ORIGINAL ARTICLE

Rates and determinants of peripartum and puerperal anemia in Enugu, Nigeria

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Abstract

Background: Anemia in the peripartum or postpartum period could pose a significant risk for maternal morbidity and mortality during and after delivery.

Aims: To determine the rates of anemia at term and in the puerperium and describe the determinants of puerperal anemia among a cohort of women with both normal and cesarean deliveries, following uncomplicated term singleton pregnancies in Enugu, Nigeria.

Methods: A prospective longitudinal study involving women with uncomplicated singleton pregnancies who were recruited at term at two tertiary maternity centers and were followed up with the determination of hemoglobin and ferritin concentrations till 6 weeks after delivery. Data were analyzed with descriptive and inferential statistics at 95% level of confidence using the Statistical Package for Social Sciences computer software version 20.0 for Windows (IBM Corporation, Armonk, NY, USA).

Results: A total of 202 women were studied. The mean hemoglobin levels at term, 48 h, and 6 weeks postpartum were 11.1 ± 0.9 g/dL, 10.5 ± 0.8 g/dL, and 11.2 ± 1.0 g/dL, respectively. The proportions of women with anemia at term, 48 h, and at 6 weeks postpartum were 46.0%, 72.8%, and 47.5%, respectively. Forty-eight hours postdelivery, 17.3% had anemia with low serum ferritin compared to 7.4% by 6 weeks postdelivery. Anemia at term (adjusted odds ratio [aOR] 2.02; 95% confidence interval [CI] 1.01, 4.05), anemia at 48 h postdelivery (aOR 6.17; 95% CI 3.30, 11.6), and low ferritin at 48 h postdelivery (aOR 3.11; 95% CI 1.51, 5.09) all increased the likelihood of anemia at 6-week postpartum.

Conclusions: A high proportion of low-risk pregnant women in the study centers could go through delivery with undetected anemia and this would predispose to high rates of postpartum anemia. Screening of low-risk women at term and in the immediate postdelivery periods may be necessary to improve detection of such cases.

Key words: Anemia, Nigeria, parturient, peripartum, postpartum, puerperium

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Introduction

Anemia in pregnancy is a state in which the hemoglobin concentration in an individual has fallen below a threshold

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lying at two standard deviations below the median for a healthy population of same age, sex, and stage of pregnancy.[1] It is also defined as a condition in which the number of red blood cells (and consequently their oxygen-carrying capacity) is insufficient to meet the body's physiologic needs.[2]

Anemia in pregnancy is a condition of public health importance with a worldwide prevalence of 41.8%.[3] It is seen in both the developed and developing countries. In America and Europe, the prevalences are 24.1% and 25.1%, respectively.[3] In Africa, however, a prevalence of 48.1% was reported by the World Health Organization (WHO).[3] Anemia is estimated to wholly account for 20% of maternal death and partly contribute to 50% more of all maternal deaths worldwide.[4] Iron deficiency anemia which is the most common cause of anemia in pregnancy underlies 115,000 maternal death per year.[5]

Women in sub-Saharan Africa may have higher risks factors for antepartum anemia than their counterparts in Western countries because of the endemic poverty and malaria in the subregion.[6,7] Untreated antepartum anemia could predispose to puerperal anemia.[8] Previous studies done in Enugu or other parts of South Eastern Nigeria on anemia in the obstetric population were mainly during the antepartum period such that little is known about the prevalence of puerperal anemia.[6,9] A recent study on postpartum morbidity in Enugu identified anemia to be one of the most common causes of puerperal maternal morbidity.[10] However, we found no studies on the determinants of puerperal anemia in this part of the country. The aims of this study were therefore to determine the rates and determinants of peripartum and puerperal anemia among a cohort of women with both normal and caesarean deliveries, following uncomplicated term singleton pregnancies at two university teaching hospitals in Enugu, Southeast Nigeria.

