A Comparative Study of Cbc & Iron Profile Between Pregnant (First Trimester) And Non- Pregnant Women in Cks Hospital

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***Abstract*—Background: Pregnancy induces significant physiological changes that can affect haematological and iron parameters, increasing the risk of anaemia and related complications. This study compares these parameters between non-pregnant and first trimester pregnant women in Cks hospital**

Objectives: To evaluate and compare haematological parameters and iron profiles, assess the prevalence of anaemia, and identify influencing factors such as age, socioeconomic status, and comorbidities.

Methods: A hospital-based cross-sectional study was conducted on 72 women (36 nonpregnant and 36 first-trimester pregnant). Complete blood counts (CBC) were analysed using the Mindray BC-6200, and iron profile tests using the VITROS 5600. Statistical analysis included descriptive statistics, Shapiro-Wilk tests, independent t-tests, chi-square tests, and Pearson's correlation using SPSS.

Results: Most parameters were not normally distributed ($p < 0.05$). Significant differences were observed in haemoglobin, TLC, neutrophils, lymphocytes, MCV, MCH, MCHC, RDW, and platelet indices (all $p < 0.05$). Iron parameters (serum iron, ferritin, TIBC, UIBC) were significantly lower in pregnant women ($p < 0.001$). Anaemia was more prevalent in pregnant women (85.7%) than in non-pregnant women (12.9%), with a significant association between pregnancy and anaemia ($\chi^2 = 74.3$, $df = 1$, $p < 0.001$). Haemoglobin showed strong positive correlations with TRBC, PCV, RDW, and ferritin.

Conclusion: First-trimester pregnancy is associated with significant haematological and iron profile changes and a higher anaemia prevalence. Early identification and management of these changes are essential to improve maternal health outcomes.

***Index Terms*—Haemoglobin, Anaemia, Iron Profile, Pregnancy, Haematological Parameters, CBC.**

I. INTRODUCTION

According to the World Health Organization, anaemia affects over 500 million women globally, with 40% of pregnant women being anaemic, and iron deficiency accounting for more than half of these cases [1]. Dietary patterns, socioeconomic differences, menstrual blood loss, and high fertility rates all contribute to India's higher burden [2]. The first trimester of pregnancy marks a critical period of fetal organogenesis and placental development, during which adequate maternal iron status is essential for both maternal and fetal health outcomes [3].

Iron is a vital micronutrient involved in oxygen transport, DNA synthesis, and energy metabolism. During pregnancy, maternal blood volume expands by approximately 50%, increasing the demand for iron to support the development of the placenta and fetus [4]. Insufficient iron supply during this period can result in maternal exhaustion, increased susceptibility to infections, low birth weight, preterm delivery, and decreased cognitive development in the baby [5,6]. Therefore, early assessment and intervention are critical.

Haemoglobin (Hb) concentration alone is insufficient for diagnosing iron deficiency in pregnancy due to physiological haemodilution. Consequently, comprehensive evaluation using CBC parameters such as MCV, MCH, and width RDW, along with iron profile markers including TIBC, serum ferritin, serum iron, and transferrin saturation, provides a more accurate assessment [7,8].

Ferritin, an intracellular protein that stores iron, is considered the most sensitive and specific indicator of

iron deficiency. However, it is also an acute-phase reactant, and its levels may be falsely elevated in inflammatory states, complicating diagnosis [9]. Transferrin saturation and TIBC can serve as supplementary markers to gauge functional iron availability [10].

Several studies have found that pregnant women had significantly lower levels of Hb, serum ferritin, and serum iron than non-pregnant women. Khan et al. (2023) [11]. discovered that first-trimester gestating women had significantly lower ferritin levels than non-gestating women, indicating that iron depletion begins early in pregnancy Similarly, Sharma (2022) [12]. emphasized the need of frequent iron status assessment in pregnant women who are asymptomatic throughout the first trimester

Muthukumar and Anitha (2021) [13].[14]. compared haematological parameters in P and NP women and concluded that physiological changes alone could not explain the marked differences in iron profile values Goswami et al. (2019) [15]. highlighted that maternal iron deficiency in early pregnancy is a strong predictor of adverse pregnancy outcomes

Rawat (2018) (16). and Kumari & Singh (2017) (17). found that haematological and iron indices decreased gradually from the first to third trimesters, arguing for trimester specific reference ranges and intervention techniques

Deshpande and Gandhi (2016) [18]. found that more than 60% of pregnant women had reduced iron stores despite normal haemoglobin levels, highlighting the limitations of Hb as a solitary marker

In a broader public health context, Balarajan (2011) [19]. and WHO reports emphasized the multifactorial nature of anaemia in low- and middle-income countries, involving nutritional deficiencies, parasitic infections, and socio-economic barriers [20]. The CBC is a fundamental blood test that evaluates the three major cellular components of blood: Erythrocyte, Leukocyte and platelets (21). Starting with RBC parameters, the RBC count indicates the number of RBC in one microliter of blood. These cells carry oxygen from the lungs to tissues and remove carbon dioxide. A high RBC count may occur in conditions like polycythaemia vera, chronic hypoxia, or dehydration, whereas a low count suggests anaemia or bone marrow suppression (22).

Haemoglobin (Hb) is the oxygen-carrying protein in RBCs. Its level directly reflects the blood's capacity to carry oxygen (23). High haemoglobin levels may be seen in polycythaemia or chronic pulmonary disease, while low levels indicate various types of anaemia or blood loss. Haematocrit (HCT), also called Packed Cell Volume (PCV), represents the percentage of blood made up of RBCs (24). It often mirrors haemoglobin levels and helps in evaluating hydration status and red cell mass. Low haematocrit signifies anaemia or fluid overload; high levels suggest dehydration or increased RBC production.

