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# Comparative Cross-Sectional Analysis of Hematological Indices Between Pregnant and Non-Pregnant Women at DHQ Teaching Hospital, Haripur

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**ABSTRACT**

**Background:** Pregnancy is a physiological phenomenon that requires appropriate prenatal care to ensure a good fetal-maternal result. The mother's and the growing fetus's general health throughout pregnancy are significantly influenced by the hematological parameters. The aim of the study was to compare the hematological parameters during various stages of pregnancy.

**Method:** Over the course of two months, from November 2023 to December 2023, 90 samples (70 pregnant women and 20 controls) were collected at DHQ Hospital in District Haripur. Through a convenient sampling technique 2 to 3 ml venous blood samples were taken under aseptic conditions and automated hematological analyzers (Sysmex KX 21) were used for the analysis. Data was analyzed using SPSS version 22.

**Result:** Our study reveals that WBCs count increased in pregnant women which is up to 9.2 x 103/µl which have been seen to vary during pregnancy is compared to non-pregnant women whose WBCs count were 8.3 x 103/µl. Additionally various Red Blood Cells index like red cell count, hemoglobin concentration, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, and mean corpuscular volume. Hematocrit levels (HCT) were lower in pregnant women compared to non-pregnant women, while platelet counts showed slight to moderate variations, with a count of 247 x $10^3$/µl in pregnant women and 249 x $10^3$/µl in non-pregnant women.

**Conclusion:** According to the current study, anemia is widespread in the third Trimester in pregnant women. Therefore,for the mother's and the fetus's growth,a balanced and nutritious diet is strongly advised during the whole trimester.

**Keywords:** Pregnant women, Red Blood Cells indices, White Blood Cell Count, Platelets

## INTRODUCTION

Pregnancy occurs naturally, and careful monitoring of care is necessary to achieve positive outcomes. As pregnancy progresses, various physical changes become more noticeable. These changes can be affected by factors like status, cultural influences, the environment, and access to services. Hematological parameters are blood components that significantly impact the health of both the developing baby and the expectant mother.[1] A red blood cell count (CBC) blood test is done routinely as part of assessing normal variations in blood parameters and screening for any pregnancy-related risk factors. A mother's lifestyle can affect those changes. Pregnant women may face different kinds of pregnancy-related problems.[2] Testing of a woman's hematological health should be done by taking her blood samples during each trimester. Variables that can be quantified include the red blood cell (RBC) count, white blood cell (WBC) count, hemoglobin concentration, the mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), the mean corpuscular volume (MCV), platelet count, and packed cell volume (PCV).[3] Hematological parameters including hematocrit, hemoglobin concentration, white blood cells, and platelets are pregnancy-sensitive.[4] The hematocrit during pregnancy is likely to decrease as compared to non-

pregnant women; furthermore, it shows no appreciable change throughout the entire pregnancy period. On the other hand, a study by Pucohit *et al.,* 2019 indicated that there was a change in hematocrit value with the advancement of pregnancy from the first to the third trimester. The decrease in hematocrit percentage that happens during pregnancy does not follow a predictable pattern. To be more precise, the second trimester shows a marked and substantial decrease, whereas the first and third trimesters show a lower hematocrit percentage.[5]

The total red blood cell count (RCC) in non-pregnant women typically falls between 4.5 and 5.4 million per microliter of blood. On the other hand, compared to non-pregnant women, the overall RBC count dramatically drops during pregnancy. The RBC count decreases as the pregnancy goes on or as the pregnancy progresses.[5] The RBC mass increases gradually over the first eight to ten weeks of pregnancy. When women take iron supplements during pregnancy, it progressively rises by 20–23% (or 250–450 ml\dl) over pre-pregnancy levels. However, the rise is only about 15 to 20 percent in women who do not take iron supplements.[6] These are the typical natural circulatory system changes that occur during this stage of pregnancy and may cause hemoglobin levels to drop below what is thought to be normal for adult women. During pregnancy, there is a disproportionate increase in erythrocyte mass and an increase in plasma volume, which results in physiological anemia. Hemoglobin concentration falls as plasma volume grows more than red blood cell mass.[3]

