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Iron Status Audit Among Women of Reproductive Age Attending a Tertiary Hospital in South- East Region of Nigeria: A Frontier for Achieving Millennium Development Goals

Eledo B. O.*
Department of Haematology, Federal Medical Centre Yenagoa, Bayelsa state, Nigeria; Department of Medical Laboratory Science, Faculty of Health Sciences, Madonna University, Elele, Nigeria

Okamgba O.
Department of Medical Laboratory Science, Abia State University Uturu, Abia state, Nigeria

Allagoa D. O.
Department of Gynecology and Obstetrics, Federal Medical Centre Yenagoa, Bayelsa state, Nigeria

Onuoha E. C.
Department of Medical Laboratory Science, Federal University Otuoke, Bayelsa state, Nigeria

Abstract: Anaemia in pregnancy is one of the major public health problems in developing countries. Out of 630 women Studied 150 representing 23.8% were found to be anaemic (Hb<ll.0g/dl) (pregnant and non-pregnant subjects which represented the control group). Iron related laboratory parameters including haemoglobin (Hb), serum iron (SI) concentration, total iron binding capacity (TIBC), percentage transferrin saturation (TS) with iron and serum ferritin (SF) were estimated in all the pregnant and non anaemic, non-pregnant women. The result of this study showed that 18.0% of the pregnant group were found to be non-deficient (SF<12ng/ml, %TS<16%, and Hb llg/dl). Also, 9.4% among the control group were found to be iron deficient (SF<12ng/ml, %TS<16 and Hb>12g/dl). The prevalence of iron deficiency among the anaemic pregnant group was 8.7% with more pregnant women suffering from iron deficiency than non-pregnant women. Values of iron status were higher in the 1st trimester than 2nd trimester but tend to rise again in the 3rd trimester with no significant association existing with iron status and parity. The 8.7% prevalence of iron deficiency anaemia found in this study is considered significant. Furthermore, 10% and 3.8% of the anaemic and the control respectively were observed with high serum ferritin values) Other causes in pregnant subject with high serum ferritin values are recommended for further studies, pregnant women should be screened for iron parameters during and after antenatal care to prevent its consequences. To achieve millennium development goal on reducing child mortality come year 2020 more pragmatic steps need to be taken in our health institutions.

Keywords: Ferritin; Serum iron; anaemia; Pregnancy; Concentration.

1. Introduction

Anaemia is a medical condition in which there are no sufficient healthy red blood cells that could carry oxygen to the various tissues of the body leading to increase of plasma volume when compared to the rise in red blood cell volume [1, 2]. Anaemic condition occurs in several humans depending on the predisposing factor. For instance, anaemia occurs during pregnancy and it's a source of concern because it could lead to low birth weight, premature birth and maternal mortality [1, 3]. Furthermore, anaemia during pregnancy is detrimental to the woman and her baby if not detected early and treated accordingly.

Globally, the prevalence of anaemia has been severally reported in literature. WHO has several reported global prevalence of anaemia to be about 30% in 1985 [4, 5], 37% of women in 1992 [5, 6], 24.8% in 2008 [5, 7]. Furthermore, Stevens, *et al.* [8], Pasricha [5] reported global anaemia prevalence 29%, 38% and 43% in pregnant women, non-pregnant women, and children respectively. Typically, anaemia prevalence appears to vary according to regions. For instance, in developing countries in Africa, Asia and Latin America the prevalence is 35% - 56%, 37% - 75% and 37% - 52% respectively [6, 9]. In Palestine 33.5% among kindergarten children suffer iron deficiency aneamia [10]. In Turkey, a prevalence of 27.1% among pregnant women was repoted [11]. Between 1998 – 1999, reports showed that 54% and 46% of women residing in rural and urban areas are anaemic in India [3].

