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Iron Status of Pregnant Women in Rural and Urban Communities of Cross River State, South-South Nigeria

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Summary: Anaemia in pregnancy is a major public health problem in Nigeria. Iron deficiency is one of the major causes of anaemia in pregnancy. Inadequate iron intake during pregnancy can be dangerous to both baby and mother. Iron status of pregnant women was assessed in two rural and one urban communities in Cross River State Nigeria. Packed cell volume, haemoglobin, mean cell haemoglobin, mean cell haemoglobin concentration, red cell count, serum iron, total iron binding capacity, transferrin saturation, serum ferritin, soluble transferrin receptor and soluble transferrin receptor/ferritin ratio were measured in plasma/serum of 170 pregnant women within the age range of 15-45 years. Seventy participants were from antenatal clinic of University of Calabar Teaching Hospital Calabar (urban community), 50 from St Joseph Hospital Ikot Ene (rural community) in Akpabuyo Local Government Area and the remaining 50 from University of Calabar Teaching Hospital extension clinic in Okoyong (rural community), Odukpani Local Government Area of Cross River state. The prevalence of anaemia, iron deficiency, iron depletion and iron deficiency anaemia were found to be significantly higher ($p<0.05$) among pregnant women from the two rural communities when compared to the urban community. it was also observed that the prevalence of anaemia, iron deficiency, iron depletion and iron deficiency anaemia were significantly higher ($p<0.05$) among pregnant women from Akpabuyo 38(76.00%), 20(40.00%), 23(46.0%) , 16(32.00%) respectively followed by Okoyong 24(48.0%), 20(40.0%), 16(32.0%), 6(12.0) and then those from Calabar 14(20%), 12(17.90%) , 14(20.0%). The mean haemoglobin and haematocrit were significantly reduced ($p<0.01$) in pregnant women from the two rural communities. Serum iron, serum ferritin and transferrin saturation showed no significant difference while total iron binding capacity and soluble transferrin receptor significantly ($p<0.01$) increased among pregnant women from Okoyong when compared to those from Calabar. It was also shown that pregnant women in their third trimesters and multigravidae had the highest prevalence of iron depletion and iron deficiency anaemia while prevalence of iron deficiency and anaemia were higher in primigravidae and the pregnant women in their second trimester. In conclusion, this study has shown that the prevalence of anaemia and iron deficiency anaemia are higher among pregnant women in the rural communities when compared to those in the urban areas.

Keywords*:* Anaemia, Iron deficiency, Iron status, Okoyong, Akpabuyo, Calabar

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INTRODUCTION

Iron deficiency is the most frequent nutritional deficiency disorder in the world (Demaeyer *et al.*, 1985). A recent estimate based on World Health Organization (WHO) criteria indicated that around 600-700 million people worldwide have a marked iron deficiency anaemia (Demaeyer *et al.*,1985). Iron deficiency anaemia in pregnancy has been defined by the National Academy of Sciences panel on nutrition and pregnancy as ferritin level lower than 12 µg/L and WHO define anaemia in pregnancy as haemoglobin levels less than 11g/dl (Elzahrani, 2012). The absence of iron stores (iron deficiency) can be diagnosed by showing that there is no stainable iron in the reticulo-endothelial cells in bone marrow smears. Bone marrow examination is generally regarded as the definitive marker of iron deficiency. Such examination is uncomfortable, cumbersome and impractical for routine use. There is a clinical need for non- invasive and sensitive means of detecting iron deficiency and a possible approach is the estimation of serum ferritin (SF) and of recent, serum soluble transferrin receptor (STfR) (Okafor *et al.*, 2014). During pregnancy, there is an increase in both red cell mass and plasma volume to accommodate the needs of the growing uterus and fetus. The plasma volume increases more than the red cell mass leading to a fall in the concentration of haemoglobin in the blood. Despite the increase in the total number of red cells, this drop in haemoglobin concentration decreases the blood viscosity and this enhances the

placental perfusion providing a better maternal-fetal gas and nutrient exchange (Elzahrani, 2012).

