High prevalence of postpartum anemia among low-income women in the United States

Lisa M. Bodnar, MPH, RD,[a, b] Kelley S. Scanlon, PhD, RD,[b] David S. Freedman, PhD,[b] Anna Maria Siega-Riz, PhD, RD,[a, c] and Mary E. Cogswell, DrPH, RN[b]

Chapel Hill, NC, and Atlanta, Ga

OBJECTIVE: To determine the prevalence of anemia from 4 to 26 weeks post partum and to examine prenatal predictors of postpartum anemia.

STUDY DESIGN: Retrospective cohort analysis of 59,428 participants in the Special Supplemental Nutrition Program for Women, Infants, and Children in 12 US states.

RESULTS: The prevalence of postpartum anemia was 27%. Anemia rates were higher among minority women, reaching 48% among non-Hispanic black women. Of 9129 women who had normal hemoglobin in the third trimester, 21% had postpartum anemia. Prenatal anemia was the strongest predictor of postpartum anemia (adjusted odds ratio, 2.7; 95% confidence interval, 2.5-2.8). Maternal obesity, multiple birth, and not breast-feeding also predicted postpartum anemia.

CONCLUSION: The high prevalence of post partum anemia among low-income women highlights the importance of anemia screening at 4 to 6 weeks post partum. These data suggest that screening should not be limited, as it is at present, to women considered at high risk. (Am J Obstet Gynecol 2001;185:438-43.)

Key words: Low-income women, postpartum, anemia, hemoglobin, surveillance data

Although anemia is a common complication of pregnancy, it is not a normal occurrence and is not without consequence to the mother and infant. Maternal iron deficiency anemia during pregnancy has been associated with a 2-fold risk for preterm delivery and a 3-fold risk for delivering a low birth-weight infant.[1] Iron deficiency anemia among nonpregnant women has been associated with impaired physical work capacity.[2] Cognitive function also may be adversely affected by iron deficiency.[3]

In the United States, about 1 in 10 women of childbearing age is iron deficient; 1 in 20 is iron deficient and anemic.[4] Data from the Centers for Disease Control and Prevention (CDC) Pregnancy Nutrition Surveillance System (PNSS), however, indicate that among low-income US women attending public health programs the prevalence of anemia is 8%, 12%, and 29% in the first, second, and third trimesters of pregnancy, respectively.[5] After delivery, maternal hematologic status is expected to improve as the expanded red cell mass of pregnancy contracts and iron returns to body stores.[6] Studies that have followed women beyond delivery report that by 4 to 6 weeks post partum maternal hemoglobin (Hb) concentration returns to prepregnancy or first trimester levels.[7–11] Most studies of postpartum anemia, however, are limited by small sample size and infrequent measurements of Hb or hematocrit (Hct) concentration among low-risk women.

Available data suggest that women are at low risk of postpartum anemia; thus, the CDC and the American College of Obstetricians and Gynecologists recommend anemia screening at 4 to 6 weeks post partum only for women considered to be at high risk of developing postpartum anemia: women with anemia through the third trimester of pregnancy, excessive blood loss during delivery, or multiple births.[12] Only 1 investigation examined predictors of maternal anemia immediately after delivery,[13] however, and predictors of anemia after expected recovery of iron status have not been examined.

The objectives of this study were to determine the prevalence of maternal anemia from 4 to 26 weeks post partum among low-income women and to examine the predictors of postpartum anemia.

Material and methods

We used data from the 1996 CDC PNSS to address the objectives. PNSS monitors the prevalence of nutrition problems and behavioral risk factors among women enrolled in federally funded public health programs in par-

From the Departments of Nutrition[a] and Maternal and Child Health,[c] University of North Carolina School of Public Health, Chapel Hill, NC, and the Division of Nutrition and Physical Activity,[b] National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia.

Received for publication July 28, 2000; revised November 6, 2000; accepted March 23, 2001.