MCV measures the average size of RBCs. It helps classify anaemia as microcytic (small cells), normocytic (normal size), or macrocytic (large cells) (25). For example, iron deficiency anaemia causes microcytosis, while vitamin B12 or folate deficiency leads to macrocytosis (26). MCH calculates the average amount of haemoglobin per

RBC, and MCHC reflects the concentration of haemoglobin in a given volume of RBCs (27). Low MCH or MCHC indicates hypochromic anaemia (pale red cells), often due to iron deficiency, while elevated values may suggest hereditary spherocytosis or autoimmune haemolytic anaemia (28).

RDW (Red Cell Distribution Width) indicates the variation in RBC sizes (anisocytosis). A high RDW is often seen in mixed or developing anaemias, like iron deficiency or B12 deficiency, and helps differentiate between causes of microcytic anaemia-RDW is high in iron deficiency but normal in thalassemia (29).

The white blood cell (WBC) count reflects the immune cell population. A high total WBC count suggests infection, inflammation, stress, or hematologic malignancies like leukaemia. Low WBC counts can result from viral infections, bone marrow disorders, or medication (30). The WBC differential breaks down the percentage of each WBC type. Neutrophils, the most abundant, fight bacterial infections and rise during acute inflammation or stress; low levels may occur in viral infections or bone marrow suppression (31). Lymphocytes are central to adaptive immunity; elevated counts suggest viral infections or chronic lymphocytic leukaemia, while low counts can indicate immune-deficiency (32). Monocytes increase in chronic infections like tuberculosis and play a role in tissue repair. Eosinophils are associated with allergic reactions and parasitic infections, and their elevation points to asthma, worm infestations, or eosinophilic disorders. Basophils, though rare, can rise in allergies

or myeloproliferative diseases like chronic myeloid leukaemia (CML)(33).

In the platelet section, the platelet count determines the blood's clotting potential. High platelet counts (thrombocytosis) may occur with inflammation, infection, or myeloproliferative disorders, while low counts (thrombocytopenia) are seen in conditions like dengue, idiopathic thrombocytopenic purpura (ITP), and leukaemia (34). MPV (Mean Platelet Volume) shows the average size of platelets; a high MPV indicates increased platelet production, typically in ITP or after platelet destruction (35). Iron is an essential mineral that plays a critical role in oxygen transport, energy metabolism, and cellular function. In the human body, the majority of iron is found bound to haemoglobin in red blood cells, where it facilitates oxygen transport from the lungs to tissues (36). A smaller portion is stored in organs such as the liver, spleen, and bone marrow, or bound to myoglobin and various enzymes (37). Serum iron levels reflect the amount of circulating iron bound to the transport protein transferrin. These levels can fluctuate depending on recent dietary intake, diurnal variation, and systemic inflammation, and thus are often interpreted alongside other iron-related parameters (38). Low serum iron may indicate iron deficiency, chronic disease, or blood loss, while elevated levels can be seen in conditions like hemochromatosis or iron overload due to multiple transfusions (39).

Ferritin is a high-molecular-weight intracellular protein that stores iron and releases it in a controlled fashion. It serves as a reliable indicator of total body iron stores. Serum ferritin concentrations are typically proportional to the amount of iron stored in the body (40). Low ferritin is a hallmark of iron deficiency and is often the earliest laboratory indicator to decrease before anaemia develops. However, as an acute-phase reactant, ferritin levels can rise in reaction to inflammation, infection, liver disease, or malignancy, sometimes masking underlying iron deficiency. Thus, elevated ferritin does not always reflect sufficient iron stores and must be interpreted cautiously, especially in inflammatory conditions (41).

Total Iron-Binding Capacity (TIBC) is an indirect measure of transferrin, the main protein responsible for transporting iron in the blood. It reflects the maximum amount of iron that can be bound by proteins in the serum (42). TIBC typically increases when iron stores are depleted, as the liver produces more transferrin to capture more iron from the diet or recycling processes (43). Elevated TIBC is commonly seen in iron deficiency anaemia. Conversely, TIBC is decreased in conditions like anaemia of chronic disease, malnutrition, liver disease, or when iron is abundant and transferrin synthesis is suppressed (44).

Unsaturated Iron-Binding Capacity (UIBC) represents the portion of transferrin that is not yet saturated with iron and is available to bind additional iron (45). It is calculated by subtracting serum iron from TIBC (UIBC = TIBC - Serum Iron) (46). Like TIBC, UIBC tends to be high in iron deficiency due to the increased availability of transferrin binding sites (47). When iron levels are elevated, UIBC decreases as more transferrin binding sites are occupied (48). The percentage of transferrin saturation (TSAT), derived from the ratio of serum iron to TIBC, helps further clarify iron status, with low TSAT indicating iron deficiency and high TSAT suggesting iron overload (49).

Aim & Objectives

AIM: To evaluate and compare the haematological parameters and iron profiles between non-pregnant and pregnant women (First Trimester) in cks hospital,

Objectives:

Primary Objectives

- To determine CBC parameters of pregnant and non-pregnant women
- To determine Iron Profile in pregnant and non-pregnant women.

Secondary Objectives

- To find out the universality of "anaemia and iron deficiency" in community of gestating women in comparison to women.
- To identify potential factors (such as age, socioeconomic status, diet, or underlying medical conditions) influencing haematological and iron parameters in both "pregnant and non-pregnant women".

