Low Hemoglobin Level Is a Risk Factor for Postpartum Depression1

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ABSTRACT The role of maternal anemia in the development of postpartum depression (PPD) is unclear. PPD is a serious disorder that may negatively affect the physical and emotional health of a new mother and her infant. Although psychosocial factors that increase the risk of developing PPD are known, few studies have identified physiologic factors that predispose a woman to PPD. New mothers were visited at home on d 7, 14 and 28 after an uncomplicated labor and delivery. Hemoglobin (Hb) concentration was measured via finger-prick blood at each visit, and the women completed the Center for Epidemiological Studies-Depressive Symptomatology Scale (CES-D) on d 28. There was a negative correlation between Hb concentration on d 7 postpartum and depressive symptoms on d 28 ($r = -4.26; P = 0.009$). CES-D scores (means ± SEM) on d 7 of women with normal Hb levels > 120 g/L (12 g/dL) were significantly lower (6.90 ± 1.04) than those of women with Hb levels ≤ 120 g/L (12 g/dL) [16.36 ± 3.34; $t(35) = -3.632$, $P = 0.001$]. Thus, women suffering early postpartum anemia may be at increased risk of developing PPD. J. Nutr. 133: 4139–4142, 2003.

Childbirth is usually a time of great joy for all involved. Sometimes, however, the development of postpartum depression (PPD)$^3$ takes away the joy and threatens the health and happiness of a new mother and her infant. A woman suffering from PPD may experience interference in maternal role attainment and interruption of maternal-infant bonding (1–3). Long-term effects on her infant may result, including behavioral, developmental and cognitive delay, and may last years beyond infancy (3–9). Other family members, including partners and older children, may also suffer (3,10). Unfortunately, PPD is not uncommon, with a recent study estimating a 12% prevalence of major and 19% of minor PPD (11), rates consistent with previously published reports (12,13).

A number of psychosocial risk factors, including prenatal depression, child-care stress, infant temperament, low self-esteem and poor social support have been identified as contributing to the development of PPD (11). However, except for evidence that thyroid dysfunction may play a role in select cases [see (2) for review], few studies have identified physiologic variables that contribute to PPD. Recently, we identified one physiologic variable, fatigue, as a significant predictor of PPD (14). A second physiologic variable, anemia, contributes to fatigue and is associated with additional symptoms such as irritability, apathy and an inability to concentrate (15–17). Interestingly, iron deficiency, a common cause of anemia, alters thyroid hormone metabolism (18–21). All of these symptoms (fatigue, anemia, abnormal thyroid status) are probably interrelated in certain individuals; if they occur during the postpartum period, they could affect maternal health outcome. Whether anemia plays a role in the development of PPD, however, has received limited attention. Thus, the following study was designed to test the hypothesis that the occurrence of anemia in the early postpartum period is associated with an increased likelihood of a woman developing depression following the birth of a child.

SUBJECTS AND METHODS

This study was part of a larger investigation utilizing a longitudinal design to investigate the role of proinflammatory cytokines in the development of postpartum fatigue (22). Correlational analysis was used to evaluate this relationship as well as the relationship of anemia to depressive symptoms.

Sample. Women ($n = 37$) were recruited from two hospitals in central Pennsylvania within 24 h of giving birth. Inclusion criteria included the following: vaginal birth without complications including postpartum hemorrhage, full-term singleton infant, both mother and infant leaving the hospital together within 72 h, neither mother or infant demonstrating any acute or chronic illness upon discharge or at any time, and neither mother or infant taking any medications other than maternal usage of postnatal vitamins.

Instrumentation. The Center for Epidemiological Studies-Depressive Symptomatology Scale (CES-D) was used to screen for symptoms of depression. This 20-item self-report scale has been shown to be a valid and reliable measure of symptoms of depression (23). The CES-D has been used frequently in studies of depressive symptomatology in postpartum women (24–29). Of 0–60 points that can be scored on the CES-D, a cut-off point of 16 is used to indicate symptoms of severe depression and 11 to indicate symptoms of mild depression (23).

Procedure. Hospital staff members distributed invitation-to-participate letters to just-delivered mothers, requesting volunteers for a study concerning postpartum fatigue. Mothers who were willing to participate returned the completed invitation form to a staff nurse, who notified the investigators. The researchers then visited the new mothers while they were still in the hospital, within the first 24 h after delivery. At that time, the potential participants were provided

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3 Abbreviations used: CES-D, Center for Epidemiological Studies-Depressive Symptomatology Scale; Hb, hemoglobin; PPD, postpartum depression.

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a description of the study and, after agreeing to participate, signed an informed consent. Demographic information was collected, including age, marital status, parity, ethnicity, work outside the home, intent to breast- or bottle-feed and use of prenatal vitamins. At the end of the hospital interview, arrangements were made for follow-up visits to the participants’ homes. The Pennsylvania State University Institutional Review Board provided full approval for this protocol.

