# Serum Ferritin Levels and Haemogram Profiles in Primigravida Women Attending Antenatal Clinics at Central Hospital, Benin City

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***Abstract-*** ***Iron deficiency is the most common nutritional disorder worldwide, with iron deficiency anaemia (IDA) during pregnancy posing significant health risks. The National Academy of Sciences defines IDA in pregnancy as a ferritin level <12 µg/L, while the World Health Organization defines anaemia as haemoglobin (Hb) <11 g/dL. Serum ferritin levels typically increase in the first trimester but decrease significantly in the second and third trimesters, whereas haemogram parameters remain relatively stable due to increased plasma volume. This cross-sectional study determined the prevalence of IDA among primigravida women attending antenatal clinics at Central Hospital, Benin City. Ninety primigravida women aged 20-45 years were recruited, and their haemograms and serum ferritin levels were assessed using an autoanalyzer and ELISA, respectively. The majority (55.6%) were aged 25-29 years, while the 35-39 age group had the lowest representation. Serum ferritin levels were significantly lower (P=0.001), whereas RBC, Hb, haematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) showed no significant differences (P > 0.05). These findings suggest that, despite significant reductions in ferritin, RBC indices remain unaffected, likely due to physiological adaptations during pregnancy.***

***Indexed Terms-*** ***Iron deficiency anaemia, Primigravida, Serum ferritin, Haemoglobin, Pregnancy***

## I. INTRODUCTION

Iron deficiency is the most prevalent nutritional deficiency disorder worldwide [1]. Iron deficiency anaemia (IDA) during pregnancy poses significant health risks to both the mother and fetus. The National Academy of Sciences defines IDA in pregnancy as a ferritin level below 12 µg/L, while the World Health Organization (WHO) defines anaemia in pregnancy as a haemoglobin level below 11 g/dL [2]. Due to increased iron requirements during pregnancy, iron deficiency can lead to maternal anaemia and reduced neonatal iron stores, increasing the risk of adverse pregnancy outcomes [3].

Iron deficiency progresses in stages, from iron depletion (low iron stores with normal haemoglobin) to iron-deficiency anaemia, where iron supply is insufficient to maintain haemoglobin levels [4]. Pregnant women are particularly vulnerable due to increased iron demand to support erythrocyte mass expansion, plasma volume expansion, and fetal-placental growth. WHO estimates that 30–40% of pregnant women are iron deficient, with nearly half experiencing anaemia [5].

During pregnancy, haemoglobin concentration, haematocrit, and red blood cell (RBC) count decline due to plasma volume expansion exceeding red cell mass expansion, reducing blood viscosity and improving maternal-fetal nutrient exchange [1]. However, total circulating haemoglobin rises in direct proportion to red cell mass, which depends on the individual's iron status. Pregnant women are recommended to maintain haemoglobin levels between 12–16 g/dL, with values below 12 g/dL indicating iron deficiency and below 10.5 g/dL indicating anaemia [6].

Ferritin is the primary iron storage protein, primarily found in reticuloendothelial cells and hepatocytes, with small amounts stored as haemosiderin [7]. Iron is absorbed in the small intestine, transported by transferrin, and regulated by hepcidin; a liver-derived protein that controls iron homeostasis based on the body's needs. In pregnancy, increased iron demand for RBC mass expansion, fetal growth, and placental development exceeds dietary iron intake, necessitating iron supplementation [7, 8].

A small fraction of body ferritin circulates in serum, serving as a diagnostic marker for iron deficiency and microcytic hypochromic anaemia [9]. The high prevalence of iron-deficiency anaemia in pregnancy highlights the insufficiency of physiological adaptations to meet increasing iron requirements, reinforcing the importance of routine iron supplementation [10].

During the first trimester, serum ferritin levels increase significantly compared to non-pregnant women, but decline sharply in the second and third trimesters [11]. However, haemogram parameters exhibit minimal changes, primarily due to plasma volume expansion. The frequency of depleted iron stores increases as gestation progresses [11]. This study aims to determine the prevalence of iron deficiency anaemia and haemogram changes among primigravida women attending antenatal clinics at Central Hospital, Benin City

## II. MATERIALS AND METHOD

### Study Area

This study was conducted in the Department of Haematology at Central Hospital, Benin City, Edo State, Nigeria. Benin City is the capital of Edo State, located approximately 40 kilometers (25 miles) north of the Benin River and 320 kilometers (200 miles) east of Lagos by road.