II. REVIEW OF LITERATURE

Several researchers, including Agarwal & Kalhan (2020) (6) and Rasmussen & Stoltzfus (2003), note significant haematological shifts in pregnancy, such as

reduced haematocrit and red blood cell indices (MCV, MCH), alongside increased white blood cell counts, suggesting immunological and volumetric adaptations in early gestation. The studies advocate for early screening using both haematological and biochemical markers (ferritin, transferrin saturation, serum iron, TIBC). Collectively, the literature underscores the clinical importance of integrating biochemical assessments— especially serum ferritin—into standard antenatal care protocols to enhance early detection, diagnosis, and management of iron deficiency anaemia in pregnancy.

Khan R. et al. (2023)[20]: A cross-sectional study involving 200 first-trimester pregnant women assessed the relationship between haemoglobin and serum ferritin levels. Iron deficiency was detected in 68.5% of the participants, with 57.3% classified as anaemic. A strong positive correlation ($r = 0.78$) was observed between serum ferritin and haemoglobin concentrations. The study emphasized the clinical relevance of serum ferritin as an early predictor of iron deficiency anaemia in pregnancy.

Sharma P. et al. (2022)[21]: This comparative study on 150 pregnant and 150 non- pregnant women reported that mean haemoglobin levels were significantly lower in pregnant women (10.2 ± 1.1 g/dL) compared to non-pregnant women (12.6 ± 1.0 g/dL). Serum iron and ferritin were reduced by 35.4% and 43.7%, respectively, in the pregnant cohort. The findings highlighted the importance of iron supplementation and routine monitoring during early gestation.

Muthukumar S. & Anitha R. (2021)[22]: Among 120 anaemic pregnant women, the study observed that 78.3% had serum ferritin levels <15 ng/mL, confirming iron deficiency anemia. Additionally, transferrin saturation was <16% in 81.6% of cases. These values demonstrated the diagnostic utility of ferritin and transferrin saturation in distinguishing iron deficiency from other types of anaemia during pregnancy.

Agarwal N. & Kalhan M. (2020)[23]: In a study involving 180 women (90 pregnant, 90 non-pregnant), the pregnant group showed a 23.5% decrease in haemoglobin, 18.7% drop in haematocrit, and a 12.4% increase in WBC count compared to controls. These haematological shifts were attributed to pregnancy-induced haemodilution and immunological modulation. The authors advocated for trimester-wise CBC monitoring.

Goswami T. et al. (2019)[24]: A cross-sectional analysis of 250 first-trimester pregnant women showed that 72% had serum ferritin levels below 30 ng/mL, while TIBC was elevated in 63.5%, indicating early iron depletion. The study concluded that biochemical iron markers were more sensitive than haemoglobin alone in detecting early-stage anaemia and urged routine ferritin screening in antenatal care.

Deshpande and Gandhi (2016)[27] A comparative study of 200 women (100 pregnant vs. 100 non-pregnant) showed that pregnant women had a 25% lower mean ferritin level and a significant reduction in haemoglobin ($p < 0.05$). Furthermore, 40% of pregnant women had microcytic hypochromic anaemia, whereas this was seen in only 10% of non-pregnant women. The findings confirmed that iron deficiency was already established in the first trimester.

Sharma S et al. (2016)[28] conducted a cross-sectional study to assess nutritional markers in pregnant women. The study showed significant variations in serum iron and haemoglobin levels, linking nutritional deficiencies with adverse maternal outcomes. It underscores the importance of screening during pregnancy for early intervention.

Menon KC et al. (2016)[29] evaluated the effects of anaemia at different gestational stages on infant outcomes in a large cohort study. The findings revealed that anaemia in early and mid-gestation had stronger adverse effects on birth weight and neonatal health than in later stages. This highlights the need for trimester-specific anaemia management.

Bedi R et al. (2015)[30] explored maternal factors associated with anaemia in the third trimester and correlated it with fetal outcomes. Their results emphasized the role of maternal nutrition, parity, and socio-economic status in determining anaemia prevalence and birth complications.

Johnson-Wimbley TD and Graham DY (2011)[31] presented a review article focusing on the diagnosis and management of iron deficiency anaemia. It outlines modern tools for diagnosis, like serum ferritin and transferrin saturation, and stresses individualized therapy including oral or parenteral iron. 0

Campbell NA (2008)[34] in his textbook "Biology", explains the physiological changes in blood volume, red cell mass, and iron metabolism during pregnancy. It is a theoretical source that offers foundational knowledge for understanding haematological shifts during gestation.

Windsor JS and Rodway GW (2007)[35] described the physiological effects of altitude on haemoglobin levels. Though not directly related to pregnancy, their insights are valuable for understanding adaptive changes in haemoglobin concentration, which can inform care for pregnant women living in high-altitude regions.

Horton S and Ross J (2007)[36] discussed the economic burden of iron deficiency in their corrected review. Their work established a strong link between iron-deficiency anaemia and reduced productivity, cognitive development, and maternal health, making a compelling case for public health interventions.

Akingbola TS et al. (2006)[37] reported on haematological profiles of pregnant women in Ibadan, revealing similar findings to Akinsegun et al., with a slight increase in leukocyte counts and a consistent decline in red cell indices. The study supported routine haematological monitoring in antenatal care.

Rasmussen and Stoltzfus (2003)[39] Conducted among 220 women (110 pregnant and 110 non-pregnant), the study found that the mean haemoglobin level in pregnant women was 10.3 ± 0.9 g/dL, compared to 12.4 ± 1.1 g/dL in non-pregnant controls. Serum iron and TIBC values were significantly altered ($p < 0.01$) in pregnancy, indicating depleted iron stores and altered iron metabolism. The researchers emphasized early nutritional intervention.

Bernhard JH (2003)[40] published a review on maternal physiological changes during pregnancy, particularly from the anaesthesiology perspective. It emphasizes how blood parameters like haemoglobin and plasma volume are altered, impacting aesthetic considerations and oxygen delivery during surgery.