The development of iron deficiency anaemia is associated with increased risk of preterm births and low birth-weight infants. The physiologic importance of storage iron is that it provides a rapidly available supply in the event of blood loss. To achieve iron balance, towards the end of pregnancy, the absorption of 4-5 mg/day is necessary. Requirements are higher during periods of rapid growth in early childhood and adolescence (Yip *et al.*, 1996). In industrialized countries, the prevalence of iron deficiency anaemia is much lower and usually varies between 2 percent and 8 percent (Armstrong, 2011). However, the prevalence of iron deficiency, including both those with and without anaemia is much higher. In industrialized countries, for example, an absence of iron stores or subnormal serum ferritin values is found in about 20-30 percent of women of fertile age, in adolescent girls the prevalence is even higher (Garn *et al.*, 1981; Armstrong, 2011). Worldwide, the highest prevalence figures for iron deficiency are found in infants, children, teenagers, and women of childbearing age and pregnant women. Better information and access to fortified cereals for infants and children, has markedly improved the iron situation in these groups in most industrialized countries, where the highest prevalence today is observed in menstruating women and adolescents of both sexes (Hallberg, 1992).

In developing countries, where the prevalence of iron deficiency is very high (Okafor *et al.*, 2014) and the severity of anaemia is marked (Okafor *et al.*, 2013), studies on the distribution of haemoglobin in different population groups can provide important information as a valuable basis for action programmes. A more detailed analysis of subsamples may then give excellent information for the planning of more extensive programmes. The aim of this study was therefore to compare the prevalence of anaemia and iron deficiency anaemia among pregnant women in rural (Akpabuyo, Okoyong) and urban (Calabar) communities of Cross River State, South South Nigeria.

MATERIALS AND METHODS

Subjects

One hundred and seventy pregnant women within the age range of 15-45 years were recruited as subjects in this study; seventy of the pregnant women were from antenatal clinic of University of Calabar Teaching Hospital Calabar, fifty were from St. Joseph's Hospital, Ikot Ene in Akpabuyo Local Government Area and the remaining fifty pregnant women were from University of Calabar Teaching Hospital extension clinic in Okoyong, Odukpani Local Government Area of Cross River state.

Ethical clearance was obtained from the Cross River State Ministry of Health before the commencement of the study and informed consent letter was signed by all the women that participated in this study. The subjects were given questionnaires to fill which provided useful information such as age, parity, marital status, educational status and occupation.

Methods

red cell count, haematocrit, haemoglobin, mean cell haemoglobin and mean cell haemoglobin concentration were carried out using full automated blood cell counter, PCE-210 version 5.10 by ERMA INC. Tokyo. Serum iron and TIBC were determined using serum iron kit (TECO DIAGNOSTICS 1268 N. Lakeview Avenue Anaheim, CA 92807) and transferrin saturation with iron was determined using this formula:

$$\text{TS} = \frac{Serum\ Iron\ concentration}{TIBC} X\ 100$$

Serum ferritin was determined using human ferritin enzyme immunoassay test kit by Diagnostic Automation, Inc. Calabasas USA. Soluble Transferrin Receptor was measured using human soluble transferrin receptor ELISA Kit (Biovendor Diagnostics USA). The manufacturer instructions were strictly followed when using all the kits.

Iron depletion is defined as serum ferritin<12 ng/ml, Iron deficiency is defined as soluble transferrin receptor >2.4µg/ml. Anaemia is defined as Hb<11g/dl (WHO, 1994), Iron deficiency anaemia is defined as soluble transferrin receptor >2.4µg/ml and Hb <11g/dl (Okafor *et al.*, 2013).

