International Journal of Gynecology and Obstetrics (2008) **101**, 62–66

available at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/ijgo

www.figo.org

CLINICAL ARTICLE

Anemia and iron deficiency in pregnant Ghanaian women from urban areas

Cyril Engmann [a,*], **Richard Adanu** [b], **Tsui-Shan Lu** [c], **Carl Bose** [a], **Betsy Lozoff** [d]

[a] *Department of Pediatrics, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA*
[b] *Department of Obstetrics and Gynecology, University of Ghana Medical School, Accra, Ghana*
[c] *Department of Biostatistics, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA*
[d] *Center for Human Growth and Development, University of Michigan, Ann Arbor, Michigan, USA*

Received 21 June 2007; received in revised form 14 September 2007; accepted 22 September 2007

KEYWORDS
Anemia;
Iron deficiency;
Ghana;
Urban areas;
Pregnancy

Abstract

Objectives: To determine the prevalence and identify risk factors for iron deficiency and anemia in pregnant Ghanaian women from urban areas. *Methods:* A cross-sectional study of 452 healthy pregnant women receiving prenatal care in Accra, Ghana, was conducted. A sociodemographic health questionnaire was performed and hematologic parameters were measured. Logistic regression methods were used to identify risk factors for anemia and iron status. *Results:* Complete data were available for 428 women. Anemia (hemoglobin <11 g/dL) was present in 144 (34%), iron deficiency (ferritin ≤ 16 µg/L) in 69 (16%), and iron deficiency anemia in 32 (7.5%) women. The adjusted odds ratio (OR) for anemia was 3.4 and 9.8 if iron deficiency and malaria parasitemia were present, respectively; the OR was 0.6 if women were at ≥ 36 weeks of pregnancy. The adjusted OR for iron deficiency was 2.7 if women were at ≥ 36 weeks of pregnancy and 0.12 if they had sickle trait. *Conclusion:* Although anemia and iron deficiency remain substantial problems in pregnant Ghanaian women from urban areas, their prevalence is less than previously reported.

1. Introduction

Anemia affects over 2 billion people and the World Health Organization (WHO) estimates that half of these cases are due to iron deficiency [1–3]. A disproportionate percentage of anemia and iron deficiency cases occur in low income countries [4,5], accompanied by adverse pregnancy outcomes such as preterm birth, low birth weight, and increased maternal mortality [6–11]. Although these adverse events exact a heavy toll in terms of ill-health and premature death, iron deficiency and anemia remain endemic, and global prevalence has declined little [12–15].

* Corresponding author. CB 7596, 4th Floor UNC Hospitals, University of North Carolina at Chapel Hill, Chapel Hill, NC 27599-7596, USA. Tel.: +1 919 966 5063; fax: +1 919 9663034.
E-mail address: cengmann@med.unc.edu (C. Engmann).

0020-7292/$ - see front matter
doi:10.1016/j.ijgo.2007.09.032

Table 1 Health characteristics of women in the study group and stage of pregnancy [a]

Characteristics	Study group (n=428)	≤24 weeks (n=181)	≥36 weeks (n=247)	P value
Anemia	144 (34)	76 (42)	68 (28)	0.0018
Iron deficiency	69 (16)	20 (11)	49 (20)	0.015
Iron supplement during pregnancy <twice/week	113 (27)	81 (46)	32 (13)	<0.0001
Malaria parasitemia	32 (7)	21 (12)	11 (4)	0.0055
Menstrual bleeding severity [b]				NS
Little	44 (10)	20 (12)	24 (10)	
Moderate	276 (66)	103 (59)	173 (70)	
Heavy	101 (24)	51 (29)	50 (20)	
Irregular menstruation [b]	274 (65)	113 (64)	161 (65)	NS
Number of children				NS
0–2	317 (74)	140 (79)	177 (72)	
3 or more	106 (26)	37 (21)	69 (28)	
Donated blood once or more	33 (8)	15 (8)	18 (7)	NS
Intrauterine device	18 (6)	4 (4)	14 (6)	NS
Maternal education				NS
No formal education/elementary education	277 (66)	128 (73)	149 (61)	
Secondary/advanced education	144 (34)	48 (27)	96 (39)	
Eat meat/week <twice/week	206 (49)	86 (49)	120 (49)	NS
Eat fruits/vegetables <twice/week	50 (12)	20 (11)	30 (12)	NS
Take vitamin C <twice/week	389 (92)	166 (94)	223 (91)	NS
No iron supplement before pregnancy	370 (88)	151 (86)	219 (89)	NS
History of malaria in the past year	204 (48)	79 (45)	125 (51)	NS
Folate deficiency	11 (3)	4 (2)	7 (3)	NS
Sickle cell trait	56 (13)	23 (13)	33 (13)	NS

[a] Values are given as number (percentage) unless otherwise indicated.
[b] Defined subjectively by the women.