### Study Population

A total of 90 primigravida women aged 20–45 years were recruited for the study. Inclusion criteria comprised first-time pregnant women who provided informed consent. Exclusion criteria included: women with unwanted pregnancies, twin pregnancies, heavy alcohol intake, women with a history of anaemia and women who had received blood transfusions during pregnancy.

### Sample Collection

For each participant, a tourniquet was applied to the upper arm, and the antecubital fossa was disinfected using cotton wool soaked in methylated spirit. A total of 10 mL of blood was collected using a 10mL syringe, with 5mL dispensed into an EDTA-anticoagulated tube for haemogram analysis while the other 5mL was dispensed into a plain container for serum ferritin measurement.

### Ethical Considerations

Ethical approval was obtained from the Ministry of Health, Benin City. Participants provided written informed consent and were assured of confidentiality. They were also informed of their right to withdraw from the study at any time without consequences.

### Laboratory Methods

#### Haemogram Analysis

Haemogram analysis was performed using a Sysmex Autoanalyzer following the flow cytometry technique (Chhabra, 2018). The EDTA blood sample was inverted 10 times before being placed under the autoanalyzer's suction probe. The sample was agitated to evenly distribute cells and diluted before being partitioned into channels for: Red Blood Cell (RBC) and Platelet Counting, White Blood Cell (WBC) Counting, Haemoglobin (Hb) Measurement and red cell indices including Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC) [12, 13].

#### Serum Ferritin Measurement

Serum ferritin levels were determined using an Enzyme-Linked Immunosorbent Assay (ELISA), following the manufacturer's protocol: a volume of 25 µL of ferritin standards, controls, and serum samples were added to designated wells, then 100 µL of biotin reagent was added to each well. The plate was shaken for 30 seconds and incubated for 30 minutes at room temperature. The liquid was removed, and each well was washed three times with 300 µL of 1× wash buffer. The plate was blotted using absorbent paper. A volume of 100 µL of enzyme reagent was added to each well and the plate was incubated again for 30 minutes at room temperature. Wells were washed three more times with 1× wash buffer and blotted, then 00 µL of TMB substrate was added to each well and incubated for 15 minutes. The reaction was stopped by addition of 50 µL of stop solution to each well. Optical density (OD) of the homogenized solutions were measured at 450 nm using an ELISA reader within 15 minutes of stopping the reaction.

## III. RESULTS

A total of 90 primigravida women, aged 25–39 years, were recruited from the antenatal clinic at Central Hospital, Benin City, Edo State, Nigeria. Participants were equally distributed across the three trimesters, with 30 women in each trimester.

Demographic Characteristics

Table 1 presents the demographic distribution of participants. The majority (55.6%) belonged to the 25–29 years age group, while the 35–39 years age group had the lowest proportion. Regarding place of residence, 52.2% of participants were from urban areas, while 47.8% resided in rural areas. Most participants (95.6%) were non-smokers, while 4.4% reported a history of smoking.

Comparison of Serum Ferritin Levels with RBC, Haemoglobin, Haematocrit, and Red Cell Indices

Table 2 summarizes the comparison of serum ferritin levels with red blood cell (RBC) parameters. The RBC count, haemoglobin (HGB), haematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were not significantly elevated ($p > 0.05$); while serum ferritin was significantly lower ($p = 0.001$).

Effect of Smoking on Haematological Parameters

As shown in Table 3, smoking had no significant effect on RBC, HGB, HCT, MCV, MCH, MCHC, and serum ferritin levels ($p > 0.05$ for all parameters).

Effect of Location on Haematological Parameters

Table 4 indicates that place of residence (urban vs. rural) had no significant effect on RBC, HGB, HCT, MCV, MCH, MCHC, and serum ferritin levels ($p > 0.05$).

Analysis of RBC Parameters and Serum Ferritin Levels

Table 5 presents additional comparisons of RBC parameters with RBC, HGB, HCT, MCV, MCH and MCHC having no significant effect on ferritin level ($p > 0.05$).