Methods

The study took place in the University of Nigeria Teaching Hospital (UNTH), Ituku-Ozalla and Enugu State University Teaching Hospital, Parklane, both in Enugu. Both hospitals were tertiary health care centers that offered multidisciplinary services both at secondary and tertiary levels. They served as referral centers also to hospitals in other states in Southeast Nigeria. The hospitals were also training and research centers. The annual delivery rates ranged between 1500 and 1800 in each hospital.

Both hospitals operated identical protocols for antenatal and postnatal care. The protocol of care following delivery entailed monitoring their vital signs 4 hourly for at least 6 h immediately following delivery. Women who had normal delivery were discharged after 24 h. Routine hematinics consisting of tablets of ferrous sulfate 200 mg twice daily and folic acid once daily were given for variable durations at the obstetrician's discretion. Determination of hemoglobin concentration after normal delivery was also at the discretion of the obstetrician; however, it was routine practice following caesarean delivery. Those who had cesarean section had intravenous fluids, antibiotics, and analgesics for at least 24 h. Their vital signs were also monitored 4 hourly for the first 24 h following delivery. They were commenced on oral intake after 24 h and their parenteral medications continued for at least 72 h. They were discharged on the 5th postoperative day except those with subumbilical midline skin incision repaired with nylon for which sutures were removed on the 7th postoperative day before discharge.

The study population included all women with no medical or obstetric prenatal complication of pregnancy who carried singleton pregnancies to term and who delivered in the study centers between the gestational ages of 37 and 41 weeks plus 6 days. Inclusion criteria were term singleton pregnancy, the absence of any antenatal complications, history of intake of at least two doses of intermittent preventive therapy with sulfadoxine–pyrimethamine, and consent to participate in the study. Exclusion criteria included history of hematological disorders such as bleeding disorders, sickle cell anemia; comorbidities such as renal diseases, preeclampsia/eclampsia, diabetes mellitus, HIV Infections, fever (defined as temperature equal to or above 38°C), and antenatal blood transfusion or parenteral hematinics.

This was a prospective longitudinal study[11] which took place from December 2013 to March 2014. Participants were recruited consecutively at term and followed up through delivery till 6-week postpartum. Term was defined as 37 completed weeks to 41 weeks plus 6-day gestation. Participants were counseled on the importance of the study, the fact that those who have normal delivery may stay an extra day in the hospital with no additional cost, and that blood samples would need to be collected on three occasions. Upon recruitment, sociodemographic and antenatal characteristics were obtained with the aid of interviewer-administered structured proforma. Five milliliters of blood was also collected in ethylenediaminetetraacetic acid bottle for the determination of hemoglobin concentration. Subsequently, further data were collected prospectively during follow-up and these included gestational age at delivery, estimated blood loss at delivery, weight of the baby, hemoglobin concentration, and serum ferritin level at 48 h and 6 weeks postdelivery, and compliance with and duration of intake of routine antenatal and postnatal hematinics. Hemoglobin estimation was done by automated process using the MYTHIC 22 Auto Hematology Analyzer (OPHEE SA, Geneva-Switzerland). Serum ferritin assay was done by enzyme-linked immunosorbent assay (ELISA) technique

using ELISA machine Stat Fax-2600 (Awareness Tech Inc., Palm city, FL, USA) using the Assay Max Human Ferritin ELISA kit. The assay employed quantitative sandwich enzyme immunoassay technique. The samples of sera were made to undergo series of incubation and washing at different intervals using the reagent and buffer solutions till optimal color density was obtained. The absorbance was then read immediately on a microplate reader at a wavelength of 450 nm.

Data were analyzed with the Statistical Package for Social Sciences computer software version 20.0 for windows (IBM Corporation, Armonk, NY, USA). Peripartum period was defined as the period from term to 2 weeks after delivery. Anemia was defined as hemoglobin concentration <11.0 g/dL: Mild anemia was defined as hemoglobin concentration of 9 g/dL to 10.9 g/dL while moderate anemia was defined as 7.0 g/dL to 8.9 g/dL.[2] The normal range of serum ferritin for women for the study centers was 15–300 μg/L. Categorical variables were compared using Chi-square and Fisher's exact tests where applicable. Comparison of means was done with Student's *t*-test as appropriate. Pearson correlation coefficient was used to describe the linear association between numerical variables. A preliminary bivariate analysis was carried out to determine factors that were associated with anemia at 6-week postpartum. Variables that had significant association with anemia at 6 weeks were then selected for multivariate analysis (logistic regression) to determine the predictors of anemia. *P* value for significance was set at ≤0.05.

