# Journal of Medical Sciences

ISSN 1682-4474

science alert

ANSInet
an open access publisher
http://ansinet.com

Research Paper

J. Med. Sci., 13 (6): 425-431
15th August, 2013
DOI: 10.3923/jms.2013.425.431

JMS (ISSN 1682-4474) is an International, peer-reviewed scientific journal that publishes original article in experimental & clinical medicine and related disciplines such as molecular biology, biochemistry, genetics, biophysics, bio-and medical technology. JMS is issued eight times per year on paper and in electronic format.

For further information about this article or if you need reprints, please contact:

I.O. Obasi
Department of Medical Biochemistry, Faculty of Basic Medical Sciences, Ebonyi State University, PMB 053 Abakaliki, Nigeria

Tel: +2348035623794
+2348151928855

# Comparative Iron Related Anaemia at Pregnancy in Ebonyi State, South-east Nigeria

[1]I.O. Obasi and [2]N. Nwachukwu

This study prospectively assessed and compared the gestational iron status of urban and rural women of Ebonyi State. Iron is an inevitable micronutrient in any healthy pregnancy. Its deficiency is a major cause of gestational anaemia, affecting a good percentage of poorer pregnant women even in developed countries. Gestational anaemia was noted to be prevalent in the area of our study. A cross session of antenatal patients were randomly selected from reference urban and rural hospitals in Ebonyi State and screened for their gestational iron status. Haemoglobin level was determined using Drabkin's (Cyanmethaemoglobin) method; while Atomic Absorption Spectrometric (AAS) method was used for serum iron level. Statistical analysis was done with Statistical Program for Social Sciences (version 15.0). Gestational Iron Deficiency (GID) and the consequent Iron Deficiency Anaemia (IDA) were, respectively 65.3 and 47.5% for urban subjects. While that of the rural subjects were 48.5 and 41.9%, respectively. The iron level of the urban pregnant women was significantly ($p<0.01$) lower than that of their rural counterparts. Obstetric and socioeconomic factors did not indicate any significant influence on the iron status of either of the regional cases. Conclusively therefore, the urban women were more vulnerable to GID and of course, IDA than their rural counterparts.

**Key words:** Gestation, region, iron, residence, haemoglobin, deficiency

ANSInet
Asian Network for Scientific Information

[1]Department of Medical Biochemistry, Faculty of Basic Medical Sciences, Ebonyi State University, P.M.B. 053, Abakaliki, Nigeria
[2]Department of Biochemistry, Federal University of Technology, Owerri, Nigeria

## INTRODUCTION

Iron is one of the most essential microelements in human body, due partly to its need in many haemoproteins (Murray *et al*., 2003). Normally, human contain about 4 g of iron in their entire body. Out of this amount, 65% occur in haemoglobin, while a half of the remainder is stored chiefly as ferritin and haemosiderin in the liver, spleen and bone marrow. The iron in these molecules is available for fresh haemoglobin synthesis. The rest of the non-erythropoietic iron is available in myoglobin, cytochromes and various enzymes (Rang *et al*., 2003).

Pregnancy is a normal physiological process involving progressive changes in mother and foetus. During this period, maternal physiological adjustments impose additional demands for nutrients requirements, including iron. For a sustainable healthy gestation, pregnant women need 3-4 times the iron requirement of the non-pregnant women (Zavaleta *et al*., 2000). This essentially sustains the nutritional status of the mother and her ability to transfer nutrients to the foetus at the appropriate time during pregnancy (Jackson *et al*., 2003). A shortfall of iron, in any form, from this requirement likely generates Gestational Iron Deficiency (GID) (Godfrey *et al*., 1991) and the consequent anaemia due to iron deficiency erythropoiesis (Seshadri, 2001).

Iron deficiency, with or without anaemia, is reported to affect about 25% of the poorer pregnant women even in developed countries like USA (Beard, 1994). The present study therefore, looks into and compares the iron status of pregnant urban and rural settlers in Ebonyi State.

## MATERIALS AND METHODS

**Study site and setting:** For this study, two hospitals were selected B Federal Teaching Hospital, Abakaliki (FETHA) and St Vincent Hospital, Ndubia (SVHN). The two Hospitals represent the urban and rural divisions of the study respectively. Three hundred and seven (200 from FETHA and 107 from SVHN) pregnant women attending antenatal clinics in the two hospitals were recruited for the study. The selection was done by simple random method.

