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Emeka-Obi Obioma Raluchukwu *

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Research Article

Comprehensive Analysis of The Iron Profile in Hiv-1 And Hiv-2 Infected Pregnant Women Attending Antenatal Clinic Services at Federal Teaching Hospital Owerri

Emeka-Obi Obioma Raluchukwu [1]*, Ohajiemu Nkemakonam Rosita [2], Aloy-Amadi Oluchi C [2], Chinedu-Madu Jane Ugochi [3], Okpara Lydia Tobechukwu [4]

[1]Department of Haematology, College of Medicine, Federal University of Technology Owerri, Imo State.

[2]Department of Medical Laboratory Science, Faculty of Health Science, Imo State University Owerri, Imo State.

[3]Haematology department, Federal university otuoke, Bayelsa State.

[4]Whitetouch Diagnostic Centre, Lagos, Nigeria.

***Corresponding Author:** Emeka-Obi Obioma Raluchukwu, Department of Haematology, College of Medicine, Federal University of Technology Owerri, Imo State.

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Abstract:

Changes in iron metabolism are typical in people with HIV, and pregnancy may make these changes even more pronounced. These alterations can have an effect on the health of the mother, the immune system, and the fate of the pregnancy. This study performed a thorough examination of the iron profile in pregnant women infected with HIV-1 and HIV-2 who were receiving prenatal care at the Federal Teaching University Hospital, Owerri. There were 60 women in total, 30 of whom were pregnant and had HIV-1 or HIV-2 (the test group) and 30 of whom were not pregnant and were healthy (the control group). Standard laboratory procedures were used to assess serum iron, ferritin, transferrin, and total iron binding capacity (TIBC). We also looked at the iron profile parameters of the HIV-positive pregnant women in each of the three trimesters and how ferritin levels were related to other iron levels. We used t-tests and correlation statistics to look at the data, and $p < 0.05$ was judged statistically significant. Pregnant women with HIV had far higher levels of serum iron (146.7 ± 74.3 µg/dl vs 67.3 ± 27.5 µg/dl; $p = 2.36 \times 10^{-7}$), ferritin (327.1 ± 156.3 ng/ml vs 179.2 ± 63.7 ng/ml; $p = 0.00024$), and transferrin (271.3 ± 58.6 mg/dl vs 209.5 ± 104.7 mg/dl; $p = 0.00095$) than healthy women. On the other hand, TIBC was much lower in the group with HIV (273.4 ± 47.9 µg/dl versus 372.1 ± 225.9 µg/dl; $p = 0.045$). Serum iron levels rose considerably from the first to the third trimester of pregnancy ($p = 0.021$), although ferritin, transferrin, and TIBC exhibited non-significant rising trends. Correlation analysis showed a moderate positive relationship between ferritin and transferrin ($r = 0.461$, $p = 0.011$), but no significant links between ferritin and serum iron or TIBC.Pregnant women in Owerri who are infected with HIV-1/2 show big changes in how their bodies use iron. Their serum iron, ferritin, and transferrin levels are all higher, while their TIBC levels are lower. This could mean that iron is being redistributed or that iron is being stored in response to inflammation. The gradual increase in serum iron throughout the trimesters and the notable connection between ferritin and transferrin highlight the necessity for meticulous surveillance of iron status in this demographic to enhance maternal and foetal outcomes.

Keywords: iron profile; HIV-1; HIV-2; pregnant women

Introduction

The simultaneous occurrence of HIV infection and pregnancy constitutes a considerable public health concern, especially in areas with a substantial prevalence of HIV/AIDS. These two situations alone exert significant physiological and immunological stress on women, and when combined, they can markedly elevate the likelihood of unfavourable maternal and foetal outcomes [1]. One of the most serious problems that can happen during pregnancy or with HIV is that iron metabolism can go wrong. This can cause iron deficiency anaemia (IDA) or, in certain situations, too much iron to build up. Iron is necessary for foetal development, immunological function, and erythropoiesis. Therefore, keeping iron levels under check is very important for the health of both the mother and the kid.

