



CLIMAX IN PREVALENCE OF IRON DEFICIENCY ANAEMIA AMONG PREGNANT WOMEN IN RIVERS STATE

Beauty Echonwere^{*1}, Teddy C. Adias², Evelyn M. Eze¹, Fred K. Uwikor¹ and E.O. Bamigbowu³

¹Dept. of Medical Laboratory Science, Rivers State University, Port Harcourt, Rivers State, Nigeria.

²Dept. of Microbiology, Faculty of Science, Federal University Otuoke, Bayelsa State, Nigeria.

³Dept. of Chemical Pathology, University of Port Harcourt Teaching Hospital, Rivers State, Nigeria.

***Corresponding Author: Beauty Echonwere**

Dept. of Medical Laboratory Science, Rivers State University, Port Harcourt, Rivers State, Nigeria.

Article Received on 29/09/2018

Article Revised on 19/10/2018

Article Accepted on 09/11/2018

ABSTRACT

Pregnancy, a physiological state in women of reproductive ages, is associated with an increased requirement of macro and micro nutrients. Iron is a vital micro nutrient for human population because it plays a key role in crucial biological processes. The aim of the study was to evaluate gestational changes in serum iron status and full blood count parameters among pregnant women in Rivers State. We determined serum ferritin, soluble transferrin receptor, serum iron, haemoglobin, haematocrit, mean cell volume, mean cell haemoglobin, mean cell corpuscular haemoglobin and red cell distribution width at 12, 20, and 30 weeks of gestation in a longitudinal study of 428 apparently healthy women who consist of 328 pregnant women and 100 non-pregnant who served as control in Rivers State of Nigeria. Full blood count parameters and their absolute values were measured using Sysmex 300 haematology autoanalyzer, while Ferritin and Iron were assayed using Enzyme Linked Immunosorbent Assay and Photometric methods. Data was analyzed using (Graph Pad Prism version 9.0, and NCSS version 9.0). Results obtained were expressed mean $\pm$ SD, median and 2.5-97.5 percentile. The prevalence of anaemia increased from 39.37%, to 89.33%, and 60.37%, at weeks 12, 20, and 30 respectively. The prevalence of iron deficiency anaemia defined as (sTfR>28nmol/l) was 17.99% at week 12, 17.68% at 20 and 35.98% at week 30. From the results, it has been shown that haemoglobin concentration, serum ferritin, soluble transferrin receptor are tools diagnosing iron deficiency. This study found a progressive increase in development of IDA, even with increase iron demand by fetus economic. We had provided data and evidence on changes in serum iron parameter in pregnancy, and further asserts that these parameters are key in the diagnosis of IDA in pregnancy.

KEYWORDS: Iron, deficiency, ferritin, anaemia, pregnancy, Rivers State.

INTRODUCTION

Iron deficiency anemia of pregnancy is common, especially in Africa. It is not unconnected with adverse fetal and maternal outcomes which includes increased incidences of low birth weight, maternal mortality and preterm labor (Saeed *et al.*, 2002). Pregnancy is associated with an increased requirement of macro and micro nutrients. Screening for anemia alone is not sufficient to diagnose iron deficiency and evaluation of haemoglobin normally reveals facts about anaemia especially when the reserve of iron in the body is depleted (Milman, 2006). Pregnancy, a physiological state in women of reproductive ages, is associated with an increased requirement of macro and micro nutrients. Iron is a vital micro nutrient for human population because it plays a key role in crucial biological processes.

A study in 2000 by the United Nation Administration Committee on coordination sub-committee on

nutrition showed that only 18% of pregnant women in high income countries are affected compared to 56% in low income countries.

Consequently, this iron usage is compensated through cessation of menstrual period, but the effect is still above average causing iron recommendation for pregnant women (27 mg /day) to surpass that of women without pregnancy. During gestation, required iron increases considerably (near 10-fold), therefore risks of having iron deficiency anaemia are increased during pregnancy. The incidence of anaemia depends on nutritional status and the usage of adequate prenatal supplements.