All women were visited in their homes between 900 and 1000 h, on d 7, 14 and 28 after giving birth. The final testing time of 28 d was chosen to fit into the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (30) diagnosis of postpartum depression onset and to capture the time period of peak postpartum fatigue (28).

Continuous information on feeding method, prenatal vitamin usage, and work status was collected at each visit. At the final visit (on d 28), women completed the CES-D questionnaire to assess symptoms of depression.

**Hemoglobin concentration.** Hemoglobin concentration was measured at each home visit by collecting a blood sample via finger prick and applying it to a portable Hb analyzer (Hemaque). The presence of anemia was defined as a hemoglobin concentration $\leq 120$ g/L (12.0 g/dL) (31).

**Data analysis.** Demographic data were plotted to gather descriptive statistics regarding the population. Pearson’s correlations were conducted to identify correlations between Hb concentration at each data collection point and depressive symptoms indexed at d 28. Mean Hb concentrations for each woman were also computed, and correlations between mean Hb and depressive symptoms on d 28 were determined. Subsequent separation of the data was performed on the basis of whether the new mothers demonstrated clinically low levels of Hb ($\leq 120$ g/L (12.0 g/dL) or had Hb levels within the normal range ($>120$ g/L (12.0 g/dL)). A Student’s Independent $t$ test was used to compare scores on the CES-D between the two groups. Separate $\chi^2$ analyses were used to identify significant differences among women who scored symptomatic of depression (CES-D scores $\geq 11$) compared with those who did not (CES-D scores $<11$), in regard to marital status, ethnicity, parity and feeding method. Significance for all data analysis was accepted at $P < 0.05$. All calculations were made using SPSS software. Values in the text are means $\pm$ SEM.

**RESULTS**

**Demographic data.** Of the 37 participants, 81% of the women were married, 89% were Caucasian, 8% were Asian and 3% were East Indian. Over half of the women (62%) had other children at home. Maternal ages ranged from 19 to 37 y, with a mean age of 28.3 y. Of the 37 women, 81% were breast-feeding their infants in the hospital; by d 28, 65% of the women were still breast-feeding at least 50% of the time. Twenty-three of the women had other children at home; of this number, 19 had one other child, 3 had two, and 1 woman had three other children at home. None of the women were working outside the home during the time of this study. Thirty-five of the women reported that they had taken prenatal vitamins throughout their pregnancy and all but one reported that they were continuing to do so postpartum; 2 women denied taking vitamins during or after their pregnancies.

**Hemoglobin concentration.** During the 28-d postpartum period, Hb concentration ranged from 104 to 170 g/L with means of 135.7 $\pm$ 2.8 g/L on d 7; 137.0 $\pm$ 2.2 g/L on d 14; and 136.8 $\pm$ 2.2 g/L on d 28. There were no significant changes in hemoglobin concentration over the time of the study. Eight of the women had Hb levels $\leq 120$ g/L on d 7, 4 on d 14, and 5 on d 28. Of these women, all reported having taken prenatal vitamins throughout their pregnancy. The Hb concentration for all women during the 28-d study was 136.5 $\pm$ 1.9 g/L. Only 2 women had mean Hb levels $\leq 120$ g/L over the entire study, both of whom reported using vitamins prenatally and postnatally. Hb concentration did not differ between women who had other children at home and those without.

**Depressive symptoms.** The CES-D score, as measured on d 28 for all participants, was $8.95 \pm 1.24$ with a range from 0 to 28. On the basis of a score of $<11$ on the CES-D, 23 of the 37 women (62%) were considered to be without significant symptoms of depression. A total of 8 women (22%) had scores that indicated moderate symptoms of depression, i.e., 11–15. Using CES-D cut-off scores $\geq16$ (23), 6 women (16%) had scores that indicated severe symptoms of depression. Women whose scores indicated moderate or severe depression did not differ from those scoring without symptoms of depression in marital status, presence of other children at home, ethnicity or breast- vs. bottle-feeding. There was no correlation between CES-D score on d 28 and maternal age.

**Hemoglobin concentration and depression.** Hemoglobin concentration on d 7 was negatively correlated with self-reported depressive symptoms at d 28 ($r = -0.26$, $P = 0.009$, $n = 37$). On d 7, low hemoglobin concentration accounted for 18.2% of the variance in depressive symptoms at d 28. The mean CES-D score on d 28 of women ($n = 8$) whose hemoglobin concentration was $\leq 120$ g/L on d 7 was 16.4 $\pm$ 3.34, whereas the mean CES-D score of women ($n = 29$) whose hemoglobin concentration was $>120$ g/L was 6.90 $\pm$ 1.04 [Fig. 1 ($t(35) = -3.632$, $P = 0.001$)]. Hemoglobin concentrations on d 14 and 28 were not correlated with depressive symptoms, although all of the women who had Hb levels $\leq 120$ g/L on d 14 had scores that were symptomatic of depression on d 28, with a CES-D score of 19.7 $\pm$ 3.94. There was a significant negative correlation between overall mean Hb level and CES-D score ($r = -0.381$, $P = 0.020$, $n = 37$).