**Sample collection:** At recruitment, the obstetric and demographic data of the participants were collected through a semi-structured questionnaire. The maternal anthropometrics were also taken. Through the health experts, 5.0 mL of non-fasting venous blood sample was collected from each participant at the antenatal care (ANC) halls of the study hospitals, using dry disposable plastic syringes. From the sample, 2.0 mL was dispensed into EDTA bottle and used for haematological studies the same day; while the remaining 3.0 mL was dispensed into plane glass test tube and allowed to clot, from where serum was extracted after centrifugation. The serum was transported frozen to Kogi State University, Ayimgba where the serum iron level was assessed.

**Determination of Haemoglobin (HB) concentration:** Haematological study was done with Drabkin's method according to Cheesbrough (2000). It is based on the principle that haemoglobin is oxidized to methaemoglobin by potassium ferricyanide which reacts with cyanide ions of potassium cyanide to form cyanmethaemoglobin whose absorbance is measured at 540 nm. Haemoglobin concentration was then estimated with the help of cyanmethemoglobin curve. Samples were determined in triplicates and their average taken as the final value. Gestational Hb level <11 g $dL^{-1}$ was considered anaemic (WHO/UNICEF/UNU, 1996).

**Determination of serum iron level:** The method of atomic absorption (flame) spectrometry, according to Wojck *et al*. (2009), was employed to assess the serum iron level. The sample was wet mineralized and hot dissolved in nitric acid solution [1 mL of serum+10 mL solution of $H_2SO_4$+$HNO_3$ (1:1) and heated]. The iron level in the cleared solution (resulted mineralizate) was read in atomic absorption spectrometer in three replicates, which the mean was considered the final value. Iron level <10 μmol $L^{-1}$ was considered deficient.

**Data analysis:** One way ANOVA, students' t-test and Pearson's correlation were used for basic statistics, with statistical significance at 95% confidence limit ($p<0.05$). All statistical analysis was done using the computer software, AStatistical Programme for Social Sciences@ (SPSS for windows, version 15.0).

**Ethical approval:** The study was approved by the Research and Ethics Committee of the hospitals and also by Ebonyi State University, Abakaliki, Nigeria, under which the research was performed. Study protocols for the use of human subjects were strictly adhered to in accordance with the international guidelines for human experimentation in clinical research (WMA, 2000).

## RESULTS

During the blood sampling, one out of the 200 urban pregnant women recruited for the study refused to donate her blood sample (for her reserved reason(s)). In the rural

Table 1: Mean characteristics of the subjects

| | Parameter | Range | Mean±SD | N |
|---|---|---|---|---|
| Urban | Age (years) | 15-40 | 27.3±4.610 | 200 |
| | Gestational age (weeks) | 12-29 | 21.9±3.120 | 200 |
| | BMI (kg m$^{-2}$) | 17.8-42.6 | 27.3±3.940 | 200 |
| | Hb (g dL$^{-1}$) | 6.5-13.3 | 10.2±1.370 | 199 |
| | Serum Fe (μmol L$^{-1}$) | 1.79-45.12 | 10.0±8.070 | 199 |
| Rural | Age (years) | 18-40 | 27.3±6.150 | 104 |
| | Gestational age (weeks)$^a$ | 11-38 | 24.9±5.770 | 105 |
| | BMI (kg m$^{-2}$)$^a$ | 17.3-38.8 | 24.5±3.150 | 105 |
| | Hb (g dL$^{-1}$)$^b$ | 6.3-13 | 9.78±1.23 | 104 |
| | Serum Fe (μmol L$^{-1}$)$^a$ | 0.36-128.57 | 16.4±18.10 | 97 |

Variables with superscripts a and b were significant at $p<0.001$ and $p<0.05$, respectively (t-test used). N: Population size