Table 1: Demographic variables of the primigravida women

| Variable | Frequency | Percentage% |
|---|---|---|
| Age group | | |
| 25-29yrs | 50 | 55.6 |
| 30-34yrs | 25 | 27.8 |
| 35-39yrs | 15 | 16.7 |
| Location | | |
| Rural | 43 | 47.8 |
| Urban | 47 | 52.2 |
| Trimester | | |
| First | 30 | 33.3 |
| Second | 30 | 33.3 |
| Third | 30 | 33.3 |
| Smoking status | | |
| Yes | 4 | 4.4 |
| No | 86 | 95.6 |

Table 2: Haemogram and Serum Ferritn level using the Trimester

| | First | Second | Third | p-value |
|---|---|---|---|---|
| RBC | 14.36±10.67 | 3.81±1.90 | 4.71±1.13 | 0.411 |
| HGB | 14.26±3.49 | 11.76±5.49 | 12.02±3.10 | 0.645 |
| HCT | 31.56±2.72 | 31.96±10.21 | 34.70±2.76 | 0.118 |
| MCV | 86.65±13.59 | 96.50±39.53 | 82.18±7.81 | 0.075 |
| MCH | 40.79±9.89 | 31.40±10.41 | 28.58±3.51 | 0.304 |
| MCHC | 33.89±1.04 | 33.52±1.72 | 34.09±1.64 | 0.322 |
| Serum Ferintin | 166.66±117.60 | 138.00±96.39 | 240.00±107.19 | 0.001 |

Key: RBC – Red Blood Cell, HGB - Haemoglobin, HCT - Haematocrit, MCV – Mean Cell Volume, MCH – Mean Corpuscular Haemoglobin, MCHC - Mean Corpuscular Haemoglobin Concentration

Table 3: Haemogram and Serum Ferritn level based on Smoking habit

| | Smoking | Mean± SD | P-va |
|---|---|---|---|

| | | | lue |
|---|---|---|---|
| RBC | Yes | 4.07±0.79 | 0.830 |
| | No | 7.79±3.72 | |
| HGB | Yes | 37.17±25.29 | <0.0001 |
| | No | 11.540.40 | |
| HCT | Yes | 32.25±0.96 | 0.875 |
| | No | 32.77±6.53 | |
| MCV | Yes | 85.18±10.33 | 0.791 |
| | No | 88.59±25.51 | |
| MCH | Yes | 102.27±73.93 | <0.0001 |
| | No | 30.39±8.15 | |
| MCHC | Yes | 33.08±1.14 | 0.301 |
| | No | 33.87±1.51 | |
| Serum ferintin | Yes | 100.00±54.46 | 0.147 |
| | No | 185.35±114.09 | |

Key: RBC – Red Blood Cell, HGB - Haemoglobin, HCT - Haematocrit, MCV – Mean Cell Volume, MCH – Mean Corpuscular Haemoglobin, MCHC - Mean Corpuscular Haemoglobin Concentration

Table 4: Haemogram and Serum Ferritin level according to residential setting

| | 20-29yrs | 30-30yrs | 40-49yrs | p-value |
|---|---|---|---|---|
| RBC | 4.17±1.46 | 16.74±12.80 | 3.94±1.83 | 0.286 |
| HGB | 13.93±2.08 | 10.46±2.65 | 12.22±5.17 | 0.455 |
| HCT | 33.00±7.67 | 33.28±4.39 | 31.00±4.05 | 0.508 |
| MCV | 91.07±31.51 | 82.89±8.89 | 88.96±16.90 | 0.413 |
| MCH | 36.29±5.99 | 29.72±9.39 | 31.06±1.98 | 0.670 |
| MCHC | 33.82±1.55 | 33.97±1.69 | 33.69±0.95 | 0.848 |
| Serum Ferritin | 171.60±103.83 | 196.40±30.45 | 190.00±75.51 | 0.650 |