Reprint requests: Lisa M. Bodnar, MPH, RD, Carolina Population Center, Suite 202, 123 West Franklin St, Chapel Hill, NC 27516.

6/1/115996

doi:10.1067/mob.2001.115996

ticipating states. More than 97% of records are from the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). During 1996, 23 states, the District of Columbia, and 3 American Indian tribal governments participated in the PNSS. (All contributors hereafter are referred to as "states.") For this analysis, we included 12 states that met the following criteria: (1) submitted at least 1000 records in 1996; (2) included postpartum Hb or Hct data for 80% or more of records; (3) included prenatal Hb or Hct data for 80% or more of records; and (4) collected participants' postpartum smoking information.

Because we were interested in determining prenatal risk factors for postpartum anemia, we selected women who entered WIC prenatally, delivered a live infant, and contributed information on maternal Hb or Hct, age, and smoking status. Women contributed 1 prenatal record on entry into WIC and 1 postpartum record. The prevalence of postpartum anemia among women excluded from the analysis because they did not attend WIC prenatally was 24.3% compared with 27.2% in our final sample. A slightly greater percentage of women excluded were older and non-Hispanic black. For this study we defined the postpartum period as 4 to 26 weeks after delivery, when maternal Hb levels are expected to return to normal[6]; thus, we included only records with a postpartum visit to WIC during this period (n = 81,431).

Postpartum anemia and prenatal anemia were assessed using Hb or Hct values. Because Hb was more commonly available, Hct values were converted to Hb (Hb = Hct/3) to facilitate analysis. All Hb values then were adjusted for smoking and clinic altitude.[12] Postpartum anemia was defined as <118 g/L for women between 12 and 15 years and <120 g/L for women at least 15 years.[12] Prenatal anemia was defined as <110 g/L for first and third trimester and <105 g/L for second trimester.[12]

The following potential determinants of postpartum anemia were assessed: maternal age, education, marital status, trimester prenatal care began, trimester enrolled in WIC, prepregnancy body mass index (BMI) (based on measured height and maternal report of prepregnancy weight), breast-feeding duration, prenatal anemia, smoking status at prenatal visit, infant birthweight, and birth order. Maternal ethnicity also was considered.

Records were excluded if they were missing data on any of the following: maternal age, education, marital status, trimester prenatal care began, trimester enrolled in WIC, prepregnancy BMI, prenatal anemia, birth order, and ethnicity. The remaining sample of 59,428 was 73% of the available postpartum records. The prevalence of postpartum anemia among excluded women was 29.1% compared with 27.2% in the final sample. The distributions of maternal age and maternal ethnicity were similar for those excluded and those included (data not shown).

We also examined breast-feeding status at postpartum WIC visit as a predictor. In this subanalysis we excluded 1 state (n = 18,812) because the state did not collect breast-feeding information for more than 97% of women. We then limited the analysis to the remaining women for whom breast-feeding information was available (n = 32,947). The prevalence of anemia and distribution of maternal age were similar in the breast-feeding subsample and in those women excluded from the analysis. However, a greater percentage of non-Hispanic blacks (21.5% vs 18.5%) and Hispanics (19.4% vs 5.8%) were in the excluded group versus the final subsample. This was expected, as the excluded state had a high proportion of minority women.

We calculated the mean adjusted Hb and percent postpartum anemia by week of postpartum visit to WIC among all women and by ethnic group. The prevalence of postpartum anemia by other maternal characteristics also was computed. We used multiple logistic regression to examine the variables that were associated independently with postpartum anemia. Because of the large sample size, most of the unadjusted odds ratios for postpartum anemia were significant statistically but irrelevant clinically. Therefore, predictors with unadjusted odds ratios for postpartum anemia >1.25 or <.80 were considered noteworthy and included in the multivariate model. We used SAS software (SAS Institute, Cary, NC) for all statistical analysis.