Iron deficiency anaemia is still one of the most common nutritional illnesses in the world, and it affects both people with and without HIV. In people with HIV, iron metabolism becomes even more complicated because of long-term immunological activation, ongoing inflammation, and changes in cytokine signalling, all of which make it harder for the body to absorb, transport, store, and use iron [2]. Pregnancy makes this metabolic balance even more difficult since the foetus needs more iron for growth, the placenta needs more iron to grow, and the mother's blood volume has to be larger. Thus, pregnant women with HIV are a particularly vulnerable group with a high risk of iron dysregulation, which can show up as iron insufficiency, functional iron deficiency, or iron excess.

Sub-Saharan Africa has the highest rate of HIV/AIDS in the world. Pregnant women in this area have to deal with both HIV infection and not getting enough nutrients, such iron. Nigeria, in particular, has a lot of HIV incidences in West Africa. About 1.4% of adults aged 15 to 49 have the disease [3]. In this context, Owerri, the capital of Imo State, serves as a pertinent locale for examining the interplay between HIV infection, pregnancy, and iron metabolism, particularly due to the Federal University Teaching Hospital (FUTH)'s function as a principal referral centre for antenatal and HIV care.

Even if antiretroviral therapy and prenatal care have gotten better, pregnant women with HIV still have serious metabolic and haematological problems. Iron deficiency anaemia is still frequent during pregnancy, and it raises the chances of maternal illness, poor foetal growth, preterm birth, and low birth weight. In women with HIV, these risks may be exacerbated by viral-induced inflammation, opportunistic infections, and the impact of antiretroviral medications on iron homeostasis. HIV is known to affect iron homeostasis by overexpressing hepcidin, sequestering iron in macrophages, and changing the way iron transport proteins are made. All of these things can make it harder for the body to make red blood cells, even whether there is enough or too much iron in the body [4].

While the significance of iron status in HIV-infected pregnant women is widely recognised, there is a considerable lack of data from Nigeria, especially from southeastern areas like Owerri. The majority of existing research have concentrated on either HIV-infected non-pregnant adults or pregnant women without distinguishing between HIV status, thereby neglecting the distinct metabolic interactions that occur when both circumstances are present. Moreover, limited research has concurrently assessed other iron indices, including serum iron, ferritin, transferrin, and total iron-binding capacity (TIBC), which is essential for a thorough evaluation of iron homeostasis [5].

Consequently, the primary issue examined in this study is the absence of comprehensive and locally pertinent data regarding the iron profile of HIV-1 and HIV-2 infected pregnant women receiving prenatal clinic services at the Federal University Teaching Hospital, Owerri. This study seeks to address this deficiency by methodically assessing critical biochemical indicators of iron metabolism within this demographic. The study aims to quantify blood iron, ferritin, transferrin, and total iron-binding capacity (TIBC), evaluate the prevalence of iron shortage and overload, and investigate the variations in iron status across the trimesters of pregnancy [6].

Furthermore, this study seeks to elucidate potential disparities in iron metabolism linked to viral subtype by analysing women infected with both HIV-1 and HIV-2. Comprehending these trends is crucial for formulating evidence-based methods to enhance iron supplementation, nutritional assistance, and clinical treatment in HIV-infected pregnant women. Ultimately, this initiative aims to enhance maternal and foetal health outcomes by supplying data that can guide targeted treatments and policy decisions in HIV-endemic areas like Owerri, Nigeria.

Materials And Methodology

Study area

The area for which this research study was carried out was in Owerri. Owerri is the capital of Imo State in Nigeria, set in the heart of Igboland. It is also the state's largest city, followed by Orlu and Okigwe as second and third respectively. Owerri consists of three Local Government Areas including Owerri Municipal, Owerri North and Owerri West, it has an estimated population of about 1,401,873 as of 2016 and is approximately 100 square kilometres (40 sq mi) in area

Study Design

A cross sectional study was conducted in the month of February, 2024. This research study was carried out under the haematology specialty of Medical Laboratory Science Imo State University in collaboration with Federal University Teaching Hospital Owerri.

Sample Collection

5mls of blood samples were collected through venipuncture using standard aseptic techniques from participants. Tourniquet was applied to upper forearm of the subjects after assuming a comfortable sitting position. The site chosen for vene-puncture was wiped with 70% alcohol for sterilization. Collection of blood specimens was done using appropriate collection tubes containing anticoagulants (e.g., EDTA, heparin) to prevent coagulation and preserve cellular components. Labeling of each specimen tube with unique identifiers, including participant identification number, date, and time of collection, to ensure accurate sample tracking and documentation shall be.