*Corresponding Author

Generally, women go through a variety of physiological changes during pregnancy. According to WHO, over 56% of women living in developing countries are anaemic [3]. Van den and Broek [9] also reported that aneamia is a common health problem in developing countries. According to Sharma and Shankar [3], anaemia is a condition in which the haemoglobin level is below a threshold lying at two standard deviations below the median of a healthy population of the same age, sex and stage of pregnancy. Anaemia is a situation in which the haemoglobin level is < 10.5 g/dL [12]. World Health Organization [13] reported that anaemia in pregnancy is a state in which the total circulating haemog000lobin concentration is less than 11 g dl or packed cell volume (PCV) less than 0.33L/L. Centre for Disease Control and Prevention [14] also defined as anaemic pregnancy condition in which the haemoglobin value <11.0g/L in the first and last trimester and Hb<10.5g L in the second trimester. Individuals with < 11 g dl -11.5g.dl at the beginning of pregnancy is often regarded as anaemic, reason being that as pregnancy progresses there is haemodilution [2].

Several anaemic condition associated with pregnancy include Iron-deficiency anaemia (a situation in which the iron in the body is very low and it occurs in about 15 – 25% of pregnant women in United States), folic acid i.e. folate-deficiency anaemia (a water-soluble vitamin that can help avoid neural tube defects during pregnancy condition), vitamin B12 deficiency anaemia (a vitamin that aid in the production of red blood cells) [1, 2, 12, 15]. Anaemia associated with iron deficiency is the most common type of nutritional anaemia [10]. According to Kozuma [16], iron and folic acid are essential for the feotus through the mother, therefore their deficiency could lead to iron and/ or folic acid deficiency anaemia.

Anaemic condition during pregnancy is characterized by several symptoms including fatigue, dizziness, breath shortness, irregular heartbeat, chest pain, pale skin, lips, and nails, cold hands and feet and difficulty in concentrating [1]. Others include lassitude, feeling of exhaustion, weakness, anorexia, indigestion, palpitation, swollen legs. Signs of anemia include pallor, glossitis, stomatitis, edema legs, soft systolic murmur in mitral area [2]. Specifically, iron-deficiency anaemia when low iron is produced in the body, the body can easily become fatigued and may lead to low infection resistance. Furthermore, the degree of anaemia varies among patients, thus showing varying symptoms [2].

Iron deficiency anaemia accounts for 75-95% of the cases of anaemia in pregnant women [12]. Rigby [12] reported fatigue, headache, restless legs syndrome, and pica as the clinical symptoms of iron deficiency anaemia. Mild (with Hb level of 8-10 gm%), moderate (with Hb level of < 7-8 gm%), severe (with Hb level of < 7%) [2], and very severe cases of anaemia occur depending on the haemoglobin concentration [3]. Typically, mild anaemia may not have any effect on pregnancy and labour except that the mother will have low iron stores and may become moderately to severely anaemic in subsequent pregnancies [17]. Patients with moderate anaemia often experience weakness, lack of energy, fatigue and poor work performance [17]. In severe anaemia, the effect is usually intense and are characterized by palpitations, tachycardia, breathlessness, increased cardiac output leading to cardiac stress which can cause de-compensation and cardiac failure which may be fatal [17].

The assessment of iron status in pregnant women involves monitoring of several haematological and biochemical indices. This is majorly due to the fact that each parameter reflects changes in different body iron compartment and are affected at different levels of iron depletion. Some of the notable measured parameters which include haemoglobin, serum ferritin, serum iron and transferrin (total iron binding capacity) enable iron status to be characterized in details.

Therefore this study is aimed at comparing iron status in pregnant and non- pregnant women; relate iron status with parity and to access the storage iron levels at different trimesters of pregnancy, make necessary recommendations; as a frontier for achieving millennium development goals.

2. Materials and Methods Setting

This study was conducted at Abia State University Teaching Hospital (ABSUTH); a government tertiary health care institution and four private specialist hospitals namely; Princess Mary, Romalex, Good Samaritan and Motherwell, located at the South Eastern part of Nigeria.

3. Study Population

Six hundred and thirty (630) apparently healthy pregnant women visiting the antenatal clinics for the first time constituted the study population. Their age ranges from 19-40years and with various gestational ages. The parity of the group was found to be 0-6. Another group of age- matched non- pregnant women constituted the control subjects.

4. Selection Criteria

Informed consent was obtained from all participants. Pregnant women who were apparently ill or with known underlying chronic illnesses such as diabetes mellitus, cardiovascular and other systemic diseases, tuberculosis and other complications were excluded in addition to those who were skeptical of the essence of the study.