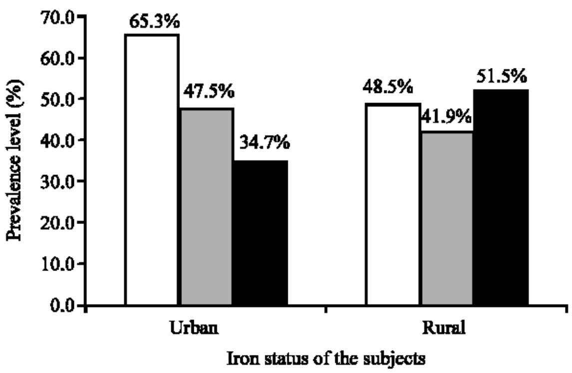


Fig. 1: Serum iron status of the pregnant women

Table 2: Influence of maternal age on the prevalence of GID and IDA

| | Matage (years) | No. of Subjects | Serum Fe (μmol L$^{-1}$) Range | Mean±SD | % GID* | % IDA* |
|---|---|---|---|---|---|---|
| Urban | <20 | 8 | 6.3-13.9 | 10.6±2.600 | 37.5 | 37.5 |
| | 20-24 | 45 | 2.4-43.0 | 8.31±6.85 | 75.6 | 56.5 |
| | 25-29 | 78 | 3.4-45.1 | 11.1±8.910 | 64.1 | 44.9 |
| | 30-34 | 55 | 1.8-43.0 | 9.77±8.38 | 63.6 | 43.6 |
| | 35-39 | 12 | 2.2-25.1 | 10.2±7.570 | 66.7 | 58.3 |
| | >39 | 1 | 12.4 | - | 0.0 | 0.0 |
| | Total | 199 | 1.8-45.1 | 10.0±8.07 | 65.3 | 47.5 |
| Rural | <20 | 7 | 4.5-28.8 | 13.7±9.68 | 57.1 | 50.0 |
| | 20-24 | 23 | 0.4-61.8 | 12.7±12.3 | 60.9 | 56.0 |
| | 25-29 | 34 | 1.8-80.0 | 14.1±13.9 | 50.0 | 42.9 |
| | 30-34 | 17 | 1.1-72.0 | 20.3±18.8 | 35.3 | 26.3 |
| | 35-39 | 10 | 6.4-44.5 | 18.8±13.0 | 30.0 | 25.0 |
| | >39 | 5 | 0.4-128.6 | 32.3±54.1 | 60.0 | 60.0 |
| | Total | 96 | 0.4-128.6 | 16.3±18.2 | 49.0 | 42.3 |

*%GID/%IDA: Urban (p = 0.234/0.134), rural (p = 0.485/0.670)-Pearson's $\chi^2$ used. Matage: Maternal age

Table 3: Influence of gestational age on the prevalence of GID and IDA

| | Gesage (weeks) | No. of Subjects | Serum Fe (μmol L$^{-1}$) Range | Mean±SD | % GID* | % IDA* |
|---|---|---|---|---|---|---|
| Urban | <12 | - | - | - | - | - |
| | 12-17 | 18 | 1.8-44.8 | 13.3±12.4 | 55.6 | 36.8 |
| | 18-23 | 103 | 2.1-32.7 | 9.00±6.36 | 68.0 | 50.5 |
| | 24-29 | 78 | 2.1-45.1 | 10.6±8.70 | 64.1 | 46.2 |
| | 30-35 | - | - | - | - | - |
| | >35 | - | - | - | - | - |
| | Total | 199 | 1.8-45.1 | 10.0±8.07 | 65.3 | 47.5 |
| Rural | <12 | 2 | 5.0-9.8 | 7.41±3.41 | 100.0 | 100.0 |
| | 12-17 | 8 | 6.8-16.3 | 11.2±2.64 | 25.0 | 20.0 |
| | 18-23 | 24 | 0.4-44.5 | 13.1±11.1 | 58.3 | 48.0 |
| | 24-29 | 48 | 0.4-80.0 | 18.0±17.4 | 45.8 | 43.8 |
| | 30-35 | 11 | 1.8-128.6 | 21.1±36.2 | 54.5 | 42.9 |
| | >35 | 4 | 8.2-29.5 | 18.6±10.7 | 25.0 | 16.7 |
| | Total | 97 | 0.4-128.6 | 16.4±18.1 | 48.5 | 41.9 |

*%GID/%IDA: Urban (p = 0.570/0.777), Rural (p = 0.306/0.346)-Pearson's $\chi^2$ used. Gesage: Gestational age

sampling also, two were dropped along the line on health ground, one of the blood samples was found clotted during screening (for [Hb]) and one did not indicate her age; while seven of the serum samples were lost along the line due to cracks on the vials and consequent contamination with the ice.

In Table 1, the maternal characteristics of the rural pregnant women were compared to the urban counterparts. Apart from the mean maternal age, all other parameters were significantly different from those of the urban ones. The mean maternal age of the rural women (27.3"6.15 years) has very close comparison to that of the urban women (27.3"4.61 years). The mean gestational age (24.9"5.77 weeks) and the mean serum iron level (16.4"18.1 μmol L$^{-1}$) of the rural women were significantly ($p<0.05$) higher than those of the urban counterparts (21.9"3.12 weeks and 10.0"8.07 μmol L$^{-1}$, respectively). Mean [Hb] (9.78"1.23 g dL$^{-1}$) and BMI (24.5"3.15 kg m$^{-2}$) of the rural pregnant women were significantly ($p<0.05$) lower than those of the urban subjects 10.2"1.37 g dL$^{-1}$ and 27.3"3.94 kg m$^{-2}$, respectively.