Results

Among women in the final sample, 65% were non-Hispanic white; 60% were unmarried; 57% were 20 to 29 years of age; 26% were teenagers (12-19 years); and 36% had not yet completed high school.

The overall prevalence of postpartum anemia was 27.2%. Women returning to WIC at postpartum week 13 or later were grouped because of the small sample sizes (Table I). For the total sample, mean Hb was fairly constant from 4 to 26 weeks post partum. The prevalence of anemia was highest at 12 to 18 weeks post partum. At any one time, more than 25% of all women were anemic. Although not included in our sample, the women who returned to WIC for the first postpartum visit before 4 weeks post partum had a prevalence of postpartum anemia and mean Hb of 37.0% and 125 g/L at week 1, 29.7% and 127 g/L at week 2, and 26.6% and 128 g/L at week 3, respectively.

Non-Hispanic black women had a lower mean Hb and higher prevalence of postpartum anemia than did other ethnic groups. Non-Hispanic white women had the highest mean Hb and lowest proportion of anemia; their mean Hb changed little during the postpartum period. Among non-Hispanic black and Hispanic women, the mean Hb was fairly constant until weeks 19 to 26, when it was slightly higher; however, the number of women in these groups was small.

Table I. Mean hemoglobin and percent anemia by week of postpartum visit to the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), Centers for Disease Control and Prevention (CDC) Pregnancy Nutrition Surveillance System (PNSS), 1996

	Non-Hispanic whites			*Non-Hispanic blacks*			*Hispanics*			*Total*		
		*Mean**	*%*		*Mean**	*%*		*Mean**	*%*		*Mean**	*%*
Week	*No.*	*Hb† (SD)*	*Anemia*	*No.*	*Hb† (SD)*	*Anemia*	*No.*	*Hb† (SD)*	*Anemia*	*No.*	*Hb† (SD)*	*Anemia*
4	9467	131 (15)	22.6	2318	122 (14)	41.2	1441	126 (16)	32.5	13,712	129 (15)	26.8
5	9749	131 (14)	21.3	2447	122 (14)	41.3	1637	127 (14)	28.0	14,260	129 (15)	25.7
6	7131	132 (14)	19.9	2928	121 (14)	45.7	1401	126 (15)	31.8	11,798	128 (15)	28.1
7	3972	131 (14)	21.4	1384	121 (14)	44.8	789	126 (14)	30.4	6378	128 (15)	28.0
8	2521	131 (14)	20.4	930	121 (14)	43.9	576	125 (13)	31.3	4195	128 (15)	27.2
9	1490	131 (14)	18.7	520	121 (14)	45.6	354	125 (14)	33.1	2469	128 (14)	26.7
10	1056	131 (13)	19.9	342	122 (14)	39.8	277	126 (15)	38.9	1759	129 (14)	25.5
11	705	131 (14)	22.0	237	122 (13)	42.2	190	125 (14)	34.7	1189	129 (14)	25.5
12	523	130 (14)	24.9	184	120 (14)	45.7	106	123 (15)	39.6	838	127 (15)	30.9
13-14	711	129 (17)	26.9	233	121 (13)	48.0	121	125 (14)	36.4	1131	127 (16)	32.5
15-18	838	131 (15)	24.3	216	123 (14)	47.7	109	124 (15)	35.8	1216	129 (15)	29.4
19-26	348	131 (15)	23.9	60	125 (14)	38.3	52	129 (15)	23.1	483	130 (15)	25.5

*Adjusted for altitude and smoking according to CDC recommendations (CDC, 1998).
†g/L.

The analysis in Table I was stratified by breast-feeding status to examine the influence of breast-feeding on postpartum anemia (data not shown). The prevalence of anemia from 4 to 26 weeks was 7.2 to 14.3 percentage points greater in women not breast-feeding compared with women breast-feeding post partum. The highest prevalence of anemia was observed between 12 and 14 weeks post partum in both strata. Mean Hb was approximately 50 g/L higher in lactating women compared with nonlactating women.