Infections caused by hookworms and intestinal helminths result in gastrointestinal blood loss leading to decrease of the iron stores and eventually impaired erythropoiesis. They also lead to mal-absorption and inhibition of appetite thereby worsening

micronutrients deficiency and maternal anaemia, (Adinma *et al.*, 2002).

Iron is a vital micro nutrient for human population because it plays a key role in crucial biological processes". In pregnancy, iron is key because of the swift cell and tissue development associated with fetal growth" (Buseri *et al.*, 2008). Approximately 800mg of iron are required in pregnancy, which is far higher than the "230mg of iron that non-pregnant women needed, and the 150mg that may be lost during" delivery via blood loss (Bender, 2003; Bothwell, 2000). Iron deficient mothers, irrespective of anemia, are at risk of delivering iron deficient neonates (Bothwell, 2000; Scholl, 2011; Zhao *et al.*, 2015). Intravenous iron is safe, effective and should be considered early in the treatment paradigm for iron deficient gravidas, irrespective of the presence or absence of anemia. Iron deficiency (ID) is a top-level widespread nutritional deficiency among pregnant women globally (Scholl, 2011) and the key cause of iron-deficiency anaemia in pregnancy". WHO 2015, "estimated that 38% of pregnant women globally are anemic, with a highest incidence in sub-Saharan Africa, and in Nigeria".

"In developing country like Nigeria, most pregnant women are characterized by iron deficiency with no nutritional or iron supplementation during pregnancy, and thus resulting in higher perinatal maternal morbidity and mortality (Allen, 2000), and premature delivery and low birth weight as previously stated" (WHO, 2015; Haider *et al.*, 2013). "Some studies have reported a substantial connection in placental transport of iron and maternal hepcidin concentration" (Van *et al.*, 2013; Ganz & Nemeth 2012; Rehu *et al.*, 2010; Young *et al.*, 2008). "The aim of this research focused on evaluating the gestational changes in haematological parameters and iron status in different trimesters among pregnant women in Rivers State".

MATERIALS AND METHODS

Study Design

The study was a longitudinal research performed on 428 apparently healthy women of reproductive ages between August 2017 and April 2018. They comprised 328 women with pregnancy and 100 women without pregnancy who served as Control and were all resident in Rivers State, Nigeria.

Study Setting

This study was done in Rivers State, located at the South-South zone of Nigeria with a population of 5,198,716 according to 2006 Census report and is located at Coordinates, 4°55'N, 6°50'E. "Rivers State is bounded by the south by Atlantic Ocean, the North by Imo, Abia and Anambra States, to the East by Akwa-Ibom State and to the West by Bayelsa and Delta States". This study was carried out in a tertiary, secondary and nine primary health care facilities, three were located at each senatorial district in Rivers State". "They include the

University of Port Harcourt Teaching Hospital, a major tertiary-care teaching and research facility located at East West Road, Rivers State between latitudes 4°53'58"N, and longitude 6°55'43"E. Braithwaite Memorial Specialist Hospital, a specialist hospital ranked among the largest hospitals in Niger Delta, located at 5-8 Harvey Street, old GRA, Port Harcourt, Rivers State between latitude 4°46'49" N, and longitude 7° 0'50" E and Obio Cottage Hospital, a health facility located at Trans-Amadi Industrial Layout Road, Rumuobiakani, Port Harcourt, between latitude: 4.8340° N, and Longitude: 7.0334° E, at the Rivers South Senatorial District. Model Primary Health Care Centres Iriebe Abonchia, and Yeghe were located at Rivers South East Senatorial District, and Model Primary Health Care Centres Buguma, Ahoada and Omoku were located at Rivers West Senatorial District.

Study Population

This study was carried out on pregnant women who were attending antenatal clinic at Braithwaite Memorial Specialist Hospital (BMSH), University of Port Harcourt Teaching Hospital (UPTH) and selected Primary Health Centres located at each 3 senatorial districts in Rivers State". The non-pregnant control women were age-matched female members of staff and students of Rivers State university Port Harcourt, BMSH and UPTH in Rivers State. The biodata and medical history of each of the apparently healthy pregnant subjects who were attending the antenatal clinic at the mentioned hospitals were obtained. All participants were age matched and were randomly chosen.