From Fig. 1, it showed that gestational iron deficiency (GID) and the consequent Iron Deficiency Anaemia (IDA) were significantly ($p<0.01$) more prevalent in the urban population (65.3, 47.5%, respectively) than in their rural counterparts (48.5, 41.9%, respectively).

In the urban sub-group, the maternal age 20-24 years ranked lowest in the mean serum Fe level (8.31"6.85 μmol L$^{-1}$) and higher prevalence of GID (75.6%) and then ranked next to 35-39 years age group (which ranked highest with 58.3%) in prevalence of IDA, though there was no statistical significance in each case (Table 2). In the rural counterparts, those 30 years of age and above showed higher mean serum Fe than the younger women, while the age groups 20-24 years and >30 years indicated higher prevalence of GID than the other groups but there was no significant difference in each case. The age groups below 24 years and above 39 years showed higher prevalence of IDA, which was not statistically significant still.

In Table 3 is the influence of gestational age on the prevalence of GID and IDA. All the urban subjects were, more or less, beyond the 1st trimester stage. The mean serum Fe level and the prevalence of GID among the urban and rural sub-groups did not show any significant

Table 4: Influence of parity on the prevalence of GID and IDA

| | | | Serum Fe (μmol L⁻¹) | | | |
|---|---|---|---|---|---|---|
| | Parity | No. of Subjects | Range | Mean±SD | %GID* | %IDA* |
| Urban | Primigravida | 72 | 2.1-32.7 | 10.4±6.62 | 56.9 | 47.2 |
| | Primipara | 45 | 1.8-43.0 | 9.60±9.31 | 75.6 | 48.9 |
| | 2 | 35 | 3.1-44.8 | 9.91±9.20 | 71.4 | 44.4 |
| | 3 | 18 | 3.5-16.1 | 7.80±3.60 | 66.7 | 61.1 |
| | >3 | 29 | 2.1-45.1 | 11.4±9.82 | 62.1 | 41.4 |
| | Total | 199 | 1.8-45.1 | 10.0±8.07 | 65.3 | 47.5 |
| Rural | Primigravida | 26 | 0.4-61.8 | 13.5±14.4 | 65.4 | 60.7 |
| | Primipara | 14 | 4.8-26.1 | 11.1±6.02 | 50.0 | 37.5 |
| | 2-Jan | 7 | 1.8-72.0 | 19.6±24.2 | 57.1 | 57.1 |
| | 3 | 12 | 3.9-33.2 | 14.0±8.55 | 41.7 | 41.7 |
| | >3 | 38 | 0.4-128.6 | 20.5±23.3 | 36.8 | 28.6 |
| | Total | 97 | 0.4-128.6 | 16.4±18.1 | 48.5 | 41.9 |

*%GID/%IDA: Urban (p = 0.283/0.102), Rural (p = 0.241/0.325)-Pearson's $\chi^2$ used

relationship with the gestational age of the pregnant women. Neither was there any significant relationship between the gestational age of the subjects and the prevalence of IDA. However, in the rural subgroup the women within the gestational age of 12-17 weeks and those >35 weeks were at the lowest prevalence level of GID (25.0%). The lowest prevalence level of IDA was also obtained from >35 weeks gestational age women (16.7%), followed by 12-17 weeks gestational age women (20.0%). On the other hand, the highest prevalence level of both GID (55.6%) and IDA (36.8%) were shown on the 18-23 weeks gestational age women.

From the result in Table 4, grand multiparous (parity >3) urban subgroup showed highest mean serum Fe level (11.4"9.82 μmol L⁻¹), while highest prevalence of GID (75.6%) was observed in the primiparous women. In the rural counterparts, the mean serum Fe level peaked on the grand multiparous women also (20.5"23.3 μmol L⁻¹), while highest prevalence of GID (65.4%) was rather shown in primigravida women. Neither of the subgroups showed statistical significance ($p>0.05$) based on parity. Highest prevalence of IDA (61.1%) was observed in the multiparous (parity = 3) urban women, followed by the primiparous ones (48.9%); while in the rural counterpart, higher prevalence of IDA was identified in the primigravida (60.7%), with the grand multiparous women (parity>3) showing least prevalence (28.6%), though none of the cases was statistically insignificant.

The result in Table 5 showed that the BMI of the pregnant women had no significant influence on either the mean serum Fe level or the prevalence of GID in each case. In the urban sub-group however, there was a direct relationship, though statistically insignificant ($p>0.05$), between the BMI grouping and the mean serum Fe level. The mean serum Fe level increased alongside the energy status classification of the subjects; with the severely malnourished having the least value (7.74 μmol L⁻¹) and the obese women the highest value (10.5"8.85 μmol L⁻¹). In the rural sub-group, such direct relationship seems to exist between the maternal BMI and GID, but not with the mean serum Fe level and the prevalence of IDA. In the urban sub-group, lower prevalence of IDA (33.3%) was identified from the moderately malnourished and the obese women (43.9%). In the rural counterparts, such was shown by the normal (42.2%) and overweight (30.0%) women but were all statistically insignificant ($p>0.05$).