The diagnostic criteria for anemia might change based on the pregnancy's trimester. Reduced expansion of plasma volume during pregnancy has been linked to unfavorable pregnancy outcomes, such as hypertensive diseases of pregnancy. Birth weight is positively correlated with both the total rise in plasma volume throughout the third trimester.[7] The platelet count does not significantly vary during the course of the three trimesters of pregnancy.[5] Pregnancy has been shown to raise the total white blood cell (WBC) count, and this count can grow even higher during delivery and the postpartum phase.[8] The absolute WBC count begins to grow in the first trimester of pregnancy and continue to increase throughout throughout. The process of neutrophil apoptosis, a rise in neutrophil count, and the stress of pregnancy are the main causes of this increase.[9] During the second and third trimesters of pregnancy, there is a notable increase in total leukocyte count (TLC). However,there is not much of a difference in TLC between non-pregnant and first trimester of pregnant women Compared to women who are anemic, non-anemic women often have greater TLC counts throughout the first trimester. However, anemic women often have greater TLC counts in the second and third trimesters than non-anemic women.[5] The total number of neutrophils starts to rise in the second month of pregnancy and stabilizes in the second or third trimester.

There is no discernible difference in the total number of lymphocytes in healthy women or in the proportion of T and B cells. The number of monocytes usually stays constant. However, there may be slight alterations in the basophil and eosinophil numbers.[6] The mean corpuscular volume (MCV) increases significantly from the first to the third trimester of pregnancy, according to James *et al*. On the other hand, another study conducted by Akinbami *et al,* claims that anemia among patients causes MCV to actually drop from the first to the third trimester. Other research studies point out that the mean corpuscular hemoglobin (MCH) does not significantly alter throughout pregnancy and remains unchanged throughout all three trimesters. On the other hand, MCH readings significantly drop or dramatically drop in the second and third trimesters, according to previous research. Furthermore, compared to non-pregnant women, pregnant women often have reduced MCHC (mean corpuscular hemoglobin concentration), which may be caused by inadequate iron consumption. A study conducted by Abrac *et al.* found that MCHC remains constant during pregnancy with no changes observed.[5] This study aims to evaluate major hematological parameters in pregnant women at DHQ Teaching Hospital, District Haripur, across different trimesters of pregnancy.

## MATERIALS AND METHODS

This cross-sectional study was conducted at DHQ teaching hospital, District Haripur, Pakistan. By using a convenient sampling technique, a total of 90 samples (70 pregnant women and 20 non-pregnant controls) were collected at DHQ hospital, District Haripur over a two month period from November 2023 to December 2023.[10] The University of Haripur research Ethics Committee granted the study ethical approval for the study, and informed consent was obtained from patients participating in research. Only the comparison of hematological parameters during different trimesters of pregnancy is included in this study. This study excludes factors like pre-existing medical conditions, the use of certain medications, a history of blood disorders, or any other factors that could potentially affect the hematological parameters being studied.

Each participant had 3 milliliters (ml) of venous blood drawn into an EDTA (ethylene diamine tetra-acetic acid) tube Automated hematological analyzers (Sysmex KX 21) were used for the determination of complete blood count. Only comparisons of hematological parameters among pregnant and non-pregnant women from district Haripur were included in this study. The factors like pre-existing medical conditions, the use of certain medications, a history of blood disorders, or any factors that could potentially affect the hematological parameters being studied were excluded from the study. Data analysis was performed using SPSS version 22.