Sample Size and Sampling Technique

The sample size was obtained using the formula (Naing *et al.*, 2006). Prevalence rate of anaemia in pregnant women receiving regular supplements is" 75% (Olujimi *et al.*, 2014). $n = Z^2 \times P(1 - P)/d^2$

Where n = Sample size

Z= Confidence interval 95%-1.96

P = Prevalence rate 75.0%

d = degree of accuracy 0.05

$n = 1.96^2 \times 0.750(1-0.750)/0.05^2$
=288

20% Attrition = 58

288+58 = 346

Informed Consent

All participants of this study registered informed consent to take part after successful completion of the Questionnaire administered to each of them. "The ethical committee of the University of Port Harcourt Teaching Hospital Port Harcourt endorsed the study"

Ethical Approval

Ethical Approval was granted for the study by the ethical Committee of University of Port Harcourt Teaching Hospital, Rivers State.

LABORATORY ANALYSIS

Sample Collection

Seven milliliters (7ml) of venous sample was taken from each participant of which 5ml of the blood was added to a plane sarstedt monovette, for determination of ferritin, serum iron, serum transferrin receptor and TIBC concentration while 2ml of the blood was added to dipotassium ethylene diamine tern-acetic acid (EDTA) plastic micro-container to the final concentration of 2.0mg/ml and mixed for full blood count.

Quantitative Determinant of Human Soluble Transferrin Receptor (sTfR)

Method: Accu-bind Microplate Enzyme Immunoassay, Colorimetric (ELISA technique as described by Vikstedt 2004). Product code: 8625 -300

Quantitative Determination of serum ferritin

Method: Accu-Bind Microplate Immunoassay Assay. ELISA technique as described by Tietz (1999). Product code: 2825-300.

Analysis of Complete blood count Red

Method: (Sysmex XP-300 Automated CBC Haematology Analyzer) Coulter

Haematology Analyzer are used widely to count and characterize blood cells for disease detection and monitoring. The three main physical technologies used in haematology analyzer are: electric impedance, flow cytometry and fluorescent flow cytometry. They are used in combination with chemical reagents that lyse or alter blood cells to extend the measurement parameters.

Statistical Analysis

Graph Prism 6.1 and National Council of Social Science (NCSS 9.0) were used to analyze the data generated. Normality of distribution was tested using kolmogorov smirnov test. Data were presented in mean values of standard deviation for normal distribution and non-parametric data were presented in median values. Group differences were determined by student's t test and Analysis of Variance (ANOVA) for two and three groups respectively. Correlation analysis was performed using Pearson correlation. Association between variables with Hepcidin were measured by linear regression, and hepcidin diagnostic test accuracy (Area Under the Receiver Operating Curve – AUC^{ROC}), Sensitivity, Specificity, Cutt off for iron deficiency anaemia at each time points were assessed. An error probability $p(\leq 0.05)$ was considered significant.

RESULTS

A total of 466 subjects were initially enrolled into our longitudinal study. Of this number, 428 were finally enrolled, while 18 were excluded. These were subjects who had abortion, lost contact, or deliberately refused to continue with the study. The enrolled subjects were all apparently healthy and comprised 328 pregnant and 100 non-pregnant control subjects.

Comparisons were made in the haematological parameters between trimesters of pregnancy and control. Significant differences ($p < .05$) were observed for all parameters between all pairs of trimesters and control except for the Mean Cell Haemoglobin (MCH) between 3rd trimester and control; and the Mean Cell Haemoglobin Concentration (MCHC) between each of 1st trimester and control and 3rd trimester of pregnancy and control ($p > .05$). The Haemoglobin concentration in each of the trimesters were significantly lower than that of the control values ($p = .05$ for 1st trimester; $p < .01$ for 2nd and 3rd trimesters). A similar trend was observed in the packed cell volume (PCV) ($p \leq .01$) for all trimesters, and MCH ($p \leq .05$) at 1st and 2nd trimesters only. The mean cell volumes (MCV) and red cell distribution width (RDW) of each trimester were significantly higher than that of the control groups ($p < .01$). Other details are cited in Table 4.1.