Table 5: Influence of BMI of the subjects on the prevalence of GID and IDA

| | | | Serum Fe (μmol L⁻¹) | | | |
|---|---|---|---|---|---|---|
| | BMI group | No. of Subjects | Range | Mean±SD⁺ | %GID* | %IDA* |
| Urban | Severe | 1 | - | 7.74 | 100.0 | 100.0 |
| | Moderate | 3 | 4.3-11.2 | 8.51±3.65 | 66.7 | 33.3 |
| | Normal | 57 | 1.8-32.7 | 9.46±6.60 | 68.4 | 54.4 |
| | Overweight | 40 | 2.1-45.1 | 9.84±8.42 | 67.5 | 46.3 |
| | Obese | 98 | 2.1-44.8 | 10.5±8.85 | 63.3 | 43.9 |
| | Total | 199 | 1.8-45.1 | 10.0±8.07 | 65.8 | |
| Rural | Severe | 1 | - | 2.68 | 100.0 | 100.0 |
| | Moderate | 13 | 6.4-128.6 | 22.5±33.4 | 53.9 | 46.2 |
| | Normal | 42 | 0.4-80.0 | 14.6±13.0 | 54.8 | 42.2 |
| | Overweight | 26 | 1.4-72.0 | 19.3±18.1 | 57.7 | 30.0 |
| | Obese | 15 | 0.4-36.8 | 11.7±11.1 | 66.7 | 56.2 |
| | Total | 97 | 0.4-128.6 | 16.4±18.1 | 57.7 | 41.9 |

*%GID/%IDA: Urban (p = 0.060/0.960), Rural (p = 0.637/0.637)-Pearson's $\chi^2$ used Severe and moderate refer to the extent of protein energy malnutrition

Table 6: Influence of maternal occupation on the prevalence of GID and IDA

| | | | Serum Fe (μmol L⁻¹) | | | |
|---|---|---|---|---|---|---|
| | Occupation | No. of subjects | Range | Mean±SD | %GID* | %IDA* |
| Urban | H/W | 40 | 3.1-45.1 | 10.6±9.21 | 62.5 | 50.0 |
| | C/S | 75 | 2.1-44.8 | 10.2±9.06 | 68.0 | 46.1 |
| | Artisans | 49 | 1.8-32.7 | 9.84±7.10 | 63.3 | 49.0 |
| | Students | 31 | 2.4-25.2 | 8.72±5.22 | 67.7 | 45.2 |
| | Farming | 4 | 7.5-23.3 | 13.1±7.20 | 50.0 | 50.0 |
| | Total | 199 | 1.8-45.1 | 10.0±8.07 | 65.3 | 47.5 |
| Rural | H/W | 9 | 3.9-26.1 | 11.3±7.00 | 55.6 | 50.0 |
| | C/S | 1 | 11.8 | | 0.0 | 0.0 |
| | Artisans | 40 | 0.4-61.79 | 13.6±12.7 | 57.5 | 53.5 |
| | Students | 2 | 15.5-16.3 | 15.9±0.50 | 0.0 | 0.0 |
| | Farming | 45 | 0.4-128.6 | 20.0±23.2 | 42.2 | 32.7 |
| | Total | 97 | 0.4-128.6 | 16.4±18.1 | 48.5 | 41.9 |

*%GID/%IDA: Urban (p = 0.915/0.409), Rural (p = 0.286/0.168)-Pearson's $\chi^2$ used, H/W: House wives, C/S: Civil servants

Table 6 presents the effect of the occupation of the pregnant women on their Fe status. The occupation of the women did not show any significant effect on the Fe status of the subjects. However, the urban women who engaged in farming showed the highest mean serum Fe level (13.1"7.20 μmol L⁻¹) and lowest prevalence of GID (50.0%), but highest prevalence of IDA (50.0%), which equals that of the house wives (H/W). Students and civil servant (C/S) showed higher prevalence of GID but lower incidence of IDA than the rest. In the rural sub-group also, the farmers showed the highest mean serum Fe level

