ORIGINAL ARTICLE

Haemoglobin and ferritin concentrations of pregnant women at term

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Summary

Background: Anaemia in pregnancy is defined as haemoglobin (Hb) concentrations of less than 11 g/dL while low ferritin is defined as serum ferritin (SR) levels of less than 10 μg/L. Hb and ferritin concentrations of pregnant women at term were determined to establish their mean values and to determine the prevalence of anaemia in our locality.

Methods: Haemoglobin and ferritin levels of 170 non-smoking and HIV-negative pregnant women were determined at term. The majority 143 of 170 (84.1%) of the pregnant women recruited for the study, booked at the beginning of the second trimester and received 200 mg elemental iron in three divided doses and 5 mg folic acid daily which were commenced at booking. Five millilitres of blood were collected from each patient at term into EDTA bottles for full blood count analysis and another 5 mL into plain bottles for SR assay.

Results: The mean Hb and ferritin values were 10.9 ± 1.9 and 47.84 ± 98.39 μg/L, respectively. The prevalence of anaemia at term was 46.4%. Only 11.2% (19 of 170) of pregnant women at term had low SR (iron stores). A statistically significant relationship was found between women's education and SR ($P = 0.032$). Booking status also correlated directly with SR and haemoglobin concentrations, while increasing age and parity did not.

Conclusion: About half of the patients were anaemic. Iron deficiency is not the major cause of anaemia in pregnancy in this study because the majority of the pregnant women had normal iron stores. Education and booking status are possible factors that contribute to anaemia.

Keywords: haemoglobin, ferritin concentration, pregnant women

INTRODUCTION

In developing countries, the prevalence of anaemia in the general population is relatively high (33–75%).[1–3] Iron deficiency is the most common cause of anaemia in pregnancy worldwide.[1,2] The risk of iron deficiency is particularly high in women with high parity and short intervals between pregnancies,[4,5] the incidence being lower in women on oral iron supplementation.[6,7] Iron deficiency in pregnancy may have severe consequences on the outcome of the pregnancy.[8] It may underlie anecdotal reports of increased blood loss at delivery in anaemic women.[9]

Babies born to iron-deficient mothers may perform poorly in the Bayley Mental Development Indices[10] and may develop anaemia within the first year of life when iron intake is very poor. There is a reported association between iron deficiency during pregnancy and preterm birth and low birth weight.[9,11] More importantly, low birth weight has been linked to the development of high blood pressure in adult life.[12]

The majority of women who attend antenatal clinics in tertiary health centres in Nigeria receive supplemental iron during pregnancy. However, despite adequate iron supplementation, other factors such as malnutrition, poor compliance due to gastric disturbances associated with iron intake, and defective absorption due to intestinal infestations, may affect iron bioavailability. The result is that 52% of pregnant women present with proven iron deficiency.[13]

Though haemoglobin and ferritin concentrations are both markers of iron deficiency, haemoglobin is a late marker and may not reflect tissue iron status. However, serum ferritin (SR) is generally considered the best measure of iron deficiency in pregnancy. The level falls early in the development of iron deficiency, and it is not affected by recent iron ingestion.

Data regarding the level of iron stores of pregnant women at delivery are scarce in our local area. This study was carried out to establish the mean values for haemoglobin concentration and SR for pregnant women at term and to evaluate the prevalence

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of anaemia and iron deficiency (using these parameters) in pregnant women attending a tertiary health centre.

MATERIALS AND METHODS

A cross-sectional study was carried out at the Lagos State University Teaching Hospital, Maternity Centre (Ayinke House), Ikeja in the south-western part of Nigeria between June 2009 and February 2010. One hundred and seventy consenting non-smoking and HIV-negative pregnant women aged 17–48 years were admitted after 37 weeks gestation.

Ferritin is an acute phase reactant and levels will rise when there is active infection or inflammation. Participants with a history of chronic illness, such as hepatitis, sickle cell disease, renal disorders and those with obstetric complications such as preterm labour, preeclampsia, gestational diabetes and HIV infection, were therefore excluded. The research was approved by the Ethics and Research Committee of the hospital.

Anaemia in pregnancy is defined as haemoglobin (Hb) concentration less than 11 g/dL while low ferritin is defined as SR less than 10 μg/L.[13] Subjects were grouped into three predelivery Hb concentrations and two SR levels according to WHO grouping,[13] i.e. non-anaemic (Hb $\geq$ 11 g/dL), mild to moderate anaemia (Hb 7–10.9 g/dL) and severely anaemic (Hb $<$ 7 g/dL); and into normal (SF $\geq$ 10 μg/L) and low (SF $<$ 10 μg/L) ferritin.

Demographic data including age, education status, parity, cigarette smoking, alcohol consumption and obstetrical history were obtained with the aid of a questionnaire.