Table 4.2 shows the prevalence of anaemia [Haemoglobin (Hb) value < 11.00 g/dl], iron deficiency anaemia (IDA) (ferritin < 15 ng/ml) and elevated serum transferrin receptor (STfR > 28.00 nmol/l) across the various trimesters of pregnancy. Out of a total of 328 pregnant subjects studied, 39.33% had anaemia in the 1st trimester, 89.33% in the 2nd, and 60.37% in the 3rd. IDA was 17.99% in the 1st and 2nd trimesters, and 35.98% in the 3rd. The prevalence of iron deficiency among the subjects defined by elevated STfR (> 28.00 nmol/l) was 0.00% in the 1st trimester. This value, like that of anaemia (Hb < 11.00 g/dl), peaked at 24.09% in the 2nd trimester, and finally settling at 19.51% in the 3rd trimester ($\chi^2 = 75.91$, $p = .00$). More details are cited in Table 4.2.

Table 4.2 shows the prevalence of anaemia [Haemoglobin (Hb) value < 11.00 g/dl], iron deficiency anaemia (IDA) (ferritin < 15 ng/ml) and elevated serum transferrin receptor (STfR > 28.00 nmol/l) across the various trimesters of pregnancy. Out of a total of 328 pregnant subjects studied, 39.33% had anaemia in the 1st trimester, 89.33% in the 2nd, and 60.37% in the 3rd. IDA was 17.99% in the 1st and 2nd trimesters, and 35.98% in the 3rd. The prevalence of iron deficiency among the subjects defined by elevated STfR (> 28.00 nmol/l) was 0.00% in the 1st trimester. This value, like that of anaemia (Hb < 11.00 g/dl), peaked at 24.09% in the 2nd trimester, and finally settling at 19.51% in the 3rd trimester ($\chi^2 = 75.91$, $p = .00$). More details are cited in Table 4.2.

Table 4.3 shows the sensitivity, specificity, and Youden Index of putative haemoglobin cut off values across trimesters of pregnancy. The haemoglobin cut off values, determined as the values with the highest Youden Index, fluctuated from 10.75 g/dl at 12 weeks of gestation (Youden Index = 0.218) to 11.05 g/dl at both the 20th week (Youden Index = 0.702) and 30th week (Youden Index = 0.467) of gestation. Other details are cited in Table 4.3.

The serum ferritin cut off values for assessment of iron status among the pregnant subjects seemed to fluctuate between 20.86 ng/ml at 12 weeks of gestation (Youden Index = 0.248) and 36.89 ng/ml at 20 weeks of gestation. The cut off value was 31.06 ng/ml at week 30 of gestation. Details are cited in Table 4.4.

Table 4.5 shows the sensitivity, specificity, and Youden Index at putative soluble transferrin receptor (STfR) cut off values across trimesters of pregnancy. These values increased from 18.87 ng/ml at week 12 (Youden Index = 0.269) to 23.32 ng/ml in week 20 (0.224); finally decreasing to 20.79 ng/ml at week 30 (Youden Index = 0.418). More details are cited in Table 4.5.

Table 4.1: Comparison of Haematological Parameters between Trimesters of Pregnancy and Control.