Table 7: Influence of educational level of the subjects on the prevalence of GID and IDA

| | Educational level | No. of subjects | Serum Fe (µmol $L^{-1}$) Range | Mean±SD | % GID* | % IDA* |
|---|---|---|---|---|---|---|
| Urban | None | 6 | 6.33-45.12 | 23.0±14.9§ | 33.3 | 33.3 |
| | Primary | 24 | 3.4-32.7 | 9.64±7.03§ | 66.7 | 54.2 |
| | Secondary | 98 | 1.8-44.8 | 9.83±7.75§ | 65.3 | 46.5 |
| | Tertiary | 68 | 2.1-43.0 | 9.35 (7.47)§ | 67.6 | 47.1 |
| | Total | 196 | 1.8-45.1 | 10.1±8.12§ | 65.3 | 47.2 |
| Rural | None | 42 | 0.4-128.6 | 22.5±24.9£ | 38.1 | 32.6 |
| | Primary | 47 | 0.4-33.2 | 11.3±7.76£ | 59.6 | 52.0 |
| | Secondary | 6 | 6.6-16.3 | 11.5±4.58£ | 50.0 | 42.9 |
| | Tertiary | 2 | 11.8-29.5 | 20.6±12.5£ | 0.0 | 0.0 |
| | Total | 97 | 0.4-128.6 | 16.4±18.1£ | 48.5 | 41.9 |

*%GID/%IDA: Urban (p = 0.409/0.314), rural (p = 0.111/0.143)-Pearson's $\chi^2$ used, Values with superscript § and £ showed statistical significance at p<0.01 and p<0.05, respectively-ANOVA used

Table 8: Influence of living accommodation on the prevalence of GID and IDA

| | Living accommodation | No. of subjects | Serum Fe (µmol $L^{-1}$) Range | Mean±SD | %GID* | %IDA* |
|---|---|---|---|---|---|---|
| Urban | Single room | 133 | 2.1-45.1 | 9.39±7.39 | 66.4 | 49.6 |
| | Flat | 72 | 1.8-43.0 | 10.5±8.10 | 63.9 | 42.5 |
| | Bungalow | 13 | 3.6-44.8 | 13.2±12.5 | 61.5 | 61.5 |
| | Duplex | - | - | - | - | - |
| | Total | 198 | 1.8-45.1 | 10.1±8.10 | 65.2 | 47.7 |
| Rural | Single room | 7 | 2.7-24.3 | 11.5±8.10 | 57.1 | 37.5 |
| | Flat | - | - | - | - | - |
| | Bungalow | 87 | 0.4-128.6 | 16.8±18.9 | 49.4 | 43.6 |
| | Duplex | 1 | 11.79 | | 0.0 | 0.0 |
| | Total | 95 | 0.4-128.6 | 16.3±18.3 | 49.5 | 42.7 |

*%GID/%IDA: Urban (p = 0.905/0.179), Rural (p = 0.564/0.034)-Pearson's $\chi^2$ used

(20.0"23.2 µmol $L^{-1}$); while the artisans showed highest prevalence of GID and IDA, though there was no significant difference (p>0.05).

In the Table 7, the urban women who never acquired any formal education showed significantly (p<0.01) higher mean serum Fe level (23.0"14.9 µmol $L^{-1}$), while those with tertiary education showed higher prevalence of GID (67.6%), which was insignificant (p>0.05). In rural counterpart, the women with no formal education showed significantly (p<0.05) higher mean serum Fe level (22.5"24.9 µmol $L^{-1}$) and insignificantly lower prevalence of GID (38.1%). Similarly, lower prevalence of IDA was detected in the Ano-formal-education@ women of both the urban (33.3%) and the rural (32.6%), though none of the cases proved statistically significant (p>0.05).

In the urban, those living in single room, followed by those in flat, showed lower mean serum Fe level and higher incidence of GID, while prevalence of IDA rather peaked on those living in bungalow (61.5%) (Table 8). Similar relationship applies to the rural sub-groups, where the women residing in single room showed lower mean serum Fe level and higher prevalence of GID than the rest, while the vulnerability to IDA was higher on those residing in bungalow still; but none of the sub-groups was statistically significant in each case (Table 8).

## DISCUSSION

Iron is an important trace element in human nutrition. During pregnancy, insufficient supplies of iron can lead to a state of biological competition between mother and the conceptus, culminating to iron deficiency, which can be detrimental to the health status of both (King, 2003). Anaemia due to iron deficiency has been noted to be the most prevalent nutritional deficiency problem affecting pregnant women (Thirukkanesh and Zahara, 2010).