Ethical Consideration

The study was approved by the Research Ethics Committee of the Federal Teaching Hospital Owerri, Imo state.

Selection Criteria

Inclusion criteria:

1. Participants were pregnant women attending the antenatal clinic at Federal University Teaching Hospital Owerri.
2. HIV positive pregnant women and no other infection
3. Participants who gave their informed consent
4. Age-matched HIV negative pregnant women and non-pregnant females as control

Exclusion criteria:

Those excluded from this research work shall include female patients:

1. Non-pregnant at the time of recruitment were excluded from the study
2. Participants without a confirmed diagnosis of HIV-1 or HIV-2 infection were excluded from the study. This includes HIV-negative women and those with unknown HIV status
3. Those who did not provide their informed consent
4. Those who had significant medical conditions that may confound the interpretation of iron profile parameters or pose additional risks to their health were excluded.

Sample size determination/Calculation

Using sample size formula (Araonye, 2004), sample size need to achieve desired precision of 0.05% with a confidence level of 95% and standard normal deviation corresponding to confidence level 1.960, using a prevalence level of 2%.The study population was recruited from the Federal teaching hospital Owerri and it shall be calculated using the formula below:

$$n = Z^2\frac{z^2(q)P}{D^2} = Z^2\frac{(1-P)P}{D^2}$$

Where;

n = the minimum sample size

Z = the standard normal deviation, usually set at 1.960 which corresponds to the 95% confidence interval

P = the assumed prevalence rate in the study area

D = degree of precision required

Q = (1-P)

The required sample size is calculated as follows:

Assumed prevalence = 2.0% = 2/100 = 0.02

$$n = Z^2\frac{(I-P)P}{D^2}$$

$$n = 1.96^2\frac{1-0.02)\ 0.02}{0.05^2}$$

$$n = 3.8416\ \frac{(0.98)0.02}{0.0025}$$

$$n = \frac{3.8416\ x 0.0196}{0.0025}$$

$$n = \frac{0.07529536}{0.0025}$$

n = 30

Laboratory Analysis

Determination of Serum Ferritin: Serum ferritin measurement is based on the principle that ferritin, a blood cell protein that contains iron, reflects the amount of iron stored in the body. Ferritin is a protein complex consisting of 24 protein subunits that store and release iron in a controlled fashion.

Total Iron-Binding Capacity (TIBC) and Transferrin Saturation (TSAT): were determined.Iron profile tests are based on various biochemical and immunochemical principles: Some iron profile tests, such as serum ferritin assays, utilize immunochemical methods to detect and quantify specific proteins or antigens related to iron metabolism. Immunoassays may involve enzyme-linked immunosorbent assay (ELISA) or chemiluminescent immunoassay (CLIA) techniques.

Result

Table 4.1: Mean values of Iron profile in HIV ½ infected and non pregnant women attending antenatal clinic at Federal University Teaching Hospital

The mean serum iron levels (146.7 ± 74.3 µg/dl) in HIV-infected pregnant women were significantly higher compared to the control group (67.3 ± 27.5 µg/dl), showing a strong statistical difference ($t = 6.45$, $p = 2.36 \times 10^{-7}$). Ferritin levels (327.1 ± 156.3 ng/ml) were also significantly elevated in the HIV-infected group compared to the controls (179.2 ± 63.7 ng/ml) ($t = 4.09$, $p = 0.00024$). Transferrin levels (271.3 ± 58.6 mg/dl) were notably higher in HIV-infected women compared to the control group (209.5 ± 104.7 mg/dl), and the difference was statistically significant ($t = 3.48$, $p = 0.00095$). Total Iron Binding Capacity (TIBC) values, however, were significantly lower in the HIV-infected group (273.4 ± 47.9 µg/dl) compared to the control group (372.1 ± 225.85 µg/dl) ($t = -2.08$, $p = 0.045$).