Ethical clearance was obtained from the Research Ethics Committee of the UNTH.

Results

Of the 216 women who were recruited during the period of the study, 202 completed the study and were used for analysis. The rest were excluded or lost to follow-up for various reasons, namely 6 women relocated out of Enugu before their 6-week appointment; 6 refused blood sample collection at 6 weeks visit and excluded from the analysis; 1 person developed severe secondary postpartum hemorrhage necessitating blood transfusion; and 1 developed puerperal fever and needed a course of antibiotics. Both were also excluded from the analysis.

The average age of participants was 30.3 ± 4.6 years and the mean gestational age at delivery was 38.3 weeks. Mean estimated blood loss at delivery was 276.0 mL (range: 150 mL–450 mL). The mean birth weight of the babies was 3.3 ± 0.4 kg. Table 1 shows sociodemographic characteristics of the participants. All the participants were married Christians and of Igbo ethnic group.

The mean values of hemoglobin at term, 48 h, and during the puerperium were 11.1 ± 0.9 (9.0–13.4), 10.5 ± 1.0 (8.3–13.0), and 11.2 ± 1.0 (8.5–14.2), respectively. There were significant differences between the mean hemoglobin at term and the mean hemoglobin at 48 h ($t = 1.46$, $P < 0.01$) and at 6 weeks ($t = -2.12$, $P = 0.04$). The difference between the mean hemoglobin at 48 h and the mean hemoglobin concentration at 6 weeks was also significant ($t = -11.90$, $P < 0.01$).

Correlation analysis showed a negative correlation between volume of blood loss at delivery and hemoglobin concentration at 48 h (Pearson's correlation coefficient, $r = -0.26$, $P < 0.01$) and at 6 weeks ($r = -0.07$, $P < 0.01$).

Table 1: Sociodemographic and obstetric characteristics of the study subjects

Variable	Number (%) (*n*=202)
Age group	
20-29	82 (40.6)
30-39	116 (57.4)
40-49	4 (2.0)
Educational status	
Primary level	6 (2.97)
Secondary level	48 (23.80)
Tertiary level	148 (73.30)
Employment status	
Employed	129 (63.90)
Unemployed	73 (36.10)
Parity	
Nullipara	58 (28.7)
Para 1-4	120 (59.4)
Para 5 and above	24 (11.9)
Mode of delivery	
Cesarean	82 (40.6)
Vaginal	120 (59.6)
Interval since last delivery (months)	
<12	32 (15.8)
13-24	142 (70.3)
>25	28 (13.9)
Breast-feeding	
Exclusive	124 (61.4)
Not exclusive	78 (38.6)
Return of menses by 6 weeks	
Yes	10 (5.0)
No	192 (95.0)

Table 2: Pattern of anemia

Variable (g/dL)	Proportion of parturients (*n*=202) (%)		
	Term	48 h postdelivery	6-week postdelivery
Mild anemia 9-10.9	73 (36.0)	121 (59.8)	81 (40.0)
Moderate anemia 7-8.9	20 (10.0)	25 (12.5)	35 (17.5)
Severe anemia <7l	0 (0.0)	1 (0.5)	0 (0.0)

Table 3: Association of sociodemographic and obstetric characteristics with anemia at 6 weeks