**RESULT**

A total of 90 females were recruited and categorized into two groups: group A of pregnant females (n=70) and group B of non-pregnant females/control group. WBC count showed a slight increase in first 9.4 x $10^3$/µl and second trimester 9.9 x $10^3$/µl and then a decrease in third trimester 9.0 x $10^3$/µl. WBC count normal range is 4.0 - 11.0 x $10^3$/µl.RBC count, with a normal range 3.80 - 5.20 x $10^6$/µl, decreases gradually from the first to the third trimester, which is a normal physiological adaptation to the increased plasma volume during pregnancy.Specifically, values were 3.9 x $10^6$/µl in the first trimester, 3.8 x $10^6$/µl in the second trimester, and 3.7 x $10^6$/µl in the third trimester.. Hemoglobin levels show an increase in the first two trimesters and a slight decrease in the third trimester. These variations are generally within the expected range. Hematocrit levels decrease gradually throughout pregnancy, with a more noticeable drop between the first and second trimesters. MCV decreases from the first to the second trimester and then remains relatively stable in the third trimester. MCH increases from the first to the second trimester and shows a further slight increase in the third trimester. Mean corpuscular hemoglobin concentration (MCHC) increases in the second trimester and then decreases slightly in the third trimester. There are variations in platelet count, with a significant increase in the second trimester followed by a decrease in the third trimester. It's important to note that the platelet count in the third trimester is still within the generally accepted range, but the large fluctuation may warrant further clinical evaluation. These variations in hematological parameters are shown in table 1.

A Complete Blood Count (CBC) is a routine blood test crucial during pregnancy to assess maternal and fetal health. In comparing the Complete Blood Count (CBC) test results of a pregnant female and a non-pregnant female (control group), notable differences were observed . Comparing the Complete Blood Count (CBC) results of a pregnant female (WBC 9.2 x $10^3$/µl, RBC 3.7 x $10^6$/µl, Hemoglobin 10.7 g/dL, HCT 31 %, MCV 83 fL,MCH 29 pg, MCHC 35 g/dL, Platelets 247 x $10^3$/µl) to a non-pregnant female (WBC 8.3 x $10^3$/µl, RBC 4.2 x $10^6$/µl, Hemoglobin 12.6 g/dL, HCT 36 %, MCV 85 fL, MCH 29 pg, MCHC 34 g/dL, Platelets 249 x $10^3$/µl) revealed slight to moderate variations. The pregnant female showed a slightly elevated WBC count and lower RBC count, hemoglobin, and HCT during pregnancy. MCV was slightly lower in the pregnant woman. Platelet counts were within normal range, suggesting no significant difference. The p-values for all hematological parameters were greater than 0.1, therefore, there was no significant no relationship between Pregnant and non-pregnant females. These variations in hematological parameters are shown in table 2.

**DISCUSSION**

Pregnancy is a dynamic physiological stage marked by numerous changes to support the growth of a developing fetus. Among these changes, alterations in hematological parameters also occur that play a vital

**Table 1: Trimester wise distribution hematological parameters**

| Hematological Parameters | First Trimester | Second Trimester | Third Trimester | Normal Ranges |
|---|---|---|---|---|
| WBC Count | 9.480 | 9.916 | 9.089 | 4.0 - 11.0 x $10^3$/µl |
| RBC Count | 3.998 | 3.848 | 3.705 | 3.80 - 5.20 x $10^6$/µl |
| Hemoglobin | 10.975 | 11.263 | 10.717 | 11.7 - 15.7 g/dL |
| HCT | 34.390 | 32.113 | 30.747 | 35 - 46 % |
| MCV | 86.500 | 83.450 | 83.848 | 77 - 91 fl |
| MCH | 27.550 | 29.838 | 30.010 | 27 - 32 pg |
| MCHC | 31.750 | 35.988 | 35.548 | 32 - 36 g/dL |
| PLT Count | 249.250 | 362.000 | 231.466 | 150 - 400 x $10^3$/µl |

**Table 2: Comparative analysis of hematological parameters of pregnant and control groups**

| Hematological parameters | Non-Pregnant women (control) (n=20) | Pregnant women (n=70) | Normal Range | P- Value |
|---|---|---|---|---|
| WBC Count | 8.375 | 9.2063 | 4.0 - 11.0 x $10^3$/µl | 0.85 |
| RBC Count | 4.214 | 3.7381 | 3.80 - 5.20 x $10^6$/µl | 0.609 |
| Hemoglobin | 12.650 | 10.7943 | 11.7 - 15.7 g/dL | 0.581 |
| HCT | 36.465 | 31.1110 | 35 - 46 % | 0.77 |
| MCV | 85.585 | 83.9543 | 77 - 91 fl | 0.449 |
| MCH | 29.695 | 29.8500 | 27 - 32 pg | 0.869 |
| MCHC | 34.665 | 35.3814 | 32 - 36 g/dL | 0.627 |
| PLT Count | 249.050 | 247.4000 | 150 - 400 x $10^3$/µl | 0.221 |

role in ensuring the health and well-being of both the mother and developing fetus. This study was done to estimate the hematological modifications that occur during pregnancy. The study was carried out, a subsequent examination of the different aspects of CBC test reveals variations in different parameters between pregnant and control group (non-pregnant).