Parameter	1 st Trim (Wk. 12)	Control	<i>p</i>	2 nd Trim (Wk. 20)	Control	<i>p</i>	3 rd Trim (Wk. 30)	Control	<i>p</i>
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Hb (g/dl)	11.26 ± 1.08	11.51 ± 1.13	.05*	9.93 ± 0.83	11.51 ± 1.13	.00**	10.77 ± 0.88	11.51 ± 1.13	.00**
PCV (%)	33.91 ± 3.14	35.61 ± 3.23	.00**	34.74 ± 2.62	35.61 ± 3.23	.01*	33.39 ± 2.54	35.61 ± 3.23	.00**
MCH (g/dl)	28.42 ± 2.17	27.48 ± 7.64	.05*	25.22 ± 2.04	27.48 ± 7.64	.00**	27.68 ± 2.75	27.48 ± 7.64	.68
MCHC (g/dl)	32.70 ± 3.40	32.18 ± 1.16	.14	28.09 ± 2.83	32.18 ± 1.16	.00**	32.23 ± 1.19	32.18 ± 1.16	.72
MCV (fl)	84.67 ± 5.78	81.94 ± 8.26	.00**	88.48 ± 5.81	81.94 ± 8.26	.00**	84.67 ± 5.78	81.94 ± 8.26	.00**
RDW (%)	13.86 ± 0.87	13.48 ± 1.10	.00**	14.52 ± 0.98	13.48 ± 1.10	.00**	14.27 ± 0.85	13.48 ± 1.10	.00**

Key: *Mdn* = median, wk = week, t = t-test statistic, *p* = error probability, Trim = trimester Hb = haemoglobin, PCV = Packed Cell Volume, MCH = mean cell haemoglobin, MCHC = mean cell haemoglobin concentration, MCV = mean cell volume, RDW = red cell distribution width, *Significant difference observed, *p* < .01, 5 using the paired t-test.

Table 4.2: Prevalence of Anaemia and Iron Deficiency Anaemia across the Various Trimesters of Pregnancy.

Parameter	Trimester				<i>p</i>	Trimester		<i>p</i>
	1 st (Wk.12)		2 nd (Wk.20)			3 rd (Wk.30)		
	n = 328		n = 328			n = 328		
	Freq.	%	Freq.	%		Freq.	%	
Anaemia (Hb < 11.00 g/dl)	129	39.33	293	89.33	.00**	198	60.37	.00**
IDA (Ferritin < 15.00 ng/ml)	59	17.99	58	17.68		118	35.98	
Elevated STfR (STfR > 28.00 nmol/l)	0	0.00	79	24.09		64	19.51	

Key: Wk. = week, n = total number, *p* = error probability, Freq. = frequency, Hb = haemoglobin concentration, STfR = serum transferrin receptor, **Significant association observed with groups in pairs using chi-square, *p* < .01

Table 4.3: Sensitivity, Specificity, and Youden Index at Putative Haemoglobin Cut off Values across Trimesters of Pregnancy.

Hb Cut off (g/dl)	1 st Trimester (12 weeks)			2 nd Trimester (20 weeks)			3 rd Trimester (30 weeks)		
	Sensitivity	Specificity	Youden Index	Sensitivity	Specificity	Youden Index	Sensitivity	Specificity	Youden Index
10.75	37.80	84.00	0.218*	82.32	84.00	0.663	46.04	84.00	0.300
11.05	42.38	79.00	0.213	91.16	79.00	0.702*	67.68	79.00	0.467*
12.75	91.77	12.00	0.038	100.00	12.00	0.120	98.17	12.00	0.102
13.00	96.04	8.00	0.040	100.00	8.00	0.080	100.00	8.00	0.080
13.50	100.00	1.00	0.010	100.00	1.00	0.010	100.00	1.00	0.010

Key: Hb = haemoglobin, Sensitivity = true positive detection rate, specificity = true negative detection rate, Youden Index = (sensitivity/100 + specificity/100)-1, *Hb cut off with the highest Youden Index for each Trimester

Table 4.4: Sensitivity, Specificity, and Youden Index at Putative Ferritin Cut off Values across Trimesters of Pregnancy.