The purpose of the present study was to determine if the prevalence of iron deficiency and anemia in pregnant women receiving prenatal care and living in urban areas in Ghana was as high as suggested by previous survey data, and to identify genetic, infectious, and sociodemographic risk factors for iron deficiency and anemia. Such data are critical to generate hypotheses about modifiable causes, and to select interventions for future maternal or neonatal studies.

2. Materials and methods

The study was conducted in the prenatal outpatient clinics of Korle-Bu Teaching Hospital and the Mamprobi Polyclinic, in Accra, Ghana. These clinics care for over 350 patients each day and all patients who attend receive free intermittent presumptive treatment for malaria, and iron supplementation.

The study cohort included healthy women between 18 and 40 years of age with singleton pregnancies who received prenatal care between May and August 2003. Those with sickle cell disease, major congenital or current illnesses were excluded. Among the women eligible for the study a subset was selected by a computer-generated random list of numbers. Recruitment, enrollment, and data and specimen collection occurred during a single outpatient visit at one of two distinct times during pregnancy: the first prenatal visit (4–24 weeks of pregnancy) and the last month of pregnancy (36–41 weeks).

Informed consent was obtained from all participants. The Noguchi Memorial Institute for Medical Research at the University of Ghana and the University of Michigan Ethical Review Committee approved the study.

A health and sociodemographic questionnaire that included possible risk factors for iron deficiency and anemia was conducted. The questionnaire was translated by an interpreter if the women did not speak English (42%).

The following laboratory assays were performed on a venous blood sample: a complete blood count (CBC) performed using a Sysmex KX-21 Hematology Analyzer (Sysmex Corporation, Kobe, Japan); erythrocyte sedimentation rate (ESR) measured using the Sediplast system (LP Italiana Spa, Milan, Italy); and ferritin levels using the DPC Immulite 1 ferritin assay (Diagnostic Products Corporation, Los Angeles, USA). A sickling test using sodium metabisulphate was conducted on all blood samples [16]. The BD QBC fluorescence microscopy method (Becton Dickinson Co, Franklin Lakes, NJ, USA) and a thick film (Giemsa stain) was used for detection of malarial parasites in blood smears, while a thin film was used for speciation. Stool samples were obtained to investigate the presence of intestinal pathogens. The WHO definition of anemia (hemoglobin concentration <11 g/dL) was used [17]. Iron deficiency was defined as a serum ferritin concentration ≤16 μg/L [18]. Additional analyses were performed using an alternative ferritin cutoff level of ≤12 μg/L [19,20].

Health characteristics were split into 2 groups: early (≤24 weeks) and late (≥36 weeks) pregnancy using descriptive tabular methods. The analyses of anemia prevalence conditional on explanatory variables (e.g. iron deficiency, bleeding severity, number of children, number of pregnancies, use of intrauterine device, maternal education, paternal education, number of times eating meat per week, iron supplement taken before pregnancy and during pregnancy, having malaria in the past year, gestation, and having sickle cell trait) relied on a

Table 2 Multivariate analysis of risk factors for anemia using stepwise algorithm

Factor	Anemia: hemoglobin <11 g/dL N (%)	Adjusted odds ratio	*P* value
Iron deficiency (ferritin ≤16 μg/L)			
Yes	69 (46)	3.4 (1.7–6.5)	0.0003
No	359 (31)	1	
Sub-cohort (weeks of pregnancy)			
≥36 weeks	247 (28)	0.6 (0.3–1.0)	0.044
≤24 weeks	181 (42)	1	
Malaria			
Positive	32 (72)	9.8 (2.6–37)	0.0007
Negative	396 (30)	1	

Fisher exact test procedure and logistic regression methods with stepwise variable selection algorithms, accompanied by 95% confidence intervals. Similar methods were used in the analyses of iron deficiency prevalence. Statistical analyses were performed only on subjects with complete data available. Data analyses were performed using SAS system software version 9.1.3 (SAS Institute, Cary, NC, USA).