Statistical Analysis

Data are presented as Mean ± Standard Error of Mean. All statistical analyses (One-way analysis of variance and chi square) were performed by using the program Statistical Package for Social Sciences (SPSS) for windows version 16.0 (SPSS Inc., Chicago, USA)

RESULTS

A demographic characteristic of the study groups is presented in table 1. The table shows that a significant ($P<0.05$) higher percentage of pregnant women from the two rural communities were house wives compared to those from urban community. The table also shows the level of education of pregnant women from the two rural communities to be significantly lower ($P<0.05$) than those from urban community. Fourty-two (60.00%), 4(8.00%) and 2(4.00%) of the pregnant women from Calabar, Akpabuyo and Okoyong were holders of university degree respectively. Fifty-seven (81.40%) of the pregnant women from Calabar involved in this study were taking haematinics while the lowest prevalence of women on haematinics were found in the two rural

Table 1. Demographic characteristics of the study group

Variables	Calabar (n=70)	Akpabuyo(n=50)	Okoyong (n=50)
Age (years)	28.30 ± 12.11	27.50 ± 15.30	30.10 ± 9.60
Primary Education	5 (7.10%)	16(32.00%)*	12(24.00%)*
Secondary Education	23(32.90%)	30(60.00%)*	36(72.00%)*
University Education	42(60.00%)	4(8.00%)*	2 (4.00%)*
No on iron supplementation	57(81.40%)	17(34.0%)*	16(32.00%)*
House wife	38 (54.29%)	37(74.0%)*	27(57.0%)*
Others$^{\gamma}$	32(45.71%)	13(26.0%)*	23(46.0%)

$^{\gamma}$Women who are engaged in one type of paid employment or another like teachers, nurses etc

Table 2. Red Blood Cell and Iron Related Variables of Pregnant Women in the three Communities of Cross River State

Variables	Calabar (n=70)	Akpabuyo(n=50)	Okoyong (n=50)
Hb (g/dl)	11.86±0.13	10.03± 0.24**	10.78±0.19**
Hct (l/l)	0.36±0.04	0.31±0.08**	0.32±0.05**
MCV (fl)	80.36±0.75	80.73±0.91	81.78±0.92
MCHC (g/dl)	33.13±0.12	30.84±0.17*	34.28±0.16
MCH (pg)	26.72±0.30	25.62±0.37*	28.15±0.37 *
RBC (g/l)	4.46±0.04	4.17±0.03*	3.87±0.06**
SI (ug/dl)	76.52±4.60	93.04±5.7*	95.84±5.76 *
SF (ng/ml)	30.43±4.49	30.11±4.88	45.98±8.38*
TIBC (ug/dl)	392.24±37.59	410.25±18.97*	443.84±22.36**
TS (%)	21.33±1.41	25.61±1.77*	22.85±1.69
STfR (ug/ml)	2.10±0.51	1.6±0.38*	4.13±1.32*

** significantly different when compared to values of pregnant women from Calabar ($P < 0.01$). *significantly different when compared to values of pregnant women from Calabar ($P < 0.05$). Hb-haemoglobin, Hct-haematocrit, MCV-mean cell volume, MCHC-mean cell haemoglobin concentration, MCH-mean cell haemoglobin, RBC-red blood cell, SI-serum iron, SF- serum ferritn, TIBC-total iron binding capacity, TS- transferrin saturation with iron, STfR-soluble transferrin receptor.

Table 3. Classification of Iron Status of Pregnant Women according to gestational age

Trimester	Anaemia (%)	Iron deficiency (%)	Iron deficiency anaemia (%)	Iron deficiency (%)
1st (n=40)	18(45.00)	9(22.50)	7(17.50)	12(30.00)
2nd (n=59)	27(45.70) *	22(37.30) *	11 (18.60)	18(30.50)
3rd (n=71)	31(43.60)	21(29.80)	15(21.10) *	23(32.40) *
Total (n=170)	76 (44.70)	52(30.60)	33(19.40)	53(31.20)

Iron depletion is defined as serum ferritin<12 ng/ml; iron deficiency is defined as soluble transferrin receptor >2.4ug/ml; anaemia is defined as Hb<11g/dl; iron deficiency anaemia is defined as soluble transferrin receptor >2.4ug/ml and Hb<11g/dl. * These values are significantly different from each other (P<0.05).