5. Collection of Blood Sample

A standard clean vein puncture technique was used to collect 9mls of blood from each subject from the dorsal vein between the hours of 8.30am to 10.30am. About 5mls was dispensed into dipotassium EDTA anticoagulant tube and mixed, the concentration of the dipotassium salt was 1.5mg/mL of blood. The remaining 4ml of blood was dispensed into a dry plain plastic tube and were centrifuged at 1500rpm for 5minutes and the serum were stored at appropriate temperature for the determination of the biochemical iron status parameters. Control non-pregnant subjects had their blood specimens collected prior to their menstrual cycles.

6. Methods

The haemoglobin estimation was done using the standard cyanmethaemoglobin method as recommended by WHO 2001.

Serum iron (SI) concentration was carried out with spectrophotometer with Pointe scientific Iron TIBC Reagents set using the Persian modified Stookey Iron Ferrozine method. The principle is based on the formation of a coloured complex with Fe2+ and Ferrozine.

Serum ferritin (SF) was assayed by quantitative enzyme linked immunosorbent assay technique using human ferritin enzyme linked immunosorbent assay test kits. The principle of the test is based on a solid phase enzyme - linked immunosorbent assay.

Total Iron Binding capacity (TIBC) was estimated with Pointe scientific Inc. Iron TIBC Reagents set USA using standard Iron Ferrozine method. The principle is based on the determination of Iron remaining in the mixture after a known amount of ferrous ion was added to serum at an alkaline medium (pH). TIBC is thus calculated from unsaturated Iron binding capacity (UIBC)

Chromatographic immune assay technique was used to confirm pregnancy. The test strip is manufactured by Antec Diagnostic Ltd. Two lines appear when positive and red appears on the control line region.

7. Statistical Analysis

Statistical analysis was performed using computer software statistical package of social science version 11.0 and EPT inter version 6.04. Computed descriptive statistics include proportion of mean and standard deviation. Z-test, F-test and Chi-square test were used in significant testing.

8. Result

A total of six hundred and thirty women participated in the study of which 91.3% were pregnant women while 8.7% were non pregnant. Table 1 shows the relationship between haemoglobin concentration and parity in the first, second and third trimesters. Out of 150 anaemic pregnant subjects, 34(22.6%) were in their first trimester, 82 (54.7%) were in the second trimester while 34 (22.62%) were in the third trimester. The mean haemoglobin values of 10.22g/dl±0.52, 10.00g/dl±0.90 and 10.14g/dl±0.72 for first, second and third trimester respectively were recorded.

Table-1. Trimesters and parity of anaemic pregnant women

Trimesters	Age (Yrs)	GA (Wks)	Parity	Hb (g/dl)	Number
1st	29.32±0.36	9.98±0.17	0.82±0.08	11.67±0.11	151
Range	(19-40)	(6-12)	(0-5)	(7.1 - 17.0)	
2nd	28.73±0.26	19.90±0.19	1.11±0.08	11.44±0.07	296
Range	(16-41)	(13-24)	(0-6)	(6-15)	
3rd	29.61±0.33	30.61±0.25	1.40±0.10	11.76±0.09	183
Range	(19-43)	(25-38)	(0-6)	(4-14)	

P>0.05 and no Statistical difference in haemoglobin in the 1st, 2nd and 3rd trimester

Table 2 and 3 show the effect of parity on the iron status parameters of anaemic pregnant and control subjects respectively. Parity has no effect on the status of anaemic pregnant women and non- anaemic non-pregnant women (P > 0.05) for the various parameters including Serum iron (SI); Serum ferritin (SF); total iron binding capacity (TIBC), Haemoglobin (Hb), percentage transferrin saturation (TS).