Hercberg et al. (2001)[41]A comparative evaluation of 300 women (150 pregnant vs. 150 non-pregnant) showed that the prevalence of anaemia was 60.4% in pregnant women, compared to 32.7% in non-pregnant women. Serum iron was <50 µg/dL in 74% of anaemic pregnant women, and MCV and MCH values were significantly lower ($p < 0.001$) in pregnancy. The study highlighted the increasing burden of nutritional anaemia in early pregnancy.

Bothwell (2000)[43] In this observational study of 180 antenatal women, anaemia was detected in 59.4%, with iron deficiency being responsible for 80.3% of cases. Mean serum iron was 41.2 ± 9.6 µg/dL, and TIBC was elevated (>400 µg/dL) in 66% of anaemic women. The findings underlined the diagnostic utility of both haematological and biochemical markers in antenatal anaemia screening.

Scholl and Reilly (2000)[44] A comparative clinical study conducted on 220 women (pregnant vs. non-pregnant) reported that pregnant women had significantly lower haemoglobin (mean: 10.1 ± 1.2 g/dL) and serum ferritin (mean: 10.8 ± 4.3 ng/mL) than their non-pregnant counterparts. Anaemia was seen in 62.8% of pregnant women compared to 34.5% in the control group, stressing the need for iron supplementation in early pregnancy.

Scholl and Hediger (1994)[47] This retrospective cohort study included 220 first- trimester antenatal women and showed that anaemia was present in 61.3%, with iron- deficiency anaemia accounting for 79.2% of cases. MCV was below normal in 60.7%, and serum ferritin was deficient in 66.8% of participants. The study stressed incorporating iron profiling into routine antenatal checkups.

Cotes E (1993)[48]authored a book on lung function over the human lifespan, including pregnancy-related respiratory and haematological adaptations. It outlines how increased oxygen demands during pregnancy lead to compensatory changes in haemoglobin and red cell production.

III. MATERIAL AND METHODS

Study Design: cross-sectional study
Study Area: Pathology Lab, in collaboration with the, Obstetrics and Gynaecology,
cks Hospital
Study Duration: 3 months.
Sample Size: The sample size was calculated based on standard deviation and mean
differences in lymphocyte counts between groups:

$n = (Zx/2 + Z1-\beta)2 * (\sigma 12 + \sigma 22)$
$(\mu_2-\mu_1)^2$
$n = (1.96 + 0.84)^2 * (14.52^2 + 12.52^2)$
$(43.84 - 34.68)^2$ n = 36 Samples / groups Total Sample will be 72.

Where

- $Z_{x/2}$ = Inverse probability of standard normal distribution at 95% confidence

interval

- $Z_{1-\beta}$ = Inverse probability at 80% power of the test.
- $\sigma_1^2 + \sigma_2^2$ = Standard deviation of Lymphocytes of pregnant & non-pregnant

women.

Inclusion Criteria

- Women aged 21 to 37 years.
- For the study group: Pregnant women in the first trimester (up to 12 weeks

gestation).

- For the control group: Healthy non-pregnant women of matching age.
- Willingness to participate and provide written informed consent.

Exclusion Criteria

- History of chronic illnesses (e.g., diabetes, hypertension, thyroid disorders).
- Abnormal uterine bleeding or gynaecological disorders.
- History of recent blood transfusion or iron/vitamin supplementation (within the

last 3 months).

- Current infection, inflammation, or acute illness.
- Sample Collection and Processing

Blood Collection

- After obtaining consent, 5 mL of venous blood was drawn from each participant in the morning under aseptic conditions using a sterile disposable syringe.

The blood was divided as follows:

- 2 ml into an EDTA vial for Complete Blood Count (CBC) and 3.8% sodium citrate for Erythrocyte Sedimentation Rate (ESR).
- 3 ml into a plain red-top vial for serum separation used in iron profile analysis.

Sample Handling

- Samples were immediately transported to the central diagnostic laboratory within 30 minutes for serum analysis.
- Blood in the plain vial was left undisturbed for 15–20 minutes at room temperature to allow clotting.
- Serum was “separated by centrifugation at 3000 rpm” for 10 minutes and analysed the same day or stored at -20°C for batch testing.

Laboratory Investigations

A. Complete Blood Count

- Performed using an automated haematology analyser
- Haemoglobin (Hb)

Packed Cell Volume (PCV)

- RBC Indices: MCV, MCH, MCHC, RDW”
- Total and Differential WBC Count: Neutrophils, Lymphocytes, Monocytes, Eosinophils, Platelet Count.

Table.1 Normal range of CBC Parameter

CBC PARAMETER	NORMAL RANGE	UNIT
Hb	12-15	g/dL
TLC	4.5-12.5	cells/µL
Neutrophils,	45-75	%
Lymphocytes,	25-45	%
Monocytes,	2-8	%
Eosinophil	1-6	%
Basophil	0-1	%
TRBC	4.50-5.50	million/µL
PCV	32-55	%
MCV	78-98	fL
MCH	26-30	pg
MCHC	30-34	g/dL
RDW	10-15	%

Platelet	150-450	cells/µL
PDW	10-17.9	%
MVP	7.5-12	fL

Figure 1: Mindray BC-6200 CBC Analyzer

Principle: The Mindray BC-6200 works based on three key principles:

Electrical Impedance (Coulter Principle):

- Used for counting red blood cells (RBCs), platelets (PLTs), and determining cell volume (MCV, MPV).
- As cells suspended in an electrolyte pass through a small aperture, they disrupt an electrical current. Each disruption (pulse) is counted and its size measured to determine the type and size of the cell.
- Flow Cytometry with Laser Scattering:
- Utilized for 5-part WBC differential analysis.
- Cells are stained with a proprietary fluorescent dye and passed through a laser beam.
- Forward scatter measures cell size, and side scatter detects granularity or internal complexity.
- Fluorescence intensity reflects nucleic acid content.
- These parameters allow differentiation of neutrophils, lymphocytes, monocytes, eosinophils, and basophils.