Parameters	Test N= 30	Control N=30	t-value	p-value
Serum iron (µg/dl)	146.7± 74.3	67.3± 27.5	6.45	$2.36{\times}10^{-7*}$
Ferritin (ng/ml)	327.1± 156.3	179.2± 63.7	4.09	0.00024*
Trans Ferrin (mg/dl)	271.3± 58.6	209.5± 104.7	3.48	0.00095*
TIBC (µg/dl)	273.4±47.9	372.1±225.850	-2.08	0.045*

Table 4.1: Mean values of Iron profile in HIV ½ infected and non pregnant women attending antenatal clinic at Federal University Teaching Hospital (Mean ± S.D)

key:
S.D – Standard deviation
*- Significant p Value

4.2 Mean values of Iron profile in HIV ½ infected women across the trimesters attending antenatal clinic at Federal University Teaching Hospital

Table 4.2 presents the mean values of the iron profile in HIV 1/2-infected pregnant women across different trimesters attending the antenatal clinic at Federal University Teaching Hospital. The mean serum iron levels were found to increase significantly as pregnancy progressed across the trimesters, with the first trimester showing a mean value of 123.9 ± 57.1 µg/dl, the second trimester at 143.1 ± 69.2 µg/dl, and the third trimester at 193.2 ± 73.9 µg/dl. This increase was statistically significant ($t = 4.32$, $p = 0.021$). For ferritin levels, although there was an increase from the first trimester (291.9 ± 173.9 ng/ml) to the third trimester (334.8 ± 134.9 ng/ml), the difference was not statistically significant ($t = 2.17$, $p = 0.217$). Similarly, transferrin levels showed a non-significant increase across the trimesters, from 244.9 ± 44.1 mg/dl in the first trimester to 264.8 ± 45.9 mg/dl in the third trimester ($t = 1.23$, $p = 0.306$). Total Iron Binding Capacity (TIBC) also increased slightly across the trimesters, from 273.9 ± 44.8 µg/dl in the first trimester to 294.8 ± 43.9 µg/dl in the third trimester, but this increase was not statistically significant ($t = 0.93$, $p = 0.403$).

Trimester	Number	First	Second	Third	t value	P-value
Serum iron (µg/dl)	10	123.9± 57.1	143.1± 69.2	193.2± 73.9	4.32	0.021*
Ferritin(ng/ml)	10	291.9± 173.9	301.1± 153.9	334.8 ± 134.9	2.17	0.217

Trans Ferrin (mg/dl)	10	244.9± 44.1	253.9 ± 40.9	264.8 ± 45.9	1.23	0.306
TIBC (µg/dl)	10	273.9± 44.8	283.9± 41.9	294.8± 43.9	0.93	0.403

Table 4.2: Mean values of Iron profile in HIV ½ infected women across the trimesters attending antenatal clinic at Federal University Teaching Hospital (Mean ± S.D)

Table 4.3: shows the correlation of serum ferritin with serum iron, TIBC, and transferrin in HIV-infected pregnant women at Federal University Teaching Hospital.

There was a non-significant weak positive correlation between serum ferritin levels and serum iron (r = 0.234, p = 0.218), indicating no significant relationship between these two parameters in the HIV-infected group.

A non-significant weak negative correlation was observed between serum ferritin levels and TIBC (r = -0.039, p = 0.842), suggesting no meaningful association between ferritin and TIBC in the study population.

However, there was a significant moderate positive correlation between serum ferritin levels and transferrin levels (r = 0.461, p = 0.011), indicating that higher ferritin levels were significantly associated with higher transferrin levels in HIV-infected pregnant women.

Parameters	N	R	p-value
Serum iron	30	0.234	0.218
Serum TIBC	30	-0.039	0.842
Transferrin	30	0.461	0.011*

Table 4.3: Correlation of serum ferritin with serum iron/TIBC and transferrin in HIV-infected pregnant women at Federal University Teaching Hospital