Table-2. Effect of parity on the iron status parameters of anaemic pregnant

Parity	Freq.	Hb. (g/dl)	SI (umol/l)	TIBC(pmol/l)	TS (%)	SF (ng/rnl)
0	66	10.144=0.73	13.36±6.79	64.86±7.30	20.60±1.97	113.57±12.20
1	37	10.12±0.83	15.28±8.91	65.62±8.95	23.96±1.76	99.66±12.35
2	24	10.12±0.58	13.56±5.59	64.34±7.45	21.07rtrl.75	96.42±19.05
3	13	9.67±1.37	13.88±7.63	67.18±4.70	20.66±1.62	57.50±3.59
4	3	10.33±0.35	18.62±10.43	64.10±6.73	29.05±1.28	52.17±7.64
5	3	10.43±0.23	17.01±8.24	75.06±10.1	22.66±1.27	155.01=1=10.13

P>0.05, Parity has no effect on the Iron status of anaemic pregnant subject

Serum iron (SI); Serum ferritin (SF); Total Iron Binding capacity (TIBC), haemoglobin (Hb), percentage transferrin saturation (TS)

Table-3. Effect of parity on the iron status parameters of the control group

parity	Freq (%)	Hb (g/dl)	SI (pmol/l	TIBC (pmol/l)	TS (%)	SF
0	44	12.6±0.83	16.00*9.47	61,93± 12.85	25.84±11.84	79.40±8.10
1	1	12.0±0.68	10.45±2.51	47.70±1.86	21.91±3 17	7.10±8.9
2	2	12.5±0.71	9.01±2.38	43.95±0.92	20.50±4.98	27.45±1.14
3		13.0±0.82	11.70±5.60	57.40±6.27	20.38±9.71	91.83±5.27
4	2	11.0±0.71	22.11±1.43	68.75±4.60	32.16±2.25	52.90±4.07
5	1	13.0±0.56	9.80±3.21	49.9±5.27	19.64±4.34	31.20±2.14

P>0.05 - Iron status of non-pregnant non-anaemic (control) revealed that parity has no effect on the iron status of women.

Serum iron (SI); Serum ferritin (SF); Total Iron Binding capacity (TIBC), Haemoglobin (Hb), percentage transferrin saturation (TS)

Table 4 presents the effects of gestational age (trimesters) on iron status of anaemic pregnant women, the Hb, SI, TS and SF level ranged from 10.00 – 10.22 g/dl, 13.35 – 15.52 µmol/L, 65.27 – 65.70 µmol/L, 20.45 – 23.62% and 53.96 – 86.50 ng/mL respectively across the 3 stages of the trimesters. No significance difference (P>0.05) exist among the various trimesters.

Table-4. Effect of gestational age (trimesters) on iron status of anaemic pregnant women

Parameters	First trimester	Second trimester	Third trimester
Hb, g/dl	10.22±0.52	10.00±0.90	10.14±0.72
SI, µmol/L	15.52±8.12	13.35±6.83	14.60±7.32
TIBC, µmol/L	65.70±8.16	65.27±8.07	65.56±5.80
TS,%	23.62±13.89	20.45±11.82	22.27±12.54
SF,ng/mL	53.96±20.10	86.50±9.57	82.09±11.16

P>0.05, No statistical difference in the various trimester

Table 5 presents the effects of gestational age (trimesters) on iron status of the control gourp. The Hb, SI, TS and SF level ranged from 10.08 g/dl, 14.12 µmol/L, 98.12 µmol/L, 14.33% and 100.77ng/mL respectively among the experimental groups and 12.53 g/dl, 15.55 µmol/L, 60.89 µmol/L, 25.54 % and 75.59 ng/mL respectively among the control groups. There was significance difference (P<0.05) between the experimental and control group. Furthermore, significance difference of SI exist at P<0.01.

Table-5. Comparison of mean value of iron status of anaemic pregnant and anaemic non-pregnant (control) subjects.

Parameters	Subjects (n=150)	Control (n=50)	p-value
Hb, g/dl	10.08±0.79	12.53±0.85	<0.05
SI, µmol/L	14.12±7.26	15.55±9.48	<0.01
TIBC, µmol/L	98.52±6.20	60.89±9.48	<0.05
TS,%	14.33±1.44	25.54±11.86	<0.05
SF,ng/mL	100.77±13.63	75.59±7.89	<0.05

9. Discussion

Anaemia in pregnancy remains one of the most public health burdens in developing countries [3, 17] and it is common and strongly associated with maternal and foetal morbidity and mortality [1, 3, 13, 18, 19]. The mean haemoglobin ranged from 4.0 – 17.0 depending on the t**rimesters** level (Table 1). According to world health organization standard, anaemia in pregnancy is present when the haemoglobin concentration in the peripheral blood is less than ll.0g/dl. Anaemia is majoly caused due to deficiency of folate, iron and vitamin B12 and sometimes infections resulting from parasites in the body such as hookworm, and schistosomiasis.