According to this study, we noticed that the WBC count in pregnant women is significantly higher (9.2 x $10^3$/µl) than in non-pregnant women (8.3 x $10^3$/µl) and this rate gradually increase in pregnant women during 1st (9.4 x $10^3$/µl) and 2nd (9.9 x $10^3$/µl) trimester respectively and decrease during 3rd trimester (9.0 x $10^3$/µl). The increase in WBC count during the first and second trimester reflects the body's response to the changing metabolic demands and immune requirements. Persistent deviations, either upwards or downwards, may prompt further investigations, as the immune system remains crucial in safeguarding maternal and fetal health until delivery. The RBC count in this study is lower in pregnant women (3.7 x $10^6$/µl) than non-pregnant (4.2 x $10^6$/µl) this rate is gradually increased in 1st trimester (3.9 x $10^6$/µl). The body starts adapting to the metabolic changes associated with pregnancy, but significant deviations from non-pregnant levels are not yet pronounced. This period serves as a transition phase, preparing the body for the upcoming adjustments. Then RBC is accompanied by further decrease in 2nd (3.8 x $10^6$/µl) and 3rd (3.7 x $10^6$/µl) trimesters. This reduction aligns with the expanding plasma volume, contributing to the overall increase in blood volume. While this value is lower than the non-pregnant baseline, it ensures that the blood remains fluid enough to meet the increased demands of the mother and the developing fetus.

The physiological stage of pregnancy is dynamic and characterized by several changes that assist the growing fetus. Changes in hematological parameters are essential for maintaining the health and welfare of the growing fetus as well as the mother. The purpose of this study was to evaluate the hematological alterations in females in District Haripur, Pakistan, during pregnancy. A complete blood count was conducted in each of the three trimesters of the pregnancy. Our study's findings showed that pregnant women's hemoglobin levels (10.7g/dl) were much lower than those of the non-pregnant control group (12.6g/dl), and that this rate steadily dropped with gestational age. The HGB levels in the first, second, and third trimesters of pregnancy were (10.9g/dl), (11.2g/dl), and (10.7g/dl), respectively. Our findings concur with those of another study (11) that found that pregnant women's HGB was 11.80g/dl whereas non-pregnant women's HGB was 13.01g/dl. Additionally, this investigation revealed HGB values of 12.23g/dl, 11.68g/dl, and 11.22g/dl in the first, second, and third trimesters of pregnancy, respectively. Pregnant women's reduced HGB levels are caused by hemodilution, a condition in which the body's plasma volume grows more quickly than the mass of red blood cells. This process lowers HGB levels while simultaneously increasing the need for iron, vitamin B12, and folic acid for fetal hematopoiesis. This physiological shift takes place in every pregnant woman to meet the demands of the developing fetus and its surroundings.

In comparison to non-pregnant women (4.2 X 1012) and (36.4%), the mean values of the RBC and those of the HCT or PCV (packed cell volume) dropped considerably for pregnant women (3.7 X 1012) and (31.1%), respectively. These findings are comparable to those of [12] which yielded averages of HCT of 33.56 ± 0.48 against 37.62 ± 0.60 for pregnant and non-pregnant women, and RBC of 4.11 ± 0.05 for pregnant women versus 4.45 ± 0.06 for non-pregnant women. We observed that the rate of HCT and RBC decreased with gestational age. The red blood cell count and HCT decreases in pregnant women during all trimesters (3.9 X $10^{12}$), (34.3%) in 1st trimester, (3.8 X

$10^{12}$) (32.1%) in 2nd trimester and (3.7 X $10^{12}$),(30.7%) in third trimester, respectively.

