş Ö, Taşçı Y, et al. Role of the systemic immune-inflammation index in threatened abortion patients and predicting of abortion. J Obstet Gynaecol Res. 2023;49(7):1723-8.

4. Naicker N, Yende-Zuma N, Kharsany ABM, Shozi H, Nkosi D, Naidoo A, et al. Pregnancy rates and outcomes in a longitudinal HIV cohort in the context of evolving antiretroviral treatment provision in South Africa. BMC Pregnancy Childbirth. 2022;22(1):596.

5. Fang QY, Gan DH, Huang J, Lian F. Pregnancy outcomes and risk factors for thrombocytopenia in pregnant patients with systemic lupus erythematosus. BMC Pregnancy Childbirth. 2025;25(1):344.

6. Liu D, Huang X, Xu Z, Chen M, Wu M. Predictive value of NLR and PLR in missed miscarriage. J Clin Lab Anal. 2022;36(3):e24250.

7. Wang X, Zhao Y, Fan Y, Liu Y. The Predictive Significance of Platelet-to-Lymphocyte Ratio for Miscarriage: A Systematic Review and Meta-Analysis. Immun Inflamm Dis. 2025;13(1):e70119.

8. Mu F, Huo H, Wang C, Hu N, Wang F. A new prognostic model for recurrent pregnancy loss: assessment of thyroid and thromboelastograph parameters. Front Endocrinol (Lausanne). 2024;15:1415786.

9. Zhang L, Hong HJ, Duan BD, Zhang Y, Shao CC, Wang LN, et al. Neutrophil-lymphocyte ratio and hypersensitive C-reaction protein are associated with miscarriage during the second trimester of pregnancy. J Biol Regul Homeost Agents. 2021;35(3):889-900.

10. Gangat N, Tefferi A. Myeloproliferative neoplasms and pregnancy: Overview and practice recommendations. Am J Hematol. 2021;96(3):354-66.

11. Jiang L, Du Y, Lu Y, Wu X, Tong X. Monitoring of hemostatic parameters for early prediction of first-trimester miscarriage. Biomarkers. 2021;26(6):532-8.

12. Zhang GM, Zhuang ZH. The maximum amplitude of thromboelastography can be used for predicting recurrent spontaneous abortion. Am J Reprod Immunol. 2022;87(5):e13538.

13. Salman AF, Alrawi S, Abdulrahman Hadi BA, Nori W. Maternal platelets in missed abortion; from a clinical perspective. J Pak Med Assoc. 2021;71(Suppl 9)(12):S43-s6.

14. Çallıoğlu N, Gül DK, Arslan İ, Geyikoğlu İ, Demirçivi E. Inflammatory markers in systemic immune-inflammatory index and inflammatory response index to predict early pregnancy loss. Saudi Med J. 2024;45(8):808-13.

15. Huang C, Zhang Y, Xiang Z, Li Y, Lin R, Xu J, et al. Granzyme B-expressing γδ-T and NK cells as a predictor of clinical pregnancy failure in patients with unexplained repeated implantation failure. J Reprod Immunol. 2021;144:103269.

16. Zhu L, Liu M, Zhang S, Ou Y, Chen Y, Wei J, et al. Foxp3 TSDR Hypermethylation Is Correlated with Decreased Tregs in Patients with Unexplained Recurrent Spontaneous Abortion. Reprod Sci. 2021;28(2):470-8.

17. Huang L, Wang J, Yan L, Wang J, Xiong X. Exploring the predictive value of complete blood count inflammatory parameters in early pregnancy for missed abortion. Sci Prog. 2025;108(1):368504251324356.

18. Hantoushzadeh S, Gargar OK, Jafarabady K, Rezaei MM, Asadi F, Eshraghi N, et al. Diagnostic value of neutrophil-to-lymphocyte and platelet-to-lymphocyte ratio to predict recurrent pregnancy loss and abortion; a systematic review and meta-analysis. Immun Inflamm Dis. 2024;12(3):e1210.

19. Cimsir MT, Yildiz MS. Could fibrinogen to albumin ratio be a predictive marker for recurrent pregnancy loss. Int J Clin Pract. 2021;75(10):e14520.

20. Chen D, Wang J, Liu H, Xu T, Qiao J, Liu Q, et al. Coagulation Status in Women with a History of Missed Abortion. Reprod Sci. 2024;31(2):480-7.

21. Liao J, Li Y, Li X, Su X, Peng J, Xiao N, et al. Blood CD4(+)CD25(+) T regulatory cells constitute a potential predictive marker of subsequent miscarriage in unexplained recurrent pregnancy loss. Int Immunopharmacol. 2022;110:108960.

22. Kale İ, Helvacıoğlu Ç, Muğurtay TE. Evaluation of complete blood count parameters in the first trimester: an early indicator of miscarriage. J Clin Invest Surg. 2021;6(1):48-52.

23. Biyik I, Albayrak M, Keskin F. Platelet to lymphocyte ratio and neutrophil to lymphocyte ratio in missed abortion. Revista Brasileira de Ginecologia e Obstetrícia. 2020; 42:235-9.