Ferritin Cut off (ng/ml)	1 st Trimester (12 weeks)			2 nd Trimester (20 weeks)			3 rd Trimester (30 weeks)		
	Sensitivity	Specificity	Youden Index	Sensitivity	Specificity	Youden Index	Sensitivity	Specificity	Youden Index
20.86	76.83	48.00	0.248*	46.65	52.00	-0.0140	53.96	52.00	0.060
31.06	46.65	64.00	0.107	74.09	36.00	0.101	92.99	36.00	0.290*
36.89	34.76	68.00	0.028	84.76	32.00	0.168*	92.99	31.00	0.240
41.21	30.49	76.00	0.065	89.63	24.00	0.136	96.34	24.00	0.203
51.61	20.43	80.00	0.004	91.46	16.00	0.075	98.17	16.00	0.142

Key: Sensitivity = true positive detection rate, specificity = true negative detection rate, Youden Index = (sensitivity/100 + specificity/100)-1, *Ferritin cut off with the highest Youden Index for each Trimester

Table 4.5: Sensitivity, Specificity, and Youden Index at Putative Soluble Transferrin Receptor Cut off Values across Trimesters of Pregnancy.

STfR Cut off (ng/ml)	1 st Trimester (12 weeks)			2 nd Trimester (20 weeks)			3 rd Trimester (30 weeks)		
	Sensitivity	Specificity	Youden Index	Sensitivity	Specificity	Youden Index	Sensitivity	Specificity	Youden Index
17.28	78.35	44.00	0.224	59.76	56.00	0.158	77.13	56.00	0.331
18.87	89.94	37.00	0.269*	50.91	63.00	0.139	68.29	63.00	0.313
20.79	92.38	22.00	0.144	42.07	79.00	0.211	62.80	79.00	0.418*
23.32	62.50	52.00	0.145	38.41	84.00	0.224*	51.22	83.00	0.342
30.28	100.00	9.00	0.09	14.94	89.00	0.039	7.01	89.00	-0.034

Key: STfR = Soluble transferrin receptor, Sensitivity = true positive detection rate, specificity = true negative detection rate, Youden Index = (sensitivity/100 + specificity/100)-1, *STfR cut off with the highest Youden Index for each Trimester

DISCUSSION

The haematological parameters studied in Table 4.1 shows significant differences for all pairs between trimesters and control ($p < .05$), except the MCH in the third trimester ($p = .68$), and MCHC of first and third trimester ($p = .14$; $p = .72$) respectively but tend to normalize at third trimester with first trimester values. The haemoglobin and haematocrit values had their peak decreases at week 20, which is considered a late stage of iron deficiency, thus considered late indicators of iron deficiency. Our findings agree with studies by Okpokam *et al.* (2015) and Das *et al.* (2013), the duo reported that the high haemoglobin level in first trimester is decreased in second trimester while compensatory mechanisms (maternal plasma volume and increased atrial-natriuretic peptides) increases haemoglobin in the last trimester. The non-significant decreases seen in MCH and MCHC is in line with the studies of David *et al.* (2018), Chanatepie *et al.* (2016), and Odhiambo *et al.* (2015), on haematological profiles in normal pregnant women and haematological parameters in pregnancy respectively, were they reported non-significant increase in MCH as diagnostic of iron deficiency, sideroblastic anaemia, lead poisoning, anaemia of chronic disease and thalassemia, and MCHC as diagnostic of hereditary spherocytosis, hemolysis and sickle cell disease.

Results from Table 4.2 showed the prevalence of anaemia [Haemoglobin (Hb) value < 11.00 g/dl], iron deficiency anaemia (IDA) (ferritin < 15 ng/ml), and elevated serum transferrin receptor (STfR > 28.00 nmol/l) across the various trimesters of pregnancy. Out of a total of 328 pregnant subjects studied, 129 (39.33%) had anaemia in the first 12 weeks of gestation, 293 (89.33%) at week 20, and 198 (60.37%) at week 30 ($p = .00$). The prevalence of anaemia in this study was higher than that obtained by Bah *et al.* (2017) who obtained prevalence of 34.62% at week 14.50% at week 20, and 54.62% at week 30 of gestation, in Gambia. In addition, the prevalence of anaemia in this study far exceeds that obtained by Idowu *et al.* (2005) across the various trimesters of pregnant women in Abeokuta (9.8% in 1st trimester, 63.5% in the 2nd, and 26.6% in the 3rd). Nonetheless, a similar trend was observed in comparison with these two studies: anaemia peaked at the 2nd trimester of gestation. The increased anaemia in the 2nd trimester of pregnancy may be due to rapid growth of the

fetus, as there seems to be an inverse relationship between the maternal Hb and the fetal birth weight (Kumar *et al.*, 2013). Poor diet, with especially inadequate bioavailable iron, among the women could be another likely factor (Dei-Adomakoh, 2014).