3. Results

A total of 452 pregnant women were enrolled in the study and 24 (5%) were excluded after enrollment due to incomplete data, leaving 428 women. A total of 181 women were enrolled at 24 weeks of pregnancy or earlier (22% in the first and 78% in the second trimester), while 247 were enrolled during the last month of pregnancy.

Table 1 describes the prevalence of anemia and iron deficiency for the entire cohort and separately for women enrolled in early and late pregnancy. Also listed are factors that may predict these outcomes. The prevalence of these factors are listed separately for each group (≤24 weeks versus ≥36 weeks) to identify any heterogeneity between groups that may have influenced the prevalence of anemia or iron deficiency, independent of the effect of length of pregnancy. All factors were similar between groups except malaria parasitemia and iron supplementation during pregnancy. Parasitemia was less common in late pregnancy while iron supplementation was more common in late pregnancy, presumably as a result of medical therapies during pregnancy.

The mean hemoglobin (Hb) for the entire cohort was 11.3 ± 1.3 g/dL (range, 6.1–15.5). Anemia (Hb < 11 g/dL) was present in 144 (34%) women. Thirteen women (3%) had Hb levels <9 g/dL but ≥7 g/dL, while 4 women had Hb levels <7 g/dL. Women at ≤24 weeks of pregnancy had a mean Hb of 10.9 ± 1.4 g/dL (range, 6.1–15.5); women in the last month of pregnancy had a mean Hb of 11.6 ± 1.1 g/dL (range, 8.1–14.2). Of 144 anemic women, 32 (22%) had ferritin ≤16 μg/L, 23 had malaria, and 19 had sickle cell trait. In multivariate analysis of risk factors for anemia, the odds of being anemic were increased if women were iron deficient or had malaria parasitemia. These odds of anemia were almost halved if women were at ≥36 weeks of pregnancy (Table 2).

The median serum ferritin level for the entire cohort was 34.7 μg/L (interquartile range [IQR], 20–54 μg/L). Sixty-nine women (16%) had ferritin levels ≤16 μg/L, and 32 (46%) of these were anemic; 45 women (11%) had ferritin levels ≤12 μg/L. The median serum ferritin levels in women with malaria parasitemia was 91 μg/L (IQR, 33–157 μg/L). Among women without malaria parasitemia, the median ferritin level was 33 μg/L (IQR, 20–50 μg/L). Among women with sickle cell trait ($n = 56$), the median ferritin level was 42 μg/L (IQR, 28–65 μg/L). Women without sickle cell trait had median ferritin values of 33 μg/L (IQR, 20–51 μg/L). In multivariate analysis of risk factors for iron deficiency, the odds of having a low ferritin level were increased if women were in their last month of pregnancy, and decreased if they had sickle trait (Table 3).

A total of 32 women (7%) had malarial parasitemia. Among parasitemic women, 23 (72%) were anemic and 2 (6%) were iron deficient. Malaria parasitemia was significantly less common in the last month of pregnancy compared with at ≤24 weeks of pregnancy (Table 1). In 220 stool specimens examined under microscopy, 3 had *Entamoeba coli* cysts and 1 had *Entamoeba histolytica* cysts.

4. Discussion

The present study reports a comparatively low prevalence of anemia, iron deficiency, and iron deficiency anemia (34%, 16%, and 7.5%, respectively) in pregnant Ghanaian women. Lassey et al. [21] reported that 56% of pregnant Ghanaian women in urban areas had hemoglobin levels below 11 g/dL, while the 2003 Demographic and Health Survey (DHS) reported anemia prevalence in 400 pregnant women aged 15–49 years as 65% [22]. Mockenhaupt et al. [19] reported prevalence of anemia and iron deficiency of 54% and 46%, respectively, in a study of 540 pregnant Ghanaian women from rural areas. A possible explanation for the lower prevalence of anemia and iron deficiency in the present study compared with other studies may be that women in our study population are primarily coastal urban dwellers residing in an area with increased media exposure, which may promote improved health practices. In support of this hypothesis is the DHS survey in which urban women were 6 times more likely

Table 3 Multivariate analysis of risk factors for iron deficiency using stepwise algorithm

Factor	Iron deficiency: ferritin level ≤16 μg/L N (%)	Adjusted odds ratio	*P* value
Sub-cohort (gestational weeks)			
≥36 weeks	247 (20)	2.7 (1.2–6.4)	0.022
≤24 weeks	181 (11)	1	
Sickle status			
Trait	56 (5)	0.12 (0.02–0.9)	0.037
Negative	371 (18)	1	

than rural Ghanaian women to read a newspaper, watch TV, or listen to the radio.