The prevalence of postpartum anemia was highest among non-Hispanic black women and women who had prenatal anemia, and it was lowest among non-Hispanic white women and women without prenatal anemia (Table II).

After controlling for the other maternal characteristics, we found prenatal anemia was the strongest predictor of postpartum anemia (Table II). Women with prenatal anemia at entry into WIC were 2.7 times as likely as women without prenatal anemia to have postpartum anemia. Minority women, particularly non-Hispanic black women, were more likely than non-Hispanic white women to have postpartum anemia. We observed greater odds of postpartum anemia with increasing BMI. Women with a BMI of at least 40 kg/m^2 were 1.7 times as likely as women with a BMI of 18.5 to 24.9 kg/m^2 to have postpartum anemia. Women who were 16 to 19 years old, delivered a multiple birth, had a high school education or less, or were unmarried were more likely to have postpartum anemia.

A longer duration of breast-feeding was associated with a decreased prevalence of postpartum anemia (Table III). For example, women who breast-fed for 7 weeks or longer were .76 times as likely to develop postpartum anemia as those who never breast-fed. In addition, women who were breast-feeding at the postpartum visit were .65 times as likely to develop postpartum anemia as those not breast-feeding (95% confidence interval, .61-.68).

In a separate analysis, we examined the incidence of postpartum anemia among women who entered WIC during the third trimester but were not anemic. Of 9129 women who had normal Hb at their third-trimester visit to WIC, 21.3% had postpartum anemia (data not shown). We observed similar associations between maternal characteristics and postpartum anemia in this subgroup as in the entire population.

Comment

Our investigation suggests that among low-income women in the United States, a high prevalence of anemia persists beyond the third trimester and the early postpartum period. In 12 states with data on postpartum anemia, more than 1 in 4 low-income women returning to WIC between 4 and 26 weeks post partum was anemic. The prevalence of anemia was higher among minority women, reaching 48% in non-Hispanic black women. Prevalence fluctuated only slightly with increasing weeks post partum, reaching the highest levels at 12 to 18 weeks. Time did not modify the relationship between breast-feeding and anemia; prevalence of anemia was higher in nonlactating women compared with lactating women at every week or group of weeks post partum.

Unpublished data from the National Health and Nutrition Examination Survey (NHANES) 1988-1994 indicate a similar prevalence of postpartum anemia among low-income women. Among women with an income status ≤185% of poverty, 1 in 5 was anemic at 0 to 6 months post partum; whereas, approximately 1 in 18 women whose income status was >185% of poverty was anemic post partum. Furthermore, 51% of low-income women who had

Table II. Prevalence and odds ratios for postpartum anemia by maternal characteristics, Centers for Disease Control and Prevention (CDC) Pregnancy Nutrition Surveillance System (PNSS), 1996