Characteristic	Anemia at 6 weeks (*n*=202) (%)		*P*
	Yes	No	
Age group			
20-29	36 (17.8)	46 (22.8)	0.29
30-39	58 (28.7)	58 (28.7)	
40-49	2 (1.00	2 (1.0)	
Parity			
Nullipara	28 (13.7)	30 (14.9)	0.49
Para 1-4	54 (26.7)	66 (32.7)	
Para 5 and above	14 (6.9)	10 (5.0)	
Employment			
Unemployed	44 (21.8)	29 (14.4)	0.01*
Employed	54 (26.7)	75 (37.1)	
Education			
Primary	3 (1.5)	3 (1.5)	0.48
Secondary	18 (8.9)	30 (14.9)	
Tertiary	46 (22.8)	102 (50.5)	
Mode of delivery^			
Cesarean	38 (18.8)	44 (21.8)	0.44
Vaginal	49 (24.3)	71 (35.1)	
Interval since last delivery (months)			
<12	12 (5.9)	20 (9.9)	0.66
13-24	42 (20.8)	100 (49.5)	
>25	8 (4.0)	20 (9.9)	
Breast-feeding^			
Excusive	24 (11.9)	100 (49.5)	0.85
Not exclusive	8 (4.0)	70 (34.7)	
Return of menses by 6 weeks^			
Yes	5 (2.5)	5 (2.5)	0.25
No	62 (30.7)	30 (64.4)	
Anemia at term^			
Yes	74 (36.6)	20 (9.9)	<0.001*
No	22 (10.9)	86 (42.6)	
Anemia at 48 h postdelivery^			
Yes	92 (45.5)	55 (27.2)	<0.001*
No	4 (2.0)	51 (25.2)	
Low ferritin at 48 h postdelivery^			
Yes	43 (21.3)	16 (7.9)	<0.001*
No	53 (26.2)	90 (44.6)	

*Significant; ^Fishers exact test

Table 2 shows the pattern of anemia among the cohort of women. The proportions of women with anemia at term, 48 h after delivery, and at 6 weeks postpartum were 46.0%, 72.8%, and 47.5%, respectively. Figures 1 and 2 are pie charts showing hemoglobin levels according to serum ferritin concentrations at 48 h and at 6 weeks, respectively. Forty-eight hours postdelivery 17.3% had low hemoglobin with low serum ferritin (iron deficiency anemia) compared to 7.4% by 6-week postdelivery.

Table 4: Logistic regression to determine the predictors of anemia at 6 weeks

Variable	B coefficient	OR	95% confidence limits
Employment status			
Unemployed	13.62	0.82	0.42-1.08
Employed^			
Anemia at term			
Yes	7.74	2.02	1.01-4.05*
No^			
Anemia at 24 hours			
Yes	4.12	6.17	3.3-11.6*
No^	-	-	-
Low ferritin at 24 h			
Yes	5.10	3.11	1.51-5.09*
No^	-	-	-

^Reference predictor variable. OR=Odds ratio

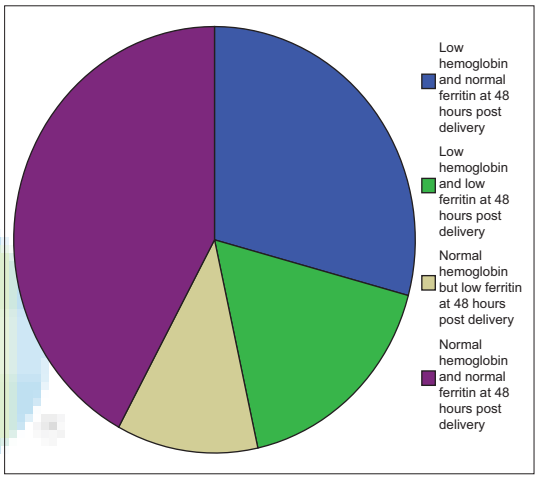

Figure 1: Classification of 48-h postpartum hemoglobin levels

Table 3 summarizes the bivariate analysis to determine the association of sociodemographic and obstetric characteristics of participants with the occurrence of anemia at 6-week postdelivery. Employment status, anemia at term, anemia at 48 h postpartum, and low ferritin concentration at 48 h postpartum had significant association with occurrence of anemia at 6 weeks postdelivery.