There was a lower prevalence of malaria parasitemia and anemia, but a higher incidence of iron deficiency late in pregnancy. The availability of free intermittent presumptive treatment or the seasonal variations in malaria prevalence may explain the reduced incidence of malaria parasitemia and anemia late in pregnancy. In contrast, the adjusted odds ratio of being iron deficient significantly increased during the last month of pregnancy compared with the first prenatal visit. This was despite the fact that nearly 90% of women in their third trimester reported taking iron twice or more weekly, compared with only 50% of women at $\leq$24 weeks of pregnancy. There are several possible explanations for this paradox. The reporting may have been inaccurate, the prescribed doses inadequate, or routine iron supplementation during pregnancy may be unsuccessful in preventing iron deficiency [6,7,11]. Assessing these possibilities is critical in developing strategies for the prevention of iron deficiency in pregnancy.

An intriguing finding of the present study was that pregnant women with sickle cell trait present a decreased risk of having iron deficiency. While there is an established association between sickle cell disease and iron deficiency, there are few data on sickle cell trait and iron deficiency in pregnancy [23,24]. Hershko et al. [25] observed a reciprocal relationship between sickle cell trait and iron deficiency anemia in 75 Lebanese subjects. They postulated that increased iron absorption, or reduced iron requirements in these patients resulted in less risk of discrepancy between iron supply and demand. Further research is needed to determine whether sickle cell trait confers increased protection against iron deficiency.

There are a number of limitations to the present study. We did not investigate the presence of HIV/AIDS and homozygous alpha thalassemia, both of which are associated with anemia and iron deficiency. However, it is unlikely that HIV/AIDS influenced the outcome of this study because of the low prevalence of HIV in Ghana (2.7% of Ghanaian women between 15 and 49 years of age [22]). The prevalence of homozygous alpha thalassemia in this population is also low (3.7% [19]), and all enrolled women denied any major illness. Additionally, the cross-sectional study design limits the ability to draw inferences about the effect of length of pregnancy on outcomes. To minimize this problem, we compared the cohorts enrolled early in pregnancy with those enrolled in the last month, with respect to factors that might influence the prevalence of iron deficiency and anemia. All factors were similar between groups except for those plausibly influenced by pregnancy-related care (administration of malaria intermittent presumptive treatment and iron supplementation). Finally, participants in this study had low-risk pregnancies and were healthy, thus it may not be possible to generalize these results across the whole population.

Although anemia and iron deficiency remain substantial problems, the data are encouraging because the prevalence of these disorders is considerably less than previously reported. The lower prevalence of malaria parasitemia among women in the last month of pregnancy also suggests a benefit of medical intervention with intermittent presumptive treatment. There was an inverse relationship between sickle cell trait and iron deficiency, and we speculate that sickle cell trait may confer a protective benefit against the occurrence of iron deficiency. Increased research and programmatic emphasis should be placed on decreasing modifiable risk factors for anemia, iron deficiency, and malaria parasitemia, such as improved nutritional intake of iron-rich local foods, wider use of insecticide-impregnated bed nets and the expanded use of intermittent presumptive treatment in the prenatal period. The potential benefits of preconception compared to intra-pregnancy iron supplementation should be investigated, as well as strategies for improving compliance with preventive therapies.

References

[1] Brabin BJ, Prinsen-Geerligs PD, Verhoeff FH, Fletcher KA, Chimsuku LH, Ngwira BM, et al. Haematological profiles of the people of rural southern Malawi: an overview. Ann Trop Med Parasitol 2004;98:71–83.

[2] Bodnar LM, Siega-Riz AM, Arab L, Chantala K, McDonald T. Predictors of pregnancy and postpartum haemoglobin concentrations in low-income women. Public Health Nutr 2004;7:701–11.