Cyanide-free Colorimetric Method for Haemoglobin (HGB):

- Uses a non-cyanide reagent to lyse red cells and form a chromogen with haemoglobin.
- The concentration is measured photometrically at a specific wavelength.

Technology

SF Cube Technology: A proprietary analysis platform that combines:

- Three-dimensional cell analysis: Size (FSC), granularity (SSC), and nucleic acid content (fluorescence).
- Enhanced accuracy in identifying abnormal cells and flags.
- CBC + 5-Part Diff: Measures over 29 parameters including:
- RBC, WBC, Platelets, Haemoglobin, Haematocrit, MCV, MCH, MCHC, RDW, PDW, PCT, and differential counts.
- Throughput: Up to 110 samples per hour.
- Sample Types: Both capillary and venous blood in EDTA anticoagulant tubes.
- Flagging System: Provides alerts for abnormal cell populations like blasts, immature granulocytes, or atypical lymphocytes.
- Closed or Open Tube Sampling: Adaptable to user safety and sample load.

B. Erythrocyte Sedimentation Rate count (ESR)

- Performed using an automated haematology analyser
- ESR

Figure2: Roller ESR Analyzer

Principle of Roller 20LC (ESR Analyzer):

The Roller 20LC operates on the modified Westergren method using infrared photometry.

Working Principle:

1. Blood Sample Mixing: EDTA-anticoagulated blood is mixed with sodium citrate in a fixed ratio.
2. Sample Placement: The sample is loaded into a dedicated cuvette or capillary tube.

3. Optical Sensing: The analyser uses an infrared sensor to continuously monitor the descent of red blood cells (RBCs) through the plasma column.
4. Time-Based Measurement: The instrument records the rate of fall (in mm/hour) over a specific period, usually 20 minutes (and extrapolates to 60 minutes).
5. Data Output: Results are displayed and can be printed.

C. Iron Profile and Micronutrient Evaluation

- Performed on a fully automated biochemical analyser ● Serum Iron: Measured using colorimetric assay.
- TIBC: Evaluated by iron saturation after excess conjugation.
- Transferrin Saturation: Calculated using the formula:
- Transferrin Saturation (%) = (Serum Iron TIBC) × 100 \ text {Transferrin

Saturation (\%)} = \ left (\ frac {\ text {Serum Iron} {\ text {TIBC}} \right) \times 100

- Serum Ferritin: Assessed using chemiluminescent immunoassay (CLIA) technique.
- Serum Vitamin B12 and Folic Acid: Measured by electrochemiluminescence immunoassay (ECLIA) method.

Table. 2 Normal range of Iron Profile

IRON PROFILE PARAMETER	NORMAL RANGE	UNIT
SERUM IRON	37-170	µg/dL
FERRITIN	6.24-137	ng/mL
UIBC	120-470	µg/Dl
TIBC	265-497	µg/dL

Figure 3. VITROS -5600

Principle: Spectro Photo Reflectance

This is primarily used for traditional biochemistry assays. It measures light reflected off the sample to determine the concentration of analytes.

Micro-Well Chemiluminescence (Chemi Lumi Sense) Technology

Utilized for immunoassay-based testing, including hormones and micronutrients (like serum ferritin, vitamin B12, folic acid).

Detects light emitted during a chemical reaction to quantify specific biomolecules.

Photometer Technology for Micro-Tip Assays

Used for other specialized biochemistry parameters.

Measures absorbance to quantify target analytes.

Intellicheck Technology

Ensures performance accuracy and system diagnostics.

Monitors sample/reagent integrity and system functions

Technology:

- Spectro photo reflectance
- Micro well Chemi Lumi sense Photometer technology
- Spectro photometer is used for biochemistry parameters and for micro well

Chemi Lumi sense technology used for Biochemistry parameters and photometer technology is used for microtip parameters and additional technology is intellichek which is used for performance of module.

Quality Control

- All assays were subjected to internal quality control using manufacturer-provided calibrators and control samples.
- Daily calibration and maintenance of instruments ensured reliability and reproducibility of results.

Data Management and Confidentiality

- Results were manually checked and digitally recorded using Microsoft Excel and

SPSS software.

- Participants were assigned coded identifiers to maintain anonymity.
- The database was secured with password protection and accessible only to the study team.

IV. RESULT

In our study, a total of 72 samples were included. Among these, 34 participants (47.22%) belonged to the 25–29 years age group, followed by 13 participants (18.06%) each in the 21–24 years and 30–34 years age groups, as presented in Table 3 and Graph 1.

The participants were divided into two groups: 36 were pregnant women and 36 were non-pregnant women. Among the non-pregnant women, the highest number of participants (16 out of 36, 45%) were in the 25–29 years age group, followed by 10 participants (27%) in the 35–49 years age group. On the other hand, in the pregnant group, the highest prevalence was also observed in the 25–29 years age group. As Presented in Table. 4 & Graph 2

Table 3: Age distribution

Age	Frequency	Percentage
21-24	13	18.06%
25-29	34	47.22%
30-34	13	18.06%
35-49	12	16.67%
Total	72	100%