Table 4 summarizes the multivariate analysis (logistic regression) to determine the predictors of anemia at 6-week postpartum. Anemia at term increased the likelihood of anemia at 6 weeks (adjusted odds ratio [aOR] 2.02, 95% confidence interval [CI] 1.01, 4.05). Anemia at 48 h postdelivery increased the likelihood of anemia at 6 weeks (aOR 6.17, 95% C.I. 3.30, 11.6). Low ferritin at 48 h postdelivery also increased the likelihood of anemia at 6-week postpartum (aOR 3.11 95% C.I. 1.51, 5.09).

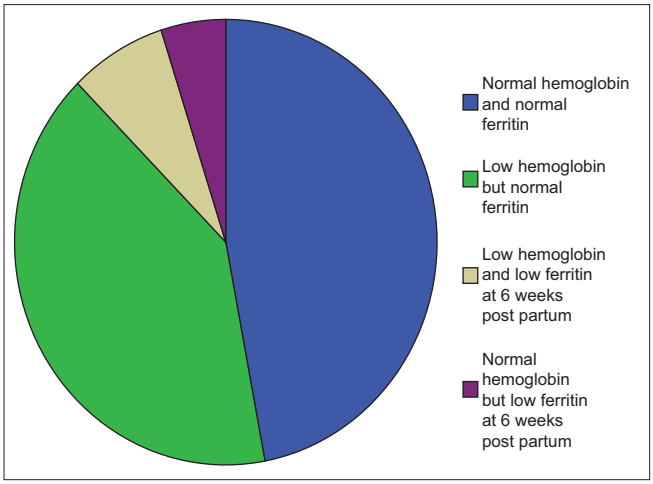

Figure 2: Classification of 6-week postpartum hemoglobin levels

Discussion

This is the first of a two-part report of a survey on postpartum hematological status among parturient women in Enugu city in Southeast Nigeria. The application of the WHO definition of anemia in pregnancy[2] in this study was intended to enable comparison with studies from other parts of the world. This differs from reports which had tended to use 10 g/dL as threshold value for defining anemia in pregnancy in Nigeria.[12-15]

Generally, our results agreed with previous studies which showed that in the puerperium, an initial reduction in the values of hemoglobin and serum ferritin was followed by a progressive rise to the prepregnancy values by 6 or more weeks postpartum.[16] Prepartum mean hemoglobin in this study dropped by 0.7 g/dL (6.3%) 48 h after delivery. However, by the end of puerperium, at 6-week postpartum, the mean hemoglobin level rose to approximate the prepartum value. This was similar to findings made by Onwukeme[12] that mean hemoglobin level rose to prepregnancy value by 42 days postpartum. A similar observation was made by Richter *et al.*[17] in which they assessed the postpartum hematological status of women with respect to possible functional iron deficiency and erythropoiesis. They found that mean hemoglobin decreased by 0.9 g/dL from 12.5 g/dL on day 0 to 11.6 g/dL on day 2, then rose to 12.6 g/dL on day 42 postpartum. Krafft *et al.*[18] and Milman *et al.*[19] also made similar observation that hemoglobin increased in all patients from postpartum weeks 1 to 12 but more so in iron-supplemented women.

Our results also showed very high levels of peripartum anemia. The high level of anemia at term among women receiving standard antenatal care is worrisome. The practice of applying a lower than the 11.0 g/dL threshold for defining anemia,[13-15] which was the practice in the study centers, might have been partly responsible for this. Such lower hemoglobin threshold for defining anemia in pregnancy could have allowed many cases of mild anemia to be missed by the attending physicians of the participants. The argument by Lawson that "serious harm to the mother or fetus did not occur until hemoglobin was below 10 g/dl or packed cell volume was <30%"[20] ignored the fact that any amount of harm to the mother or fetus could be deleterious to health either in the short or long term. Such argument would also appear to accept a lower standard of health for Africans and should therefore no longer be upheld.