[3] Joint statement by the World Health Organization and the United Nations Children's Fund. Focusing on Anaemia: Towards an integrated approach for effective anaemia control. http://www.who.int/nutrition/publications/WHOandUNICEF_statement_anaemia.pdf.

[4] van den Broek N. Anaemia in pregnancy in sub-Saharan countries. Eur J Obstet Gynecol Reprod Biol 2001;96:4–6.

[5] Bentley ME, Griffiths PL. The burden of anemia among women in India. Eur J Clin Nutr 2003;57:52–60.

[6] Blot I, Diallo D, Tchernia G. Iron deficiency in pregnancy: effects on the newborn. Curr Opin Hematol 1999;6:65–70.

[7] Scholl TO, Reilly T. Anemia, iron and pregnancy outcome. J Nutr 2000;130:443 S–7 S.

[8] Baker Jr WF. Iron deficiency in pregnancy, obstetrics, and gynecology. Hematol Oncol Clin North Am 2000;14:1061–77.

[9] Rao R, Georgieff MK. Perinatal aspects of iron metabolism. Acta Paediatr Suppl 2002;91:124–9.

[10] Allen LH. Anemia and iron deficiency: effects on pregnancy outcome. Am J Clin Nutr 2000;71(5 Suppl):1280S–4S.

[11] Beard JL. Effectiveness and strategies of iron supplementation during pregnancy. Am J Clin Nutr 2000;71(5 Suppl):1288S–94S.

[12] Hercberg S, Preziosi P, Galan P. Iron deficiency in Europe. Public Health Nutr 2001;4:537–45.

[13] Islam MZ, Lamberg-Allardt C, Bhuyan MAH, Salamatullah Q. Iron status of premenopausal women in two regions of Bangladesh: prevalence of deficiency in high and low socio-economic groups. Eur J Clin Nutr 2001;55:598–604.

[14] Seshadri S. Prevalence of micronutrient deficiency particularly of iron, zinc and folic acid in pregnant women in South East Asia. Br J Nutr 2001;85(Suppl 2):S87–92.

[15] Musaiger AO. Iron deficiency anaemia among children and pregnant women in the Arab Gulf countries: the need for action. Nutr Health 2002;16:161–71.

[16] Habibzadeh F, Yadollahie M, Ayatollahie M, Haghshenas M. The prevalence of sickle cell syndrome in south of Iran. Iron J Med Sci 1999;24:32–4.

[17] Beutler E, Waalen J. The definition of anemia: what is the lower limit of normal of the blood hemoglobin concentration? Blood 2006;107:1747–50.

[18] Hallberg L, Bengtsson C, Lapidus L, Lindstedt G, Lundberg PA, Hulton L. Screening for iron deficiency: an analysis based on bone-marrow examinations and serum ferritin determinations in a population sample of women. Br J Haematol 1993;85: 787–98.

[19] Mockenhaupt FP, Rong B, Gunther M, Beck S, Till H, Kohne E, et al. Anaemia in pregnant Ghanaian women: importance of malaria,

iron deficiency, and haemoglobinopathies. Trans R Soc Trop Med Hyg 2000;94:477—83.
[20] van den Broek NR, Letsky EA, White SA, Shenkin A. Iron status in pregnant women: which measurements are valid? Br J Haematol 1998;103:817—24.
[21] Lassey AT, Klufio CA, Annan BD, Wilson JB. Antenatal haemoglobin profile at Korle-Bu Teaching Hospital. East Afr Med J 1999:228—32.
[22] Ghana Statistical Service (GSS), Nogouchi Memorial Institute for Medical Research (NMIMR), ORC Macro. Ghana Demographic and Health Survey 2003. GSS, NMIMR, ORC Macro: Calverton, Maryland, USA; 2004.
[23] Stettler N, Zemel BS, Kawchak DA, Ohene-Frempong K, Stallings VA. Iron status of children with sickle cell disease. J Parenter Enteral Nutr 2001;25:36—8.
[24] Koduri PR. Iron in sickle cell disease: a review why less is better. Am J Hematol 2003;73:59—63.
[25] Hershko C, Moreb J, Gaziel Y, Konijn AM, Rachmilewitz EA. Reduced frequency of iron deficiency anaemia in sickle cell trait. Scand J Haematol 1982;29:304—10.