Blood sampling

Peripheral blood samples were collected from the pregnant subjects to determine haemoglobin and SR levels before delivery. Haemoglobin concentration was measured by the Sysmex autoanalyser (Changchun Wancheng Bio-electron Co Ltd, Jilin, China) on the same day of collection while serum for ferritin assay was obtained from the blood sample in plain bottles after centrifugation and stored at −40°C before analysis. Ferittin assay was done using an enzyme-linked immunosorbent assay (ELISA) technique. The ELISA kit was manufactured by TECO diagnostics, Anaheim, CA 92807, USA.

Data analysis

Statistical analyses were performed by correlating the Hb and ferritin groups with the women's booking status, parity and education. Analyses were performed using SPSS for windows, version 16. All data were expressed as mean $\pm$ SD. A probability value of $P < 0.05$ was considered to indicate statistical significance. Pearson's chi-square was used to attain the P value.

RESULTS

A total of 170 pregnant women with an age range of 17–41 years and mean age of 29.58 $\pm$ 4.66 years were tested for Hb and ferittin (Table 1). The majority of the pregnant women, 45.9% (78 of 170), were primips. The percentage of participants decreased as their parity increased (Table 1). Of the pregnant women investigated, just over half, 50.6% (86 of 170), had received both secondary and primary education. Seventy of the 170 women (41.2%) had received tertiary, secondary and primary education, with only 3.5% (6 of 170) primary education alone, while 4.7% (8 of 170) had no formal education at all (Table 1).

Table 1 **Age/parity/education frequency**

Demographic data	Frequency	Percent
Age range in years		
17–24	30	17.64
25–34	118	69.41
35–41	22	12.94
Total	170	100
Parity		
Para 1	78	45.88
Para 2	50	29.41
Para 3	22	12.94
Para 4–6	20	11.76
Total	170	100
Education		
No education	8	4.47
Primary only	6	3.52
Secondary	86	50.58
Tertiary	70	41.17
Total	170	100

The minimum Hb value was 3 g/dL, the maximum 16 g/dL and the mean Hb value was 10.90 $\pm$ 1.9 g/dL.

When the Hb values were grouped into normal, i.e. no anaemia (Hb 11 g/dL and above), mildly to moderately low, i.e. mild-to-moderate anaemia (Hb 7.0–10.9 g/dL) and severely low, i.e. severe anaemia (Hb $<$ 7 g/dL), the majority, 52.9% (90 of 170), were non-anaemic, while 43.5% (74 of 170) had mild-to-moderate anaemia. Only five of the 170 (2.9%) had severe anaemia. The Hb value of one pregnant woman was missing (Table 2).

At term, the majority, 88.8% (151 of 170), had normal serum ferittin stores (10 μg/L and above), while 11.2% (19 of 170) had low serum ferittin stores ($<$10 μg/L) (Table 2). The minimum SR level was 8 μg/L, the maximum 770 μg/L and the mean value was 47.84 $\pm$ 98.39 μg/L (Table 2).

There were significant differences with regard to women's education and ferritin levels. One hundred and forty-six of 156 (86.5%) pregnant women with a minimum of a secondary school education had normal ferritin while five of 14 (40%) pregnant women who had received only primary education or were uneducated had normal ferritin, $P = 0.032$. Women's education and Hb groupings followed a similar pattern, but were statistically insignificant, $P = 0.64$.

Increasing age and parity did not correlate directly with haemoglobin and ferritin concentrations, and the results were not statistically significant (Table 3).

The majority, 84.1%, of the pregnant women (143 of 170) had booked for antenatal care, and 15.3% (26 of 170) were unbooked. The booking status of one pregnant woman was unknown (Table 4).

Correlating booking status with Hb and ferritin groupings showed that the percentage of booked pregnant women with normal Hb and ferritin levels were 53.8% (77 of 143) and

Table 2 **Haemoglobin and serum ferritin of pregnant women**

	Normal	Low	Severe
Hb in gps	90 (52.9%)	74 (43.5%)	5 (2.9%)
Serum ferritin	151 (88.8%)	19 (11.2%)	–

Table 3 **Haemoglobin/ferritin versus age/parity of pregnant women, $P = 0.648$**

	Age				Parity				
	17–24	25–34	35–41	Total	P1	P2	P3	P4–6	Total
Haemoglobin concentrations		$P = 0.460$					$P = 0.648$		
Severely low	0	1	4	5	1	1	0	3	5
Mild–moderately low	14	52	8	74	35	16	14	9	74
Normal	16	64	10	90	42	33	8	7	90
Total	30	117	22	169	78	50	22	19	169
Ferritin concentrations		$P = 0.66$					$P = 1.00$		
Low	6	8	5	19	2	4	4	9	19
High	24	110	17	151	76	46	18	11	151
Total	30	118	22	170	78	50	22	20	170

91.6% (131 of 143), respectively, while that of unbooked pregnant women were 50% (13 of 26) and 76.9% (20 of 26), respectively (Tables 4 and 5).