Maternal characteristics	*No.*	*% Postpartum anemia*	*Odds ratio* (95% confidence interval)*
Prenatal anemia			
Yes	7858	49.0	2.68 (2.54-2.82)
No	51,570	23.8	1.00†
Maternal ethnicity			
Non-Hispanic white	38,511	21.4	1.00†
Non-Hispanic black	11,799	43.4	2.26 (2.16-2.37)
Hispanic	7053	31.1	1.58 (1.49-1.68)
Native American	1254	29.3	1.36 (1.20-1.55)
Asian and Pacific Islander	811	25.4	1.45 (1.23-1.71)
Maternal age			
12-15 y	1556	33.2	1.06 (.94- 1.19)
16-19 y	15,208	29.9	1.12 (1.07-1.18)
20-29 y	33,851	26.2	1.00†
30-39 y	8400	25.2	.88 (.83-.93)
40-49 y	413	23.7	.83 (.64-1.02)
Prepregnancy BMI			
<18.5 kg/m^2	4568	26.4	1.06 (.99-1.14)
18.5-24.9 kg/m^2	29,209	25.2	1.00†
25-29.9 kg/m^2	13,154	27.6	1.17 (1.11-1.23)
30-34.9 kg/m^2	6826	30.9	1.43 (1.35-1.52)
35-39.9 kg/m^2	3339	31.1	1.45 (1.34-1.57)
≥40.0 kg/m^2	2332	33.9	1.66 (1.51-1.82)
Birth order			
Singleton	57,510	26.9	1.00†
Multiple birth	1918	34.2	1.38 (1.25-1.53)
Maternal education			
<12 y	21,481	29.8	1.24 (1.17-1.31)
12 years	25,577	26.8	1.18 (1.12-1.25)
>12 y	12,370	23.3	1.00†
Marital status			
Married	24,011	21.9	1.00†
Not married	35,417	30.7	1.21 (1.16-1.26)
Trimester prenatal care began			
First	38,594	26.3	1.00†
Second	18,597	28.0	.96 (.92-1.00)
Third	2337	35.0	1.08 (.98-1.19)
Trimester enrolled in WIC			
First	13,549	23.2	1.00†
Second	16,833	26.3	1.06 (1.01-1.12)
Third	21,462	28.6	1.00 (.94-1.05)
Unknown	7584	32.1	1.09 (1.01-1.16)

*Adjusted for weeks post partum, prenatal anemia, maternal ethnicity, prepregnancy body mass index (BMI), maternal age, education, marital status, birth order, trimester of entry into prenatal care, and trimester of entry into WIC.
†Referent group.

post partum anemia in NHANES were iron deficient (Cogswell ME, personal communication, 2000). To compare our results with previous studies, we calculated a 25.5% prevalence of postpartum anemia when Hb was not adjusted for smoking and altitude.[12] A similar high prevalence for postpartum anemia (24.6%) was reported in a low-income Nigerian population that was not supplemented prenatally.[9] Milman et al[7] also observed a 21.1% prevalence of anemia at 8 weeks post partum among Danish women unsupplemented during pregnancy.

To obtain Hb levels WIC uses capillary blood sampling, which should underestimate anemia prevalence compared with venous sampling. We believe that there is little measurement error associated with Hb levels in our data, however, because Hb distribution in our study was very similar to that of NHANES, which uses venous blood.

Among low-income women participating in PNSS, prenatal anemia was the strongest predictor of postpartum anemia. More than 1 in 4 women without prenatal anemia in the third trimester had postpartum anemia, however, suggesting that a substantial proportion of women develop anemia during delivery or in the early postpartum period. Prepregnancy BMI and breast-feeding status were stronger predictors of postpartum anemia than were multiple births, an accepted risk factor for postpartum anemia.[12]

We found a significant relationship between obesity and postpartum anemia. Although we are unaware of any published studies that discuss the prevalence of postpartum anemia among obese women, several possibilities could account for the increased risk. Obese women more often have a poor choice of foods,[14] less often use vitamin

Table III. Prevalence and odds ratios for postpartum anemia by breast-feeding status (n = 32,947)

	No.	*% Postpartum anemia*	*Odds ratio* (95% CI)*
Breast-feeding status at postpartum visit			
Never breast-fed	19,051	29.1	1.00†
Breast-fed 1-3 wk	4774	28.1	1.05 (.98-1.13)
Breast-fed 4-6 wk	4239	22.6	.82 (.76-.89)
Breast-fed 7 wk or longer	4883	21.8	.76 (.70-.83)

*Adjusted for maternal ethnicity, age, weeks post partum, entry to prenatal care, entry to WIC, education, birth order, marital status, prenatal anemia, and prepregnancy body mass index.
†Referent group.

and mineral supplements,[15] and consume an insufficient amount of iron compared with non-obese women.[16]