This variation in hematological parameters is similar with another previous the study [11] which show count of RBC and HCT of (4.21 X $10^{12}$ ), (35.87%,) in the 1st trimester, (4.02 X $10^{12}$) (34.44%)in the 2nd trimester and (3.92 X $10^{12}$), (33.20%) in the 3rd trimester of pregnancy. The decrease in the number of red blood cells and the reduction in the HCT rate during pregnancy may be related to either the hemodilution caused by the increasing plasmatic volume during pregnancy or the hormonal changes that lead to increased fluid retention and iron deficiency.

There was a significant difference in the erythrocytes index (MCV, MCH, and MCHC) between the pregnant women and the control group as well as between the three trimesters of pregnancy. In our study, the MCV in pregnant women is significantly lower (83.9fl) than non-pregnant (85.5fl). MCH (29.8pg) and MCHC (35.3g/dl) were recorded in pregnant women which is slightly greater than MCH (29.6pg) and MCHC (34.6g/dl) of control (non-pregnant). There is somehow irregularities seen in MCV (86.5fl), (83.4fl) and (83.8fl) in 1st, 2nd and 3rd trimesters, respectively and MCHC (31.7), (36.9) and (35.5) in 1st, 2nd and 3rd trimesters, respectively. The values of MCH increase (27.5pg), (29.8pg), (30.0pg) over all trimesters, respectively. This result consolidated by the study of [12] that produces the value of the MCHC was 32.65g/dl, 33.03g/dl and 32.78g/dl in the 1st , 2nd and 3rd trimester of pregnancy, respectively but the values of MCV and MCH do not coincide with the values of previous finding.[12]

During pregnancy, our results show a slight increase in total number WBC for pregnant women (9.2 X $10^3$) compared with non-pregnant women (8.3 X $10^3$). WBC's count was (9.4 X $10^3$), (9.9 X $10^3$) and (9.0 X $10^3$) in 1st, 2nd and 3rd trimester respectively. This variation in WBC count during different trimester of pregnancy do not coincide with the previous study[13].

In our results the count of platelet for pregnant women was (247.4 X $10^9$/l) compared to non-pregnant women (249.0 X 109/l). Platelets count in all trimesters was (249.25 X $10^9$/l), (362.0 X $10^9$/l) and (231.4 X $10^9$/l). These results are similar to those of previous finding[(14)] that produces the mean value of platelet was 241.7 X $10^9$/l, 234.9 X $10^9$/l and 204.8 X $10^9$/l in the 1st, 2nd and 3rd trimester of pregnancy, respectively. More information on dynamic changes can be obtained via cross-sectional research. Small sample numbers and a lack of variety impede research on hematological markers related to pregnancy are the limitation of our study. We recommend that according on hematological characteristics and general health, consultation with healthcare specialists can offer customized care strategies. The synthesis of red blood cells depends on nutritional assistance, which includes folate, vitamin B12, and iron.

## CONCLUSION

We concluded from the current comparative study that there was a slight decrease in red blood cell (RBC) count and red cell indices in pregnant women as compared to non-pregnant women. Additionally, the white blood cell (WBC) count was found to be higher in pregnant women. Thus, it appears from the current research that the significance of health during the prenatal care period has to be emphasized more. Prenatal therapy sessions could be utilized to prevent anemia during pregnancy and, consequently, improving pregnancy outcomes.

## Competing Interest declaration

There are no Competing Interests.

## Funding Declaration

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## REFERENCES

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This study found out that the WBC count in pregnant women is significantly higher (9.2 x 103/µl) than in non-pregnant women (8.3 x 103/µl) and this rate gradually increased in pregnant women during first (9.4 x 103/µl) and second (9.9 x 103/µl) trimester, respectively, and decreased during third trimester (9.0 x $10^3$/µl). The increase in WBC count during the first and second trimester reflects the body's response to the changing metabolic demands and immune requirements. Persistent deviations, either upwards or downwards, may prompt further investigations, as the immune system remains crucial in safeguarding maternal and fetal health until delivery. The RBC count in this study was lower in pregnant women (3.7 x $10^6$/µl) than in non-pregnant women (4.2 x $10^6$/µl), this rate gradually increased in the first trimester (3.9