The finding of 73% prevalence of anemia 48 h postdelivery is higher than a previous report.[21] The high level of anemia in the immediate postdelivery period could be due to the finding that many of the participants were already anemic at delivery. It could also be due to the acute blood loss during delivery and hemodilution from intravenous infusion in some cases. This was supported by the finding in this study that blood loss at delivery significantly correlated negatively with hemoglobin level at 48 h postdelivery. This was also in keeping with previous studies that observed blood loss at delivery to be a strong predictor/risk factor for postpartum anemia and iron deficiency.[22] It has been estimated that in a person with hemoglobin concentration of 15 g/dL, each milliliter of blood lost from the body results in a loss of 0.5 mg of iron.[23]

At 6-week postpartum, the proportion of women with anemia in our study stood at 47.5%, which was lower than 70% that was recorded at 6 weeks in India by Somdatta *et al*. in a community-based study of postpartum low socioeconomic women in Indian village.[24] The finding in this study was however higher than 42% prevalence of postpartum anemia at 6 weeks reported by Petraro *et al*. in Tanzania using same 11 g/dL hemoglobin cutoff.[25] Unlike our own study, this East-African study did not calculate the proportion of women with anemia in the early puerperium to enable comparison with 6 weeks measurement. Besides, women were recruited in the second trimester of pregnancy and hematinics commenced appropriately and provision for treatment/prophylaxis of other causes of anemia such as malaria and hookworm infestation were made. This could explain why they had lower incidence of postpartum anemia at 6 weeks than in this study.

Anemia at term and at 48 h after delivery was predictive of anemia and iron deficiency at 6 weeks like as was observed in a previous study.[26] This is expected considering that uncorrected prepartum iron deficiency anemia is already a risk factor for postpartum iron deficiency and anemia.[8] Again, prepartum iron insufficiency and anemia make women vulnerable to effects of blood loss at delivery thereby limiting the amount of iron that will return to the iron stores at 6 weeks.[22,26]

The limitations of this study include its hospital-based nature which meant that only women presenting for care could be recruited. This limits the external validity of the findings of this study. Besides, the use of routine hematinics prepartum and postpartum was not to be controlled for as this could have affected the hematological responses of participants. Weekly measurements of levels of hemoglobin and ferritin during the study period if done would have thrown more light on the weekly changes in these parameters during puerperium. This was not done due to heavy financial implication.

Conclusion

We conclude that high rates of peripartum and postpartum anemia among a cohort of low-risk women recruited from two tertiary maternity centers in Enugu, South East Nigeria, suggest that a high proportion of low-risk pregnant women could go through delivery with undetected anemia, and this would predispose to high rates of postpartum anemia. Predictors of maternal anemia at 6-week postpartum included preexisting anemia at term and following delivery. Routine estimation of hemoglobin in low-risk women at term, and at 48 h and 6-week postdelivery may be recommended to improve the detection of cases of anemia.

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Conflicts of interest
There are no conflicts of interest.