Graph 1: Age distribution

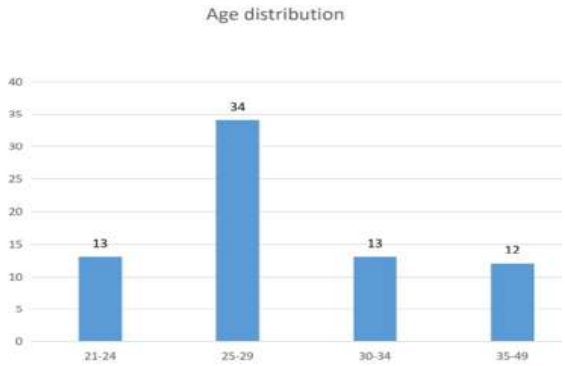
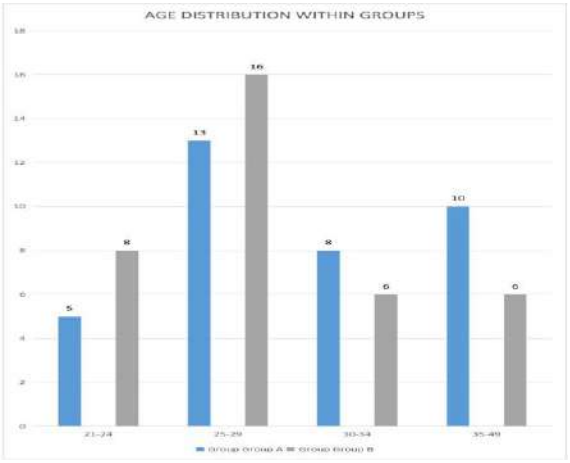


Table 4: Age distribution within groups

Age Distribution within groups			
Age	Group		Total
	Group A (NP)	Group B (P)	
21-24	5 (13%)	8(23%)	13
25-29	13 (37%)	16(45%)	29
30-34	8(23%)	6(16%)	14
35-49	10(27%)	6(16%)	16
TOTAL	36	36	72
P- VALUE	0.514		

Graph. 2 Age distribution within groups



The below table is a comparison of haematological parameters between pregnant and non-pregnant women including means, standard deviations, and p-values for each parameter.

Statistically significant differences were observed in basophils ($p=0.029$), RDW ($p<0.05$), PDW ($p=0.014$), and MPV ($p<0.05$).

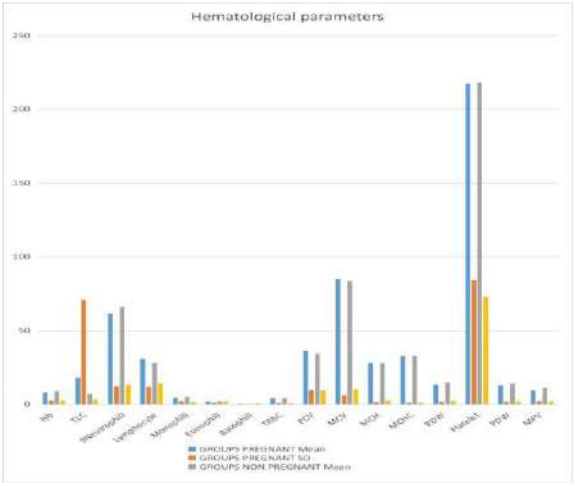
However, no statistically significant differences were observed in most haematological parameters, including Hb, TLC, Neutrophils, lymphocytes, monocytes, eosinophils, TRBC, PCV, MCV, MCH, MCHC, and platelet count (p-value >0.05)

Table 5: Descriptive statistics of haematological parameters among pregnant and non-pregnant women

PARAMETERS	GROUPS				P VALUE
	PREGNANT		NON-PREGNANT		
	Mean	SD	Mean	SD	
Hb	8.146	2.675	8.716	2.505	0.353
TLC	18.130	70.488	6.94	3.024	0.347
9Neutrophill	61.371	12.044	66.016	13.273	0.124

Lymphocyte	30.885	11.519	28.128	14.021	0.365
Monophils	4.4866	2.148	5.300	1.695	0.078
Eosinophils	1.8	0.950	1.9	1.896	0.778
Basophils	0.452	0.311	0.230	0.508	0.029
TRBC	3.868	0.804	4.201	0.723	0.072
PCV	36.416	9.573	34.361	9.382	0.360
MCV	84.85	6.042	83.508	10.060	0.495
MCH	28.138	1.450	27.658	2.701	0.351
MCHC	32.6	0.964	32.627	0.981	0.903
RDW	13.311	1.626	14.747	2.203	0.002
Platelet	217.25	84.258	218.166	72.672	0.960
PDW	12.908	1.697	13.972	1.888	0.014
MPV	9.333	2.062	11.105	2.004	0.0004

Graph 3: Graphical representation of haematological parameters among pregnant and non-pregnant women

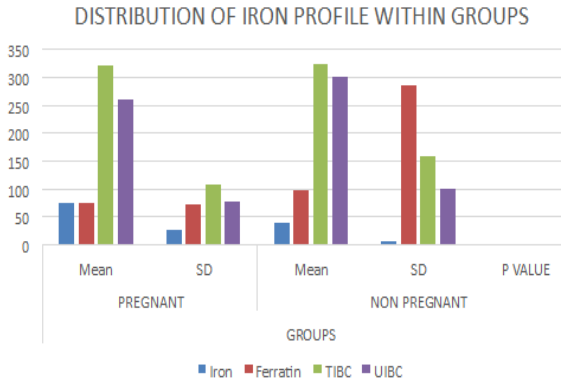


A highly significant difference was found in the levels of serum iron with a p-value of <0.05. The iron levels were observed to be higher in pregnant women (74.31 ± 27.62 µg/dL) compared to non-pregnant women. However, ferritin, TIBC, and UIBC level did not differ significantly between the two groups, although UIBC approached the threshold of significance. As shown on Table 6 & Graph 4.