*Key**= Significant p value

Discussion

In this investigation, the average blood iron level in HIV-positive pregnant women (146.7 ± 74.3 µg/dl) was markedly elevated compared to the control group (67.3 ± 27.5 µg/dl). This data corroborates with prior research indicating increased serum iron levels in HIV-infected people. In HIV-positive patients, elevated serum iron levels have been noted in comparison to healthy controls, which is attributed to dysregulated iron homeostasis resulting from chronic inflammation. The increased serum iron noted in this study may indicate the cumulative impact of pregnancy and HIV infection on iron homeostasis. Pregnancy raises the body's need for iron, but inflammation caused by HIV can mess up iron management by making iron leave the reticuloendothelial system and making it harder for the body to make red blood cells. This can lead to higher levels of iron in the blood. Nevertheless, there are conflicting reports. Lower serum iron levels have been documented in HIV-infected pregnant women, attributable to malabsorption, persistent immunological activation, and heightened dietary requirements during pregnancy [7]. These variances may indicate variations in nutritional condition, illness progression, or accessibility to antiretroviral medication (ART) [8].

Ferritin levels were markedly higher in HIV-infected pregnant women (327.1 ± 156.3 ng/ml) than in controls (179.2 ± 63.7 ng/ml). Ferritin functions as both a marker of iron reserves and an acute-phase reactant. The increase seen in this study probably indicates persistent inflammation and immunological activation linked to HIV infection. This finding aligns with [9], which indicated elevated ferritin levels in HIV-infected people due to inflammation-induced ferritin production. Increased ferritin levels may indicate iron sequestration inside macrophages, functioning as a defence mechanism against viral reproduction. Nonetheless, decreased ferritin levels have been recorded in HIV-infected pregnant women, indicating iron shortage due to inadequate food intake, chronic sickness, and the heightened iron requirements of pregnancy [10]. These variations underscore the impact of regional, dietary, and clinical factors on iron metabolism in HIV-infected people [12].

In HIV-positive pregnant women, transferrin levels were much higher (271.3 ± 58.6 mg/dl) than in controls (209.5 ± 104.7 mg/dl). Transferrin is the main protein that moves iron around, and higher levels of it mean that iron is being moved and stored more. This observation corresponds with the results of [13], which indicated that HIV infection interferes with iron homeostasis, leading to modified transferrin dynamics to ensure iron supply despite sequestration. Conversely, Ibrahim et al. indicated diminished transferrin levels in HIV-infected people, potentially attributable to compromised hepatic production in advanced stages of the disease. The elevated transferrin levels noted in this study may indicate a compensatory mechanism in response to heightened iron requirements during pregnancy [14].

Total iron-binding capacity (TIBC) was considerably diminished in HIV-infected pregnant women compared to controls, signifying a decreased iron-binding ability of plasma. Low TIBC is typical of prolonged inflammation and infection, during which iron is sequestered to restrict its accessibility to pathogens. This observation aligns with reports by [15], which noted reduced TIBC in HIV-infected people attributable to immune-mediated deregulation of iron transport proteins. A decrease in TIBC alongside higher serum iron and ferritin indicates modified iron metabolism, potentially signifying iron overload or impaired iron utilisation.

An analysis conducted across trimesters indicated a notable elevation in serum iron levels from the first to the third trimester. This pattern aligns with the rising mobilisation of iron to satisfy the demands of the foetus and mother as pregnancy advances. Nevertheless, ferritin, transferrin, and TIBC exhibited no statistically significant alterations, indicating that while circulating iron levels rise, iron reserves and transport capacity remain comparatively steady during pregnancy in HIV-infected women [16].

The substantial positive correlation between ferritin and transferrin (r = 0.461, p = 0.011) indicates a synchronised response between iron storage and transport mechanisms in HIV-infected pregnant women. Nonetheless, the limited link between ferritin and serum iron, along with the absence of an association with TIBC, suggests that ferritin may not accurately predict iron availability or binding capacity in this population due to the confounding effects of inflammation [17].

Conclusion

This study shows that pregnant women with HIV-1 and HIV-2 who go to the Federal University Teaching Hospital in Owerri have big changes in how their bodies use iron. High levels of serum iron, ferritin, and transferrin, together with low levels of TIBC, suggest that iron homeostasis is out of balance. This is probably due to persistent inflammation and metabolic problems caused by HIV. These results show how pregnancy, HIV infection, and iron metabolism all affect one other in a complicated way. This shows how important it is to keep a close eye on patients to avoid iron-related problems like functional iron deficiency or iron overload.

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