References

1. WHO/UNICEF/UNU (World Health Organization/United Nations Children's Fund/United Nations University). Indicators for Assessing Iron Deficiency and Strategies for Its Prevention (Draft Based on a WHO/UNICEF/UNU Consultation, 6-10 December 1993). Geneva: WHO; 1996.
2. WHO. Haemoglobin Concentrations for the Diagnosis of Anaemia and Assessment of Severity. Vitamin and Mineral Nutrition information System. Geneva: World Health Organization; 2011. Available from: http://www.who.int/vmnis/indicators/haemoglobin.pdf. [Last accessed 2014 Sep 30].
3. WHO. Worldwide Prevalence of Anemia 1993-2005. WHO Global Data Base on Anemia, Switzerland; 2008. Available from: http://www.whqlibdoc.who.int/publications/2008/9789241596657_eng.pdf. [Last accessed on 2014 Sep 30].
4. Galloway R, Dusch E, Elder L, Achadi E, Grajeda R, Hurtado E, *et al.* Women's perceptions of iron deficiency and anemia prevention and control in eight developing countries. Soc Sci Med 2002;55:529-44.
5. Sanghvi TG, Harvey PW, Wainwright E. Maternal iron-folic acid supplementation programs: Evidence of impact and implementation. Food Nutr Bull 2010;31 2 Suppl: S100-7.
6. Dim CC, Onah HE. The prevalence of anemia among pregnant women at booking in Enugu, South Eastern Nigeria. MedGenMed 2007;9:11.
7. Anorlu RI, Oluwole AA, Abudu OO. Sociodemographic factors in anaemia in pregnancy at booking in Lagos, Nigeria. J Obstet Gynaecol 2006;26:773-6.
8. Milman N. Postpartum anemia I: Definition, prevalence, causes, and consequences. Ann Hematol 2011;90:1247-53.
9. Iloabachie GC, Meniru GI. The increasing incidence of anaemia in pregnancy in Nigeria. Orient J Med 1990;2:194-8.
10. Iyoke CA, Ezugwu FO, Onah HE. Prevalence and correlates of maternal morbidity in Enugu, South-East Nigeria. Afr J Reprod Health 2010;14:121-9.
11. Araoye MO. Research methodology with statistics for health and social sciences. Reprinted. 1st ed. Ilorin Nigeria: Nathadex Publishers; 2004. p. 115-8.
12. Onwukeme KE. Puerperal haematological indices in the Nigerian. Afr J Med Med Sci 1992;21:51-5.
13. Harrison KA. Anaemia in pregnancy. In: Lawson J, Harrison KA, Bergstrom S, editors. Maternity Care in Developing Countries. 1st ed. London: RCOG Press; 2001. p. 113-28.
14. Ogunbode O. Anaemia in pregnancy. In: Okonofua F, Odunsi K, editors. Contemporary Obstetrics and Gynaecology for Developing Countries. 1st ed. Benin City: Women's Health and Action Research Centre; 2003. p. 515-29.
15. Aziken ME. Anaemia in pregnancy. In: Okpere E, editors. Clinical Obstetrics. 1st ed. Benin City: UNIBEN Press; 2004. p. 51-5.
16. Chandra S, Tripathi AK, Mishra S, Amzarul M, Vaish AK. Physiological changes in hematological parameters during pregnancy. Indian J Hematol Blood Transfus 2012;28:144-6.
17. Richter C, Weitzel H, Huch A, Huch R. Failure to demonstrate postpartum functional iron deficiency using quantitative red blood cell analysis. Eur J Obstet Gynecol Reprod Biol 1999;84:69-74.
18. Krafft A, Perewusnyk G, Hanseler E, Quack K, Huch R, Breymann C. Effect of postpartum iron supplementation on red cell and iron parameters in non-anaemic iron deficient women: A randomized placebo controlled study. BJOG 2005;112:445-50.
19. Milman N, Byg KE, Agger AO. Hemoglobin and erythrocyte indices during normal pregnancy and postpartum in 206 women with and without iron supplementation. Acta Obstet Gynecol Scand 2000;79:89-98.
20. Okunade KS, Adegbesan-Omilabu MA, Oluwole AA. Perinatal outcome in anaemic pregnant women in South-Western Nigeria. Int J Res Med Sci 2014;2:607-11.
21. Chan SM, Nelson EA, Leung SS, Li CY. Postnatal iron status of Hong Kong Chinese women in a longitudinal study of maternal nutrition. Eur J Clin Nutr 2001;55:538-46.
22. Bergmann RL, Richter R, Bergmann KE, Dudenhausen JW. Prevalence and risk factors for early postpartum anemia. Eur J Obstet Gynecol Reprod Biol 2010;150:126-31.
23. Bodnar LM, Cogswell ME, McDonald T. Have we forgotten the significance of postpartum iron deficiency? Am J Obstet Gynecol 2005;193:36-44.
24. Somdatta P, Reddaiah VP, Singh B. Prevalence of anaemia in the postpartum period: A study of a North Indian village. Trop Doct 2009;39:211-5.
25. Petraro P, Duggan C, Urassa W, Msamanga G, Makubi A, Spiegelman D, *et al.* Determinants of anemia in postpartum HIV-negative women in Dar es Salaam, Tanzania. Eur J Clin Nutr 2013;67:708-17.
26. Bodnar LM, Siega-Riz AM, Miller WC, Cogswell ME, McDonald T. Who should be screened for postpartum anemia? An evaluation of current recommendations. Am J Epidemiol 2002;156:903-12.