Iron Deficiency Anaemia (IDA) was 17.99% in the 1st trimester, 17.68% in the 2nd trimester, and 35.98% in the 3rd (Table 4.2). The trends in our results are in agreement with those previously reported by Okafor *et al.* (2013) who obtained the highest prevalence of IDA in the 3rd trimester of pregnancy (20.00%) among women in Calabar, Nigeria. The sample size in our study was however larger and hence provided better statistical information for the purpose of decision. Results from Table 4.2 also show that the prevalence of IDA defined by STfR > 28.00 nmol/l was nil at 12 weeks of gestation and peaked at 20 weeks of gestation (24.09%), with a terminal decline to 19.51% by week 30; and are similar to our result of haemoglobin concentration. In a study among 230 pregnant women in Seychelles, the prevalence of IDA defined by STfR > 28.00 nmol/l was determined as 20% in the 3rd trimesters, similar to our study. Transferrin receptors (TfRs) are proteins that comprise the putative pathway for cellular iron absorption in lieu of physiological needs. In hypoferraemia, these proteins are elevated on the surface of bone marrow (BM) erythroid precursors, this results in sequestration of iron in the cells (Skikne, 2008). These results from our study seems to show that a large proportion of the pregnant women were iron deficient, this could possibly because of parity, poor dietary habits and socio-economic status (Raza *et al.*, 2011; Obasi & Nwachukwu, 2013). We therefore, recommend further studies across the three partitions of pregnancy and at term to ascertain the underlining cause of this decrease.

CONCLUSION

These results from our study show that a large proportion of the pregnant women were iron deficient, this could possibly because of parity, poor dietary habits and socio-economic status. Early differential diagnosis in pregnant women could provide a basis for choosing beneficial therapeutic approach in the treatment of iron deficiency anaemia.