Okwu and Ukoha (2008) reported from their study, a higher prevalence of IDA in the rural than the urban areas of their study. While Obasi and Nwachukwu (2013) reported higher vulnerability of the rural women to gestational anaemia than their urban counterparts. In the present comparative study, the observation is showing a higher prevalence of GID and the consequent IDA in the urban region than in their rural counterpart. This is an unlikely expectation; as one would ordinarily expect that urban subjects should be on a better nutritional placement. The emergence of this phenomenon might be due to the insufficient micronutrient intake, as a result of a monotonous and imbalance diet, wherein farinaceous products prevail among the urban settlers. The above statement could be evident from table 1, where higher energy level than normal (mean BMI of 27.3"3.94 kg $m^{-2}$) was recorded against the urban subgroup. It is speculatively possible to attribute this Aunfamiliar@ finding to a pattern of lifestyle that is always common among the urban settlers. In the first instance, it is common that most urban settlers always go for refined synthetic canned foods and beverages in place of the mineral-rich natural ones. In addition, the unnecessarily carefree Ahigh@ social life of women, in which good number of them craves red wines in addition to tea and coffee beverages mostly in the urban area, could be another reason for their relatively high prevalence of GID and then IDA (which is just an advanced stage of the former). These are known to contain phenolic compounds believed to exhibit inhibitory effect on Fe absorption (Kennedy *et al*., 2003). As a consequence, iron deficiency becomes imminent, especially during pregnancy.

Such carefree Ahigh@ social life of women is not commonly, if at all, obtainable among the rural dwellers. Meanwhile, the rural women of our study area grow dark green leafy vegetables (like fluted pumpkin), as a hobby at least. And dark green leafy vegetables are natural sources of Fe. They also keep fruit plantations like pawpaw, mango and guava (natural sources of Vit. A), as well as orange (a natural source of ascorbic acid) (Devlin, 2006). These vitamins are known to facilitate non-heam iron absorption (Bloem *et al*., 1990; Thurnham, 1993; Murray *et al*., 2003; Rang *et al*., 2003). These might be associated with the better iron status of the rural women, since they can always eat these natural foods at will. Little wonder therefore, why the rural women with normal serum Fe level evidently peaks over the GID and IDA groups; whereas in the urban area, such (i.e., the normal group) was at the nadir (Fig. 1).

Though the pregnant women were always given nutrients supplements (in tablets, capsules or lozenges), their full compliance to this supplements is not always guaranteed. It has been observed that noncompliance to daily nutrients supplementation by pregnant women is a significant issue seriously militating against their nutritional status (Galloway *et al*., 2002). Even though their study did not show statistical significance, Thirukkanesh and Zahara (2010) came up with a finding that the percentage of antenatal women who complied with nutrients supplementation was lower in the urban than in their rural counterparts; and that those who complied had normal [Hb] compared to the noncompliant group. This might not be dissociated from the higher prevalence of GID and IDA among our study urban subgroup, whose greater number was civil servants (Table 6). The women of this caliber could engage in Awhite collar@ jobs, where they would often, spend long hours in the office works at the cost of keeping to their nutrients supplements regimen. Early antenatal registration is a necessary practice for possible healthy pregnancy. The absence of women in their 1st trimester among the urban subgroup (Table 3) is an indication of laxity toward such necessary practice. Again, this could be a contributory factor to the poorer Fe status of the urban subjects than their rural counterparts.

Besides, it was discovered during the course of the study that the rural women were served with powdered soymilk (ground soybeans) in addition to the orthodox nutrients supplements. Soybean is known to be rich in micronutrients including non-haem iron and vit. A, to mention but a few (Burks *et al*., 1991). This could be another good reason for better gestational iron status of rural subjects than their urban counterparts.

This study shows no significant effect of obstetrics and economic factors on the Fe status of the pregnant women in any of the regions. This does not conform to earlier studies of Ugwuja *et al*. (2010) and that of Obasi *et al*. (2013), who rather reported them as predisposing risk factors.

## CONCLUSION

It could be concluded from this study therefore, that GID and the consequent IDA were significantly more prevalent in the urban than in the rural regions of our study. Obstetrics and economic factors were not seen as the significant predisposing factors.

## ACKNOWLEDGMENTS

We wish to appreciate the management of our target hospitals (FETHA and SVHN) for giving their approval. Our thanks also go to our valued subjects (the pregnant women) for their voluntary consents and supports. We extend our immense gratitude to the health workers of the two hospitals for their unalloyed assistance. In a special way, we acknowledge the contributions of Mr.T.F. Emmanuel in the laboratory analysis of the samples (for iron levels).

## REFERENCES

Beard, J.L., 1994. Iron deficiency: Assessment during pregnancy and its importance in pregnant adolescents. Am. J. Clin. Nutr., 59: 502S-508S.

Bloem, M.W., M. Wedel, E.J. van Agtmaal, A.J. Speek, S. Saowakontha and W.H. Schreurs, 1990. Vitamin A intervention: Short term effects of a single oral massive dose on iron metabolism. Am.J. Clin. Nutr., 51: 76-79.