Table 6: Descriptive statistics of iron profile among pregnant and non-pregnant women

PARAMETERS	GROUPS				P VALUE
	PREGNANT		NON-PREGNANT		
	Mean	SD	Mean	SD	
Iron	74.305	27.619	38.444	7.101	5E- 09
Ferratin	74.963	73.511	98.480	286.011	0.635
TIBC	322.228	106.828	323.136	159.533	0.977
UIBC	261.694	76.381	301.833	99.475	0.059

Graph 4: Graphical representation of iron profile among pregnant and non- pregnant women

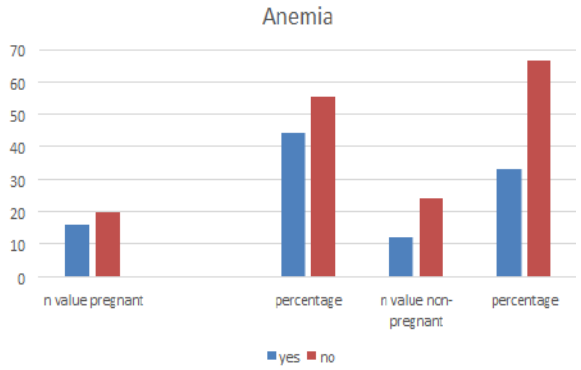


A contingency table showing the prevalence of anaemia among pregnant and non-pregnant women was created. The table categorizes women based on anaemia status, showing the frequency and percentage of anaemic and non-anaemic individuals within each group. Among the pregnant individuals, 44.44% of women were anaemic, when compared to non-pregnant women where 33.33% of them were found to be anaemic. Therefore, a high prevalence of anaemia was observed among pregnant individuals.

TABLE 7: Contingency table showing prevalence of anaemia among pregnant and non-pregnant women

ANAEMIA	Pregnant		Non-pregnant	
	N value	Percentage	N value	Percentage
Yes	16	44.44%	12	33.33%

No	20	55.55%	24	66.66%
Total	36	100%	36	100%



Below is the table showing Pearson correlation analysis used to assess the relationship between various haematological parameters and a continuous variable.

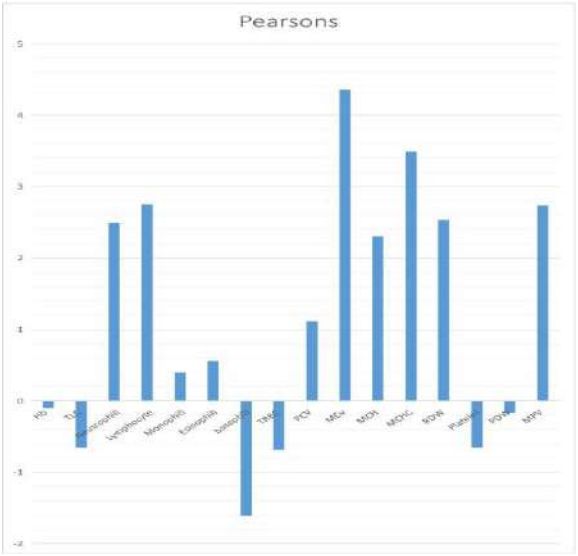
Pearson's correlation coefficients, degree of freedom, and p-values are indicated, revealing significant linear relationships.

A statistically significant positive correlations ($p<0.05$) was found in neutrophils ($p=0.018$), lymphocytes ($p=0.009$), MCV ($p<0.001$), MCH ($p=0.028$), MCHC ($p=0.001$), RDW ($p=0.016$), and MPV ($p=0.01$). the strongest correlation was observed for MCV ($r \approx 4.36$, $p<0.001$), indicating a vigorous positive relationship

Table 8: Correlation matrix for hematological parameters

Category	Pearsons	df	P value
Hb	-0.105336943	34	0.916727456
TLC	-0.65585259	34	0.516332922
Neutrophil	2.492548947	34	0.017716875
Lymphocyte	2.753712793	34	0.009390702
Monophil	0.394972357	34	0.695330365
Eosinophil	0.557197041	34	0.581042729
Basophil	-1.613991289	34	0.115773405
TRBC	-0.690314097	34	0.494823526
PCV	1.117955108	34	0.271423452
MCV	4.361634338	34	0.000113565
MCH	2.302234416	34	0.027572516
MCHC	3.494081223	34	0.001342583
RDW	2.535487616	34	0.015995195
Platelet	-0.654802724	34	0.517000473
PDW	-0.165925093	34	0.869198647
MPV	2.736844996	34	0.009792657

Graph 6: Graphical representation of correlation matrix for haematological parameters



Pearson correlation analysis was conducted to assess the relationship between iron profile parameters and a continuous variable.

The result interprets a statistically significant positive correlation between the ferratin levels and the variable of interest ($p=0.035$). Other parameters like iron and UIBC did not show significant correlations ($p>0.05$), although TIBC showed trends toward significance but did not meet the conventional threshold ($p=0.052$).

Table 9. correlation matrix for iron parameters

Category	Pearsons	df	P value
Iron	0.37888851	34	0.707127
Ferratin	2.197052297	34	0.034931
TIBC	2.015009352	34	0.051866
UIBC	1.538803355	34	0.133108

Graph 7: Graphical representation of correlation matrix for iron parameters

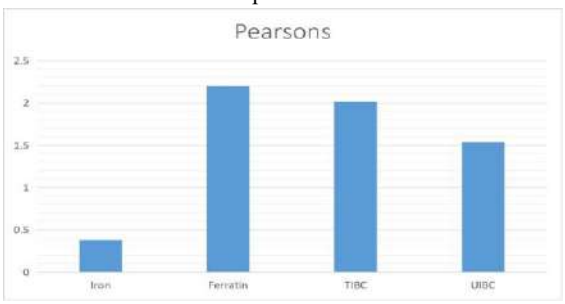
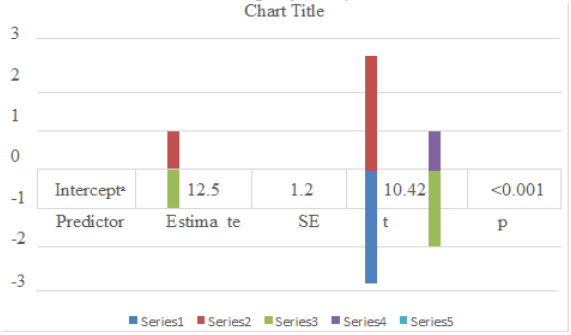


Table 10. Chi-square test for association between anaemia and pregnancy.