There is an inverse relationship between mothers' education and parity, i.e. less education was associated with higher parity, $P = 0.0001$ (Table 6).

DISCUSSION

The study revealed that 43.5% (74 of 170) of the pregnant women at term were mildly to moderately anaemic, while 2.9% (5 of 170) had severe anaemia (Hb < 7 g/dL). This finding was similar to that of Jin *et al.*[14] who reported a prevalence of 44.6% among pregnant women in the third trimester in rural south-east China, although these women were not at term.

Table 4 **Booking status and serum ferritin of pregnant women**

Ferritin	Low	Normal	Missing	Total
Booked	12	131	–	143
Unbooked	6	20	–	26
Missing	–	–	1	1
Total	18	151	1	170

Table 5 **Booking status and haemoglobin of pregnant women**

Haemoglobin	Severely low	Mild–mod low	Normal	Missing	Total
Booked	5	61	77	–	143
Unbooked	–	13	13	–	26
Missing	–	–	–	1	1
Total	5	74	90	1	170

Mild–mod, mild to moderately

Table 6 **Pregnant women's education versus parity, $P = 0.001$**

	No education	Primary only	Secondary	Tertiary	Total
Para 1	1	3	42	32	78
Para 2	1	1	26	22	50
Para 3	2	1	11	8	20
Para 4	4	1	7	8	20
Total	8	6	86	70	170

The prevalence of anaemia in our study was lower than the 59.6% obtained by Agan *et al.*[15] in pregnant women from Calabar, Nigeria, at first antenatal visit, and by Reihaneh *et al.*[16] where the prevalence of anaemia among Iranian pregnant women at term was 51.4%. However, it was higher than that found in studies in South Africa and Israel, where the prevalences of anaemia in pregnant women were 3.0% and 21.6%, respectively,[17] and higher than in a report from Ibadan, also in south-west Nigeria, where there was a prevalence of 10.4%.[18]

It was reported that in developing countries, iron supplementation programmes during pregnancy have shown limited effectiveness because of poor adherence, inefficient health-care systems, high rates of pre-existing anaemia, infection and teenage pregnancy.[19]

However, the cause of the anaemia in the pregnant women in our study may not be lack of iron. This is because only 11.2% (19 of 170) of them had low iron stores. This is not surprising because as early as 1973, Harrison and Ibeziako[20] reported that in Nigeria, red cell haemolysis that was indirectly due to *Plasmodium falciparum* was the main aetiological factor for anaemia, but that folate deficiency and haemoglobinopathy were also found; iron deficiency was rare. In an earlier report, Fleming[21] noted that among 248 consecutive admissions of anaemia during pregnancy or the puerperium in Ibadan, Nigeria, only two patients were iron deficient and both had heavy hookworm infestation. In all the other patients, anaemia was due to *P. falciparum*, folate deficiency, haemorrhage and haemoglobinopathies and various miscellaneous causes. Further corroborating our observation, Abudu *et al.*[22] reported that ferritin levels in both the non-pregnant and pregnant subjects were high and probably reflected the high iron content in Nigerian foods. Nnatu and Oluboyede[23] found a SR range of 23–270 μg/L with a geometric mean of 65 ± 66.96 μg/L (SD = 66.96), and Hb concentration range of 10.1–12.9 g/dL and a mean Hb concentration of 10.8 ± 1.02 g/dL in the third trimester. In a recent publication from Iran,[16] the mean haemoglobin and SR levels were 11.2 ± 1.2 and 45.8 ± 20.8 ng/mL, respectively. A report from Malawi however attributed anaemia in pregnant women to iron deficiency.[2]

Malaria as a cause of anaemia in our study is rather unlikely because during antenatal care, all women in our study received malaria intermittent prophylaxis with sulphadoxine-pyrimethamine regimen, were given insecticide-treated bednets, and received prompt and active treatment of acute malaria cases. In support of this argument, Asa *et al.*[24] observed that a sulphadoxine–pyrimethamine regimen is an effective, practicable strategy to decrease the risk of anaemia in women of low parity residing in areas endemic for malaria.

Though a statistically significant relationship was found only between women's education and SR ($P = 0.032$), booking status correlated with SR and haemoglobin groupings in our study. These findings were consistent with many reports.[1,25–28]

CONCLUSION

Iron deficiency is not a major cause of anaemia in our locality. There is a need for more studies to establish the cause of anaemia in pregnant women in this area. Education and booking status are factors that have strong influences on Hb concentration and SR levels.

DECLARATIONS

Conflict of interest: No conflict of interest declared.

Limitations of the study: Folic acid deficiency as a cause of anaemia in pregnancy was not evaluated. Other causes of anaemia such as hookworm infestation, vitamin B_{12} deficiency and vitamin A that may be present in these pregnant women were also not evaluated.

Acknowledgement: We are grateful to Adeyoloja S who ran the serum ferritin ELISA

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(Accepted 29 May 2011)