Table 4. Classification of Iron Status of Pregnant Women according to Age and Gravidae

	Anaemia (%)	Iron deficiency (%)	Iron deficiency anaemia (%)	Iron deficiency (%)
Primigravida (n=61)	20(32.80)	19 (31.10)	8(13.10)	18(29.50)
Multigravidan (n=109)	56 (51.40) **	33 (30.30)	25(22.90) **	35(32.10) **
15-30 yrs (n=120)	51(42.50)	39 (32.50) *	24(20.00) *	44(36.70) *
31-45yrs (n=50)	25 (50.00) *	13(26.00)	9(18.00)	9(18.00)

Iron depletion is defined as serum ferritin<12 ng/ml; iron deficiency is defined as soluble transferrin receptor >2.4ug/ml; anaemia is defined as Hb<11g/dl; iron deficiency anaemia is defined as soluble transferrin receptor >2.4ug/ml and Hb<11g/dl. * These values are significantly different from each other (P<0.05).

communities, Akpabuyo 17(34.00%) and Okoyong 16(32.00%). Table 2 shows the mean values of the estimated Red blood cell and other iron related parameters in pregnant women in the three Communities studied. The table shows that haemoglobin, haematocrit and red blood cell count are significantly ($p<0.01$) reduced among the pregnant women from the two rural communities when compared to the urban community. The table also shows that total iron binding capacity and soluble transferrin receptor are significantly increased in Okoyong when compared to pregnant women from Calabar. Anaemia 76(44.7%), iron deficiency 52 (30.6%), iron deficiency anaemia 33(19.4%) and iron depletion 53(31.20%) were recorded among the whole pregnant women studied (Table 3). It was also shown in table 3 that pregnant women in their third trimesters and multigravidae (Table 4) had the highest prevalence of iron depletion and iron deficiency anaemia while iron deficiency was recorded highest among primigravidae (Table 4) and the pregnant women in their second trimester (Table 3). Pregnant women in their second trimester also

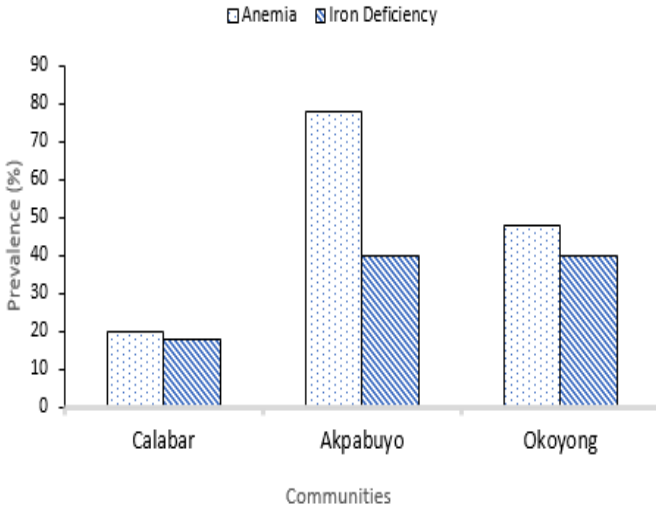

Figure 1. Prevalence of anaemia and Iron deficiency among pregnant women in the studied communities

recorded highest prevalence of anaemia. When the pregnant women were grouped according to age in table 4, those within the age range of 15-30 years had the highest prevalence of iron depletion, anaemia, iron deficiency and iron deficiency anaemia. Prevalence of anaemia and iron deficiency anaemia among pregnant women in the communities studied is shown in figures 1. The prevalence of anaemia and iron deficiency anaemia were significantly higher ($P<0.05$) among pregnant women from the two rural communities when compared to the urban community.