Burks, A.W., L.W. Williams, R.M. Helm, W. Thresher, J.R. Brooks and H.A. Sampson, 1991. Identification of soy protein allergens in patients with atopic dermatitis and positive soy challenges; Determination of change in allergenicity after heating or enzyme digestion. Adv. Exp. Med. Biol., 289: 295-307.

Cheesbrough, M., 2000. District Laboratory Practice in Tropical Countries Part 2. Cambridge University Press, Cambridge UK pp: 300-303.

Devlin, T.M., 2006. Textbook of Biochemistry with Clinical Correlations. 6th Edn., John Wiley and Sons Inc., Hoboken, New Jersey, pp: 1093-1095.

Galloway, R., E. Dusch, L. Elder, E. Achadi and R. Grajeda *et al*., 2002. Women's perceptions of iron deficiency and anemia prevention and control in eight developing countries. Social Sci. Med., 55: 529-544.

Godfrey, K.M., C.W. Redman, D.J. Barker and C. Osmond, 1991. The effect of maternal anaemia and iron deficiency on the ratio of fetal weight to placental weight. BJOG: Int. J. Obstetrics Gynaecol., 98: 886-891.

Jackson, A.A., Z.A. Bhutta and P. Lumbigranon, 2003. Nutrition as a preventive strategy against adverse pregnancy outcomes. J. Nutr., 133: 1589S-1591S.

Kennedy, G., G. Nantel and P. Shetty, 2003. The scourge of hidden hunger: Global dimensions of micronutrient deficiencies. Food Nutr. Agric., 32: 8-16.

King, J.C., 2003. The risk of maternal nutritional depletion and poor outcomes increases in early or closely spaced pregnancies. J. Nutr., 133: 1732S-1736S.

Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell, 2003. Harper`s Illustrated Biochemistry: A LANGE Medical Book. 26th Edn., Lange Medical Books/McGraw-Hill, New York, pp: 491-492.

Obasi, I.O. and N. Nwachukwu, 2013. Comparative study on the prevalence of anaemia among pregnant women of Ebonyi State, Nigeria. Global J. Bio-Sci. Biotechnol. (In Press).

Obasi, I.O., N. Nwachukwu, U.E. Nwachi, C. Aloke and O. Ogah, 2013. Pregnant women and persisting challenge of Anaemia in Ebonyi State, South-East Nigeria. Pak. J. Nutr., Vol. 11. (In Press).

Okwu, G.N. and A.I. Ukoha, 2008. Studies on the predisposing factors of iron deficiency anaemia among pregnant women in a Nigerian community. Pak. J. Nutr., 7: 151-156.

Rang, H.P., M.M. Dale, J.M. Ritter and P.K. Moore, 2003. Pharmacology. 5th Edn., Churchill Livingstone, London, UK., pp: 331-333.

Seshadri, S., 2001. Prevalence of micronutrient deficiency particularly of iron, zinc and folic acid in pregnant women in South East Asia. Br. J. Nutr., 85: S87-S92.

Thirukkanesh, S. and A.M. Zahara, 2010. Compliance to vitamin and mineral supplementation among pregnant women in urban and rural areas in Malaysia. Pak. J. Nutr., 9: 744-750.

Thurnham, D.I., 1993. Vitamin A and haematopoiesis. Lancet, 342: 1312-1313.

Ugwuja, E.I., E.I. Akubugwo, U.I. Ibiam and O. Obidoa, 2010. Impact of maternal iron deficiency and anaemia on pregnancy and its outcomes in a Nigerian population. Internet J. Nutr. Wellness, Vol. 10

WHO/UNICEF/UNU, 1996. Indicators for Assessing Iron Deficiency and Strategies for its Prevention. World Health Organization, Geneva, Switzerland.

WMA, 2000. World medical association declaration of helsinki ethical principles for medical research involving human subjects. 52nd WMA General Assembly, Edinburgh, Scotland. http://oss-sper-clin.agenziafarmaco.it/normativa/direttive_OsSC-000122-000000.pdf.

Wojck, A., T. Mituniewicz, K. Iwanczuk-Czernk, J. Sowinska, D. Witkowska and L. Choazy, 2009. Contents of macro- and micro-elements in blood serum and breast muscle of broiler chickens subjected to different variants of pre-slaughter handling. Czech J. Anim. Sci., 4: 175-181.

Zavaleta, N., L.E. Caulfield and T. Garcia, 2000. Changes in iron status during pregnancy in Peruvian women receiving prenatal iron and folic acid supplements with or without zinc. Am. J. Clin. Nutr., 71: 956-961.