Our results showed that breast-feeding was associated with a decreased risk of postpartum anemia. In a study by Kalkwarf and Harrast,[17] iron stores (as measured by serum ferritin) remained higher in lactating women (n = 76) than in nonlactating women (n = 82) at 6 months post partum, after stratifying by postnatal supplement use. In contrast to our findings, these authors reported no difference in Hb or Hct between groups. The authors attributed the difference in iron stores between the two groups mostly to the return of menses, which occurred in 98.8% of the nonlactating women compared with 14.5% of lactating women. Lactation is associated with a delay in the normal return of menses.[18] This amenorrhea decreases demand for iron, because iron losses in breast milk are only about half that lost during menstruation.[19]

Our data show that at 4 weeks post partum, when it is likely that menstruation has not resumed in either group, there is a meaningful difference in prevalence of anemia and mean Hb between lactating (18.6%, 133 g/L) and nonlactating women (29.9%, 128 g/L). Therefore, it also is possible that women who are more health-conscious or who had healthier pregnancies may be more likely to choose breast-feeding. Although PNSS does not collect data on supplementation, other research has shown that lactating women are more likely than nonlactating women to take iron or iron-containing supplements post partum and to take them longer.[17] Conversely, anemia status may influence breast-feeding status. Fatigue, a common symptom of anemia, has been named the major factor influencing milk supply post partum.[20] Henley et al[21] showed that the proportion of women who reported symptoms of insufficient milk syndrome was significantly higher for women with anemia 1 to 3 days post partum than for those without anemia. Finally, the effects of lactation on maternal iron metabolism are unknown and require further study.

Previous studies indicate postpartum hemorrhage was associated with obesity,[22] minority status,[23] and nulliparity.[24] These factors then in part may be markers for postpartum hemorrhage. Our study was limited by the absence of clinical information about the delivery and immediate postpartum period. Among women without anemia just before delivery, large blood loss (>500 mL) during delivery, intrapartum bleeding (ie, placenta previa and placental abruption), atony, and delayed postpartum hemorrhage were strong predictors of anemia immediately after delivery.[13] The proportion of women who experience excessive blood loss at delivery is small, however, estimated at 4% and 7% of women.[22]

Our study also was limited by lack of information on prenatal and postpartum prevention and treatment of anemia. A majority of studies have shown that between 6 and 12 weeks post partum, mean Hb values were significantly higher among women supplemented with iron prenatally than among unsupplemented women,[7, 9, 11] although others did not find a significant difference.[8, 10] A recent study indicated that the prevalence of anemia at 3 months post partum was almost 3 times greater among women who did not receive iron supplements prenatally.[9]

A final limitation of our study is that WIC clinics participating in PNSS do not collect data on other measures of iron status. Anemia can be caused by many factors other than iron deficiency, including other nutrient deficiencies, infection, inflammation, and heredity. It is reasonable to assume a majority of anemia in the postpartum period is attributable to iron deficiency, however. As prevalence of anemia in the population increases, so too does the proportion of cases of anemia caused by iron deficiency.[25]

Although further data on the medical causes and functional consequences of postpartum anemia are required, the high prevalence of postpartum anemia among low-income women participating in this multistate surveillance system suggests the importance of postpartum anemia screening at 4 to 6 weeks post partum for all low-income women. Given the magnitude of the problem in low-income women, the continuation of iron supplementation after delivery until women are screened at their first postpartum medical visit may be warranted.

Additional references are available upon request.

REFERENCES

1. Scholl TO, Hediger ML, Fischer RL, Shearer JW. Anemia versus iron deficiency: increased risk of preterm delivery in a prospective study. Am J Clin Nutr 1992;55:985-8.
2. Li R, Chen X, Yan H, Deurenberg P, Garby L, Hautvast JG. Functional consequences of iron supplementation in iron-deficient female cotton mill workers in Beijing, China. Am J Clin Nutr 1994;59:908-13.
3. Bruner AB, Joffe A, Duggan AK, Casella JF, Brandt J. Randomized study of cognitive effects of iron supplementation in nonanaemic iron-deficient adolescent girls. Lancet 1996;348:992-6.
4. Looker AC, Dallman PR, Carroll MD, Gunter EW, Johnson CL. Prevalence of iron deficiency in the United States. JAMA 1997;277:973-6.