NON-PREGNANT				
	GROUP A			
Predictor	Estimate	SE	t	p
Intercept[a]	12.5	1.2	10.42	<0.001
age	-0.04	0.015	-2.67	0.009
SES: UPPER CLASS – MIDDLE CLASS	1.8	0.75	2.4	0.017
DIET: IMPROPER – PROPER	-1.1	0.55	-2	0.047
Patient type: A – P	0.55	0.33	1.67	0.1
$R^2 = 0.36$				
SIZE (N) =36				

Graph 8: Chi-square test for association between anaemia and pregnancy



V. DISCUSSION

In addition to assessing the haematological and iron profile variations between pregnant and non-pregnant women, this study examined the impact of patient type, age, diet, and socioeconomic level (SES) on overall health outcomes. A statistically significant variance was seen in several parameters, including basophils ($p = 0.029$), RDW ($p < 0.05$), PDW ($p = 0.014$), and MPV ($p < 0.05$), despite the total p-value (0.514) showing no significant difference across all variables. These indices are commonly regarded as indicators of oxidative stress and systemic inflammation, both of which are commonly increased during pregnancy.

It is noteworthy that pregnant women had considerably higher blood iron levels than non-pregnant women (74.31 ± 27.62 µg/dL, $p < 0.05$...). Iron supplementation during prenatal care, which is a standard procedure in many public health initiatives, may be the cause of this (WHO, 2016)[57]. Other iron indicators, including ferritin, TIBC, and UIBC, did not differ significantly in spite of this; nevertheless, UIBC was close to significance, indicating that iron metabolism was changed without matching changes in storage markers. iron homeostasis during pregnancy is dynamic and frequently impacted by supplements rather than baseline iron reserves alone. These findings are in accordance with their findings.

Compared to 33.33% of non-pregnant women, the prevalence of anaemia among pregnant women was greater at 44.44%. This supports the data that pregnant women are more likely to develop anaemia because of their higher iron requirements and possible dietary deficits. The correlation study revealed that neutrophils, lymphocytes, MCV, MCH, MCHC, RDW, and MPV all had statistically significant positive associations with one another. Of these, MCV had the greatest connection ($r = 4.36$, $p < 0.001$). These results validate the use of red blood cell indices as sensitive markers of nutritional and haematological health.

The regression model has a modest explanatory power, explaining 35% of the variation in the outcome variables ($R2 = 0.35$). Age was one of the factors that was linked to significantly worse results ($p = 0.009$), which is in line with other research showing that aging has a detrimental impact on nutritional and haematological parameters because of chronic

inflammation and decreased absorption. The results were considerably better for those in higher socioeconomic groups ($p = 0.017$), most likely because they had greater access to healthcare, education, and nutrition—all of which are linked to better health outcomes.

Group A vs. P patient type, however, did not exhibit a significant correlation ($p = 0.1$), indicating that sociodemographic and personal lifestyle characteristics could have a greater influence than group categorization alone. In public health planning, this is consistent with research that highlights the increasing significance of individual risk factors over group-based classification.

VI. SUMMARY AND CONCLUSION

The purpose of this study was to compare and assess numerous haematological and iron profile parameters in pregnant and non-pregnant women, as well as to investigate variables influencing non-pregnant health outcomes. Most standard haematological indices, including Hb, TLC, neutrophils, lymphocytes, monocytes, eosinophils, TRBC, PCV, MCV, MCH, MCHC, and platelet count, did not differ significantly between the two groups ($p > 0.05$). However, statistically significant changes were seen in basophils, RDW, PDW, and MPV, suggesting modest Pregnancy related hematologic alterations. Pregnant women have considerably greater serum iron levels (74.31 ± 27.62 μg/dL, $p < 0.05$), while having a higher prevalence of anemia (44.44%) than non-pregnant women (33.33%). TIBC, and UIBC were not substantially different, while UIBC did approach statistical significance. Several hematological markers, including MCV, MCH, MCHC, RDW, neutrophils, lymphocytes, and MPV, showed significant positive relationships, with MCV having the highest correlation ($r = 4.36$, $p < 0.001$). Ferritin had a statistically significant positive connection ($p = 0.035$), whereas iron and UIBC did not.

In addition to these findings, a multivariate linear regression study of 36 non-pregnant women found that age, dietary habits, and socioeconomic level (SES) had a substantial influence on health outcomes. The regression model explained 35% of the variance in outcomes ($R^2 = 0.35$). Women from higher socioeconomic groups had better result ratings ($p = 0.017$), and being older was associated with worse health outcomes ($p = 0.009$). Furthermore, individuals who did not maintain a regular diet had much poorer. Results ($p = 0.047$). However, there was no significant difference in outcome between pregnant and non-pregnant patients ($p = 0.1$). These findings imply that modifiable lifestyle variables including diet and socioeconomic level, as well as age, have a greater influence on non-pregnant women's health outcomes than pregnancy status alone. Overall, the study emphasizes the need of targeted dietary treatments and socioeconomic assistance for improving women's health outcomes, particularly in resource-limited situations.

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