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The physiological stage of pregnancy is dynamic and characterized by several changes that assist the growing fetus. Changes in hematological parameters are essential for maintaining the health and welfare of the growing fetus as well as the mother. The purpose of this study was to evaluate the hematological alterations in females in District Haripur, Pakistan, during pregnancy. A complete blood count was conducted in each of the three trimesters of the pregnancy. Our study's findings showed that pregnant women's hemoglobin levels (10.7g/dL) were much lower than those of the non-pregnant control group (12.6g/dL), and that this rate steadily dropped with gestational age. The HGB levels in the first, second, and third trimesters of pregnancy were (10.9g/dL), (11.2g/dL), and (10.7g/dL), respectively. Our findings concur with those of another study (11) that found that pregnant women's HGB was 11.80g/dL whereas non-pregnant women's HGB was 13.01g/dL. Additionally, this investigation revealed HGB values of 12.23g/dL, 11.68g/dL, and 11.22g/dL in the first, second, and third trimesters of pregnancy, respectively. Pregnant women's reduced HGB levels can be caused by hemodilution, a condition in which the body's plasma volume grows more quickly than the mass of red blood cells. This process lowers HGB levels while simultaneously increasing the need for iron, vitamin B12, and folic acid for fetal hematopoiesis. This physiological shift takes place in every pregnant woman to meet the demands of the developing fetus and its surroundings.

In comparison to non-pregnant women (4.2 X 1012) and (36.4%), the mean RBC values and HCT or PCV (packed cell volume) values dropped considerably for pregnant women (3.7 X 1012) and (31.1%), respectively. These findings are comparable to those of a previous study,[12] which yielded averages of HCT of 33.56 ± 0.48 compared to 37.62 ± 0.60 for pregnant and non-pregnant women, and RBC of 4.11 ± 0.05 for pregnant women versus 4.45 ± 0.06 for non-pregnant women. We observed that the rate of HCT and RBC decreased with gestational age. The red blood cell count and HCT decrease in pregnant women during all trimesters (3.9 X $10^{12}$), (34.3%) in first trimester, (3.8 X $10^{12}$) (32.1%) in second trimester and (3.7 X $10^{12}$),(30.7%) in third trimester, respectively.

This variation in hematological parameters is similar to another previous the study, [11] which showed count of RBC and HCT of (4.21 X $10^{12}$ ), (35.87%,) in the first trimester, (4.02 X $10^{12}$) (34.44%)in the second trimester and (3.92 X $10^{12}$), (33.20%) in the third trimester of pregnancy. The decrease in the number of red blood cells and the reduction in the HCT rate during pregnancy may be related to either the hemodilution caused by the increasing plasmatic volume during pregnancy or the hormonal changes that lead to increased fluid retention and iron deficiency.

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During pregnancy, our results showed a slight increase in the total WBC count in pregnant women (9.2 X $10^3$) compared with non-pregnant women (8.3 X $10^3$). WBC count was (9.4 X $10^3$), (9.9 X $10^3$) and (9.0 X $10^3$) in first, second and third trimester respectively. This variation in WBC count during different trimesters of pregnancy does not coincide with the previous study[13]. In our results the platelet count for pregnant women was (247.4 X $10^9$/l) compared to non-pregnant women (249.0 X 109/l). Platelet count in all trimesters was (249.25 X $10^9$/l), (362.0 X $10^9$/l) and (231.4 X $10^9$/l). These results were similar to those of a previous finding,[(14)] which reported the meanplatelet values as 241.7 X $10^9$/l, 234.9 X $10^9$/l

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## CONCLUSION

The current comparative study concluded that there was a slight decrease in red blood cell (RBC) count and red blood cell indices in pregnant women as compared to non-pregnant women. Additionally, the white blood cell (WBC) count was found to be higher in pregnant women. Thus, it appears from the current research that the significance of health during the prenatal care period has to be emphasized further . Prenatal therapy sessions could be utilized to prevent anemia during pregnancy and, consequently, improve pregnancy outcomes.

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