5. Centers for Disease Control and Prevention. Pregnancy nutrition surveillance, 1996 full report. Atlanta: US Department of Health and Human Services, Centers for Disease Control and Prevention, 1998.
6. Bothwell TH. Overview and mechanisms of iron regulation. Nutr Rev 1995;53:237-45.
7. Milman N, Agger OA, Nielsen OJ. Iron supplementation during pregnancy. Dan Med Bull 1991;38:471-6.
8. Dawson EB, McGanity WJ. Protection of maternal iron stores in pregnancy. J Repro Med 1987;32(suppl 6):478-87.
9. Preziosi P, Prual A, Galan P, Daouda H, Boureima H, Hercberg S. Effect of iron supplementation on the iron status of pregnant women: consequences for newborns. Am J Clin Nutr 1997;66:1178-82.
10. Qvist I, Abdulla M, Jagerstad M, Svensson S. Iron, zinc, and folate status during pregnancy and two months after delivery. Acta Obstet Gynecol Scand 1996;65:15-22.
11. Taylor D, Lind T. Puerperal haematological indices. Br J Obstet Gynaecol 1981;88:601-6.
12. Centers for Disease Control and Prevention. Recommendation to prevent and control iron deficiency in the United States. MMWR 1998;47(RR-3):12-3 .
13. Nicol B, Croughan-Minihane M, Kilpatrick SJ. Lack of value of routine postpartum hematocrit determination after vaginal delivery. Obstet Gynecol 1997;90:514-8.
14. MRC Vitamin Research Study Group. Prevention of neural tube defects: results of the Medical Research Council Vitamin Study. Lancet 1991;338:131-7.
15. Moss AJ, Levy AS, Kim I, Park YK. Use of vitamin and mineral supplements in the United States: current users, types of products, and nutrients. Hyattsville (MD): National Center for Health Statistics; 1989. Advance Data from Vital and Health Statistics, No. 174.
16. Hotzel D. Suboptimal nutritional status in obesity (selected nutrients). Bibl Nutr Dieta 1986;21:36-41.
17. Kalkwarf HJ, Harrast SD. Effects of calcium supplementation and lactation on iron status. Am J Clin Nutr 1998;67:1244-9.
18. Billewicz WZ. The timing of post-partum menstruation and breast-feeding: a simple formula. J Biosoc Sci 1979;11:141.
19. National Research Council. Recommended Dietary Allowances, 10th ed. Report of the Subcommittee on the Tenth Edition of the RDAs, Food and Nutrition Board, Commission on Life Sciences. Washington, DC: National Academy Press; 1989.
20. Lawrence RA. Breast-feeding. A Guide for the Medical Profession. 4th ed. St. Louis: Mosby; 1994.
21. Henley SJ, Anderson CM, Avery MD, Hills-Bonczyk SG, Potter S, Duckett LJ. Anemia and insufficient milk in first-time mothers. Birth 1995;22:86-92.
22. ACOG educational bulletin. Postpartum Hemorrhage. Number 243, January 1998. American College of Obstetricians and Gynecologists. Int J Gynaecol Obstet 1998;61:79-86.
23. Combs CA, Murphy EL, Laros RK. Factors associated with post partum hemorrhage with vaginal birth. Obstet Gynecol 1991;77:69-76.
24. Newton M, Mosey LM, Egli GE, Gifford WB, Hull CT. Blood loss during and immediately after delivery. Obstet Gynecol 1961;17:9-18.
25. Binkin NJ, Yip R. When is anemia screening of value in detecting iron deficiency? In: Hercberg S, Galan P, Dupin H, editors. Recent knowledge on iron and folate deficiencies in the world. Vol. 197. Paris: L'Institut National de al Sante et de la Recharche Medicale; 1990;137-45.