DISCUSSION

Iron deficiency anaemia (IDA) during pregnancy is a very common and preventable problem. It remains a major contributing factor to maternal morbidity and mortality. It is also associated with high prenatal mortality rates (Baynes *et al.,* 1991). The current study compares iron status of pregnant women in two rural communities to that of pregnant women in an urban community. The prevalence of anaemia recorded in this study (20.0% from urban area and 76.0% and 48.0% from the two rural communities respectively) is an indication that anaemia during pregnancy is still a problem in Nigeria especially among pregnant women dwelling in rural communities. The prevalence and severity of anaemia and iron deficiency anaemia were significantly higher among pregnant women from rural communities when compared to those from urban. This may be attributed to precarious nutritional status of these pregnant women since most of them were house wives with little or no official income. Of particular interest are the pregnant women from Akpabuyo where the level of anaemia was as high as 76.0% and that of iron deficiency anaemia 32.0%. The high incidence of anaemia (76.0%), iron depletion (46.0%), iron deficiency (40.0%) and iron deficiency anaemia (32.0%) recorded among the pregnant women from Akpabuyo may be attributed to the level of education of the pregnant women from that part of Nigeria . Majority of pregnant women from Akpabuyo had only primary education which impacts on the economic situation of their family. This is consistent with the findings of Bodnar *et al.* 2004, which reported that greater than 12 years of education was one of the positive predictors of postpartum haemoglobin concentration among low income women in North Carolina, U.S.A. The result of our study differs from the 79.1% reported by Usanga et al (1990), 41.9% reported by Desalegn, (1993), 20.7% recorded by Ogbeide et al (1994), Idowu et al. 2005 (76.8%), and 61.8% reported by Okafor et al (2012). This variance may be attributable to the differences in the geographical location of the study population.

There are several compounding factors responsible for the higher prevalence of anaemia in developing countries; malnutrition, haemoglobinopathies, hookworm infestation, history of grand multiparity, low socioeconomic status, malaria infestation, late booking, HIV infection, and inadequate child spacing among others (Akanmu et al., 1998; Okafor *et al.*, 2013). In addition, lack of access to education and understanding of health-related issues can contribute to delays in seeking antenatal care and makes them prone to self-medication and patronage of quacks especially in rural communities (Van den Broek *et al.*,2000).

The peak of anaemia and iron deficiency recorded in this study (2nd trimester) coincides with the period when haemodilution is at its peak. This may have contributed to the high prevalence recorded in the 2nd trimester, indicating that anaemia is further aggravated by haemodilution in pregnancy. World Health Organization (WHO) data show that iron deficiency anaemia in pregnancy is a significant problem throughout the world with a prevalence ranging from an average of 14% of pregnant women in industrialized countries to an average of 56% in developing countries (WHO, 1994). In the current study, it was found that increasing age was associated with higher prevalence of anaemia. In the Dugdale study (2006), haemoglobin levels were negatively correlated with increasing age. This may be due to cumulative obstetric conditions and maternal exhaustions. Women frequently enter pregnancy with insufficient nutrient stores, and thus the increased demand associated with pregnancy and later with lactation is reported to cause anaemia (Singh *et al.*, 1998). This holds true in most African countries and Nigeria could not be the exception given the high rates of micro and macronutrient deficiencies resulting from the interaction of deficient dietary intake and the deeply entrenched food habits (Idowu *et al.*, 2005). Other studies support our association of multigravidae with iron deficiency (Zimmermann & Hurrell, 2007;

Hindmarsh *et al.*, 2000). Parity in particular appears to be associated, although not exclusively, with iron deficiency in studies carried out in developing countries (Gibson *et al.*, 2008; Agarwal et al., 2006). It may be particularly important to inform multiparous women in developing countries, such as Nigeria, of the importance of adequate iron intake during pregnancy. In conclusion, this study has emphasized that anaemia and iron deficiency anaemia is still a serious health problem in Nigeria especially among pregnant women that dwell within our rural communities.

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