REFERENCES

1. Saeed, G.A., Khattak, N. & Hammid, R. Anemia in Pregnancy and Spontaneous Preterm Birth. *Journal of Pakistan Institute of Medical Science*, 2002; 13(2): 698-701.
2. Milman, N., Agger, O.A. & Nielsen, O.J. Iron Supplementation During Pregnancy. Effect on Iron Status Markers, Serum Erythropoietin and Human Placental Lactogen. A Placebo Controlled Study in 207 Danish Women. *Dan Medical Bulletin*, 1991; 38: 471-476.
3. Adinma J, I., Ikechebel, J.I., Onyejimbe, U.N., Amilo, G. & Adinma, E.. Influence of Ante-Natal Care on the Haematocrit Value of Pregnant Nigerian Igbo Women. *Tropical Journal of Obstetrics Gynecology*, 2002; 19: 68-70.
4. Buseri, F.I., Uko, E.K., Jeremiah, Z.A. & Usanga, E.A. "Prevalence and Risk Factors of Anaemia Among Pregnant Women in Nigeria. *Open Journal of Hematology*, 2008; 2: 14-19.
5. Bender, D.A. Do we Really Know Vitamin and Mineral Requirement, for Infants and Children? *Journal of Royal Society for the Promotion of Health*, 2003; 123: 154-158.
6. Zhao G, Xu G, Zhou M, Prenatal iron supplementation reduces maternal anemia, iron deficiency, and iron deficiency anemia in a randomized clinical trial in China, but iron deficiency remains widespread in mothers and neonates. *J. Nutr.*, 2015; 145: 1916-1923.
7. Bothwell TH. Iron requirements in pregnancy and strategies to meet them. *American Journal of Clinical Nutrition.*, 2000; 72(1) :257S-2264.
8. Scholl T. Maternal iron status: relation to fetal growth, length of gestation, and iron endowment of the neonate. *Nutr Rev.*, 2011; 69(1): S23-S29.
9. Allen, L.H. Anemia and Iron Deficiency: Effects on Pregnancy Outcome. *American Journal of Clinical Nutrition*, 2000; 71: 1280-1284.
10. Van Santen. S., Kroot, J.J., Zijderveld, G., Wiegerinck, E.T., Spaanderman, M.E. & Swinkels, D.W. The Iron Regulatory Hormone Hepcidin is Decreased in Pregnancy: A Prospective Longitudinal Study. *Clinical Chemistry Laboratory Medicine*, 2013; 51: 1395-1401.
11. Ganz, T. & Nemeth, E. Iron Metabolism: Interactions with Normal and Disordered Erythropoiesis. *Cold Spring Harb Perspect, Medicine*, 2013; 2(5): 16-28.
12. Rehu, M., Punnonen, K., Ostland, V., Heinonen, S., Westerman, M., Pulkki, K. Maternal Serum Hepcidin is Low at Term and Independent of Cord Blood Iron Status. *European Journal of Haematology*, 2010; 85: 345-352.
13. Young, M.F., Griffin, I. & Pressman, E. Maternal Hepcidin is Associated with Placental Transfer of Iron derived from Dietary Heme and Nonheme Sources. *Journal of Nutrition*, 2008; 142: 33-39.
14. Naing, L., Winn, T. & Rusli, B.N. Practical Issues in Calculating the Sample Size for Prevalence Studies. *Archives of Orofacial Sciences*, 2006; 1: 9-14.
15. Olujimi, A., Olatunbosun, A.M., Abasiattai, E. A., Bassey, R. S., James, G. I. & Anyiekere, M. Prevalence of Anaemia among Pregnant Women at Booking in the University of Uyo Teaching Hospital, Uyo, Nigeria. *BioMedical Research International*, 2014; 10: 115-116.
16. Okpokam, D.C., Okhormhe, Z.A., Ernest, N.A, Udoh, K.N. & Akpotuzor, J.O. Comparative Study of some Haematological Parameters of Pregnant Women in Akpabuyo Local Government Area of Cross Rivers State, Nigeria Der Pharmacia. *Lettre*, 2015; 7: 1-5.
17. Das, S., Char, D., Sarkar, S., Saha, T.K. & Biswas, S. Study of Haematological Parameters in Pregnancy. *International Organization Scientific Research Journal of Dental and Medical Science*, 2013; 12: 14-44.
18. David, N.Z., Eliud, N.M. & George, O.O. Haematological Profile of Normal Pregnancy Women. *Journal of Blood Lymph*, 2018; 8(2): 220-221.
19. Chantepie, S.P., Parienti, J.J., Salaun, V., Benabed, K. & Cheze, S. The Prognostic Value of Hematogones in Patients with acute Myeloid Leukaemia. *American Journal of Haematology*, 2016; 91: 566-570.
20. Odhiambo et al, Odhiambo, C., Oyaro, B., Odipo, R., Otieno, F. & Alemnji, G. Evaluation of Locally Established Reference Intervals for Haematology and Biochemistry Parameters in Western. Kenya. *Public Library of Science*, 2015; 10: 123-140.
21. Kumar, K. J., Murthy, D. S., Sujatha, M. S., & Manjunath, V. G. Maternal Anemia in various Trimesters and its Effect on Newborn Maturity: an Observational Study. *International Journal of Preventive Medicine*, 2013; 4(2): 193-199.
22. Raza, N., Sarwar, I., Munazza, B., Ayub, M. & Suleman, M. Assessment of Iron Deficiency in Pregnant Women by Determining Iron Status. *Journal of Ayub Medical College Abbottabad*, 2011; 23(2): 36-40.