| | Setting | Mean± SD | p-VALUE |
|---|---|---|---|
| RBC | Rural | 4.05±1.79 | 0.339 |
| | Urban | 10.90±6.81 | |
| HGB | Rural | 11.16±4.54 | 0.223 |
| | Urban | 14.08±2.19 | |
| HCT | Rural | 31.21±6.54 | 0.028 |
| | Urban | 34.15±5.98 | |
| MCV | Rural | 91.88±34.94 | 0.215 |
| | Urban | 85.31±8.65 | |
| MCH | Rural | 31.65±11.04 | 0.585 |
| | Urban | 35.37±6.29 | |
| MCHC | Rural | 33.75±1.87 | 0.633 |
| | Urban | 33.91±1.09 | |
| Serum Ferintin | Rural | 154.65±118.45 | 0.032 |
| | Urban | 206.17±106.41 | |

Key: RBC – Red Blood Cell, HGB - Haemoglobin, HCT - Haematocrit, MCV – Mean Cell Volume, MCH – Mean Corpuscular Haemoglobin, MCHC - Mean Corpuscular Haemoglobin Concentration

Table 5: Haemogram and Serum Ferritin level according to Age

## IV. DISCUSSION

This study assessed the prevalence of iron deficiency anaemia (IDA) among primigravida women attending antenatal clinics at Central Hospital, Benin City. The findings revealed that serum ferritin levels were significantly lower ($p = 0.001$), while haemogram parameters (RBC, Hb, HCT, MCV, MCH, and MCHC) showed no significant differences ($p > 0.05$) across the trimesters. These results align with previous studies indicating that serum ferritin levels decline as pregnancy progresses, primarily due to increased iron demand for fetal development and maternal blood volume expansion [4].

The lack of significant differences in haemogram parameters despite reduced ferritin levels suggests physiological adaptations during pregnancy, such as

plasma volume expansion compensating for declining iron stores [1]. This highlights the importance of ferritin as an early marker of iron deficiency, as haemogram parameters may not immediately reflect declining iron status [9].

Additionally, smoking and place of residence (urban vs. rural) did not significantly affect serum ferritin levels or haemogram parameters ($P > 0.05$). This contrasts with studies that have shown smoking may reduce iron absorption and that rural populations often have lower iron intake [7]. The lack of association in this study could be attributed to the small proportion of smokers (4.4%) and relatively similar socioeconomic conditions.

Overall, these findings emphasize the need for routine ferritin screening in pregnancy, as haemoglobin alone may not be sufficient to detect early iron depletion. Further research with a larger population and dietary assessments would help clarify the influence of external factors on iron status in pregnancy.

This study assessed the prevalence of iron deficiency anaemia (IDA) and haemogram changes among primigravida women attending antenatal clinics at Central Hospital, Benin City. The findings indicate that serum ferritin levels were significantly lower ($P = 0.001$), while haemogram parameters (RBC, Hb, HCT, MCV, MCH, and MCHC) remained unchanged ($P > 0.05$). This suggests that while iron stores are depleted during pregnancy, haemogram parameters may not immediately reflect early iron deficiency due to physiological adaptations such as plasma volume expansion.

Additionally, smoking and place of residence (urban vs. rural) had no significant effect on serum ferritin or haemogram parameters ($P > 0.05$). This finding contrasts with prior studies that associate smoking with reduced iron absorption and rural residency with lower dietary iron intake. The lack of association in this study could be attributed to small sample size and similar socioeconomic conditions among participants.

## CONCLUSION

Given that ferritin depletion can occur without immediate changes in haemoglobin levels, relying solely on haemogram parameters for diagnosing IDA in pregnancy may lead to underdiagnosis and delayed interventions. These findings emphasize the importance of routine ferritin screening to detect early iron depletion and prevent severe anaemia.

To improve maternal health outcomes and reduce the burden of iron deficiency anaemia in pregnancy, the following are recommended, based on our findings: Incorporating serum ferritin testing alongside haemogram parameters in antenatal care will enhance early detection of iron deficiency before it progresses to anaemia, pregnant women should receive adequate dietary counseling and iron supplements, particularly in the second and third trimesters when iron demand increases, government and healthcare organizations should implement community-based awareness programs to educate women on iron-rich diets and prenatal care and further research with larger, more diverse populations should be conducted to confirm these findings and explore dietary and socioeconomic influences on maternal iron status

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