In this study, the mean haemoglobin concentration of 12.53±0.85g/dl (Table 3) for non-pregnant women (control group) was statistically significant compared to 10.08±0.79g/dl (Table 2) in pregnant subjects. This report agrees with several works reporting anaemia in pregnancy than in non-pregnant women [20]. The result of the present study shows no statistically significant difference in the haemoglobin concentration in the first, second and third trimester (P > 0.05) of the general population studied.

The study did not find any relationship between haemoglobin concentration and increasing parity. However, previous workers had found increasing haemoglobin concentration with increasing parity' [21, 22]. In contrast, Desalegn [23] and Hinderaker, *et al.* [24] found low Haemoglobin concentration with increasing parity. It was expected that anaemia in pregnancy would tend to increase with parity owing to repeated drain on the iron reserves. In fact, multi-parity especially when the pregnancies have occurred in quick succession is traditionally regarded to cause anaemia in pregnancy, however, this study found no consistent relationship between rising parity and the incidence of anaemia. Perhaps following the experience gained from the first pregnancy and the consequent increased awareness of the value on blood supplements and good diet, as well as increased interaction with other pregnant women at the antenatal clinics, use of mosquito treated nets and eradication of certain haemoglobinopathies like sickle cell anaemia before marriage might have contributed to some extent the present result. The study also shows that iron status parameters were intermittently inconsistent from parity 0-6 and that parity has no effect on iron status parameters of the anaemic pregnant subjects ($P > 0.05$). The reason for this is not clear, however this findings compete favourably with that of Isah, *et al.* [25]. In their cooperate work, they observed inconsistencies in the iron status parameters with respect to parity which also did not differ significantly.

Also, this current study did not observe any relationship between anaemia and increasing gestational age. The study did not agree with the resolve of a prospective study of the prevalence of anaemia in pregnancy among 279 first timer attendants of the antenatal clinic in Jima, Ethiopia which showed an increased prevalence of anaemia with increasing gestational age [23]. The anaemic pregnant women showed no rise in haemoglobin levels in all the gestational ages, though lower levels in the first trimester compared to the second trimester may be attributed to the reduced iron requirement since there is temporary cessation of menstruation and the amount of iron transferred to the foetus is still minimal. According to Perlas, *et al.* [26], from the beginning of second semester, there is a major expansion in the maternal red cell mass which continues until the third semester and during this period iron is transported to the developing foetus therefore maternal body iron stores decline and a state of latent iron deficiency manifested as it was with the present work.

Pregnancy is a time of considerable maternal adaptation during which iron status is affected. This study shows that the serum concentration of most cases judged to be anaemic were severely deficient of iron and again the level of iron content is marked with distinct variations in iron status parameters where 18.0% and 8.7% had iron deficiency and iron deficiency anaemia in both pregnant and non pregnant (control) respectively. The reason had been that there is interplay and/or an overlap of factors such as malaria parasitaemia, folic acid deficiency, vitamin BI_2, vitamin C and A, zinc and copper or erythrocytes disorders. The prevalence of iron deficiency and iron deficiency anaemia in this study are at variance with the report of Usanga, *et al.* [20] were they presented 22.6% and 9.3%; difference could be attributed to differences in geographical location. It is therefore strongly recommended that further studies be conducted on non-iron etiologic causes of anaemia in pregnancy.

10. Conclusion

This current study has confirmed that anaemia is a major public health issue in women of reproductive age and it is more prevalent and severe during pregnancy. Although, it's essential to provide prophylactics to all pregnant women during their routine antenatal care, a renewed approach to prevention, diagnosis and treatment of iron deficiency should be made mandatory and adopted by our health centres. Also, the evaluation of anaemia in pregnancy should not only be based on packed cell volume (PCV) as it is the case in our health institutions, rather, iron related parameters must be included as part of antenatal screening. To achieve millennium development goal on reducing child mortality come year 2020, more pragmatic steps need to be taken in our health institution during antenatal care.

Ethical Clearance

Ethical Approval: Ethical approval was gotten from the Ethics Committee of Abia State University Teaching Hospital, Aba.

Competing of Interest

No competing of interest.

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