**DISCUSSION**

The results of this study suggest that early postpartum anemia, as indicated by low Hb concentration, is a significant risk factor for PPD. Although low Hb levels are normal during...
a healthy pregnancy and the first 3–4 d postpartum, Hb levels are expected to rise and, because of volume contraction, even exceed the normal range by d 7 postpartum (32,33). For 8 women in this study, a return to normal Hb levels by d 7 did not occur, and for all except one of these 8, symptoms of depression were soon apparent.

This study does not allow us to determine whether the relationship between anemia and PPD is causal. However, given the results of several studies demonstrating a negative effect of anemia on self-reported quality of life (15,16,34), it is conceivable that anemia could contribute to depression in a new mother. Anemia has been shown to worsen symptoms of fatigue, irritability and poor concentration (15), all of which might influence how a new mother feels during the postpartum period and how she interacts with her infant. Because we did not measure symptoms of PPD at any time other than d 28 in this study, the possibility that a high CES-D score may have been found earlier cannot be ruled out. However, the finding that Hb levels were not correlated in d 28 suggests that the relationship between these variables need not be fixed in time. In explaining how the occurrence of anemia on d 7 might influence the development of symptoms of PPD on d 28, it is possible that the being anemic during the first 1 or 2 wk postpartum may cause a new mother to either miss or misinterpret her infant's cues early on or to become impatient with her infant or other children. It might also so negatively affect her quality of life that her feelings of happiness with having a new baby fall short of her expectations. Any of these developments could precipitate a new mother's spiral into clinically relevant depression by d 28.

To our knowledge, three previous publications have reported the relationship between anemia and PPD. In the first (35), low Hb levels were associated with low energy, faintness, painful perineal sutures and tingling of the extremities, but no correlation was found between Hb levels and PPD. However, the women who were most likely to have low Hb levels in the study were those who had had an abnormal delivery and those who had experienced heavy blood loss with delivery; these criteria would have been exclusionary in the current study. Women who become anemic as a result of a perinatal incident might represent a different population with different risks for developing PPD, compared with women who are anemic postpartum without having experienced heavy perinatal blood loss. In the second study, women who were determined to be anemic between 12 and 36 h postpartum had a reduced feeling of well-being on d 5 postpartum compared with women who were nonanemic soon after giving birth (36). Again, however, a large proportion (62%) of the women who were identified as anemic had experienced complications during delivery, including cesarean section, compared with a much lower proportion (6%) of the women who were not anemic on d 28. As mentioned above, women experiencing perinatal trauma or surgery may have risks for PPD unrelated to anemia. The third study, conducted in the African republic of Tanzania (37), found a high degree of overlap between anemia and postnatal depression. However, in that study, only women suffering from postnatal psychosis were included. The incidence of anemia in a comparison group of nonpsychotic mothers was not reported.

The implications of a linkage between low Hb concentration and PPD are important. First, although the cause of low Hb in this population of new mothers is unclear, the most common cause of reduced Hb in healthy adults is iron deficiency (38). Iron deficiency is estimated to occur in >50% of women of reproductive age (39,40); therefore, identifying a link between iron-deficiency anemia and PPD could potentially affect the health of thousands of women and children around the world. Second, prevention of PPD with iron supplementation may be possible for some women identified as being anemic either prenatally or soon after giving birth. However, as described above, all but 2 of the mothers in this study reported taking prenatal vitamins throughout their pregnancies, yet 8 were found to be clinically anemic on d 7 postpartum. Neither of the 2 women who denied vitamin usage had low Hb levels. Whether the women in this study actually took the vitamins as prescribed, however, and with what regularity, is unknown. Finally, in spite of these caveats, all new mothers should be counseled by health care providers about the risks of anemia throughout their pregnancies and should be reminded to continue eating well even after delivery.

Limitations to this study include its relatively small sample size and its homogeneity, with most of the women Caucasian, married and choosing to breast-feed. Also, although nearly 95% of the participants in this study claimed to be taking vitamins, they were not asked when in their pregnancies they began taking vitamins, and, as mentioned above, their adherence was not verified. In addition, although the most common cause of anemia in otherwise healthy adults is iron deficiency, we did not measure serum iron or ferritin levels in this population and so cannot rule out the possibility that for some of the women, low Hb may have been a result of a disorder other than iron deficiency. And finally, although none of the women had been diagnosed with a thyroid disorder, we did not screen for thyroid dysfunction and so cannot rule out the possibility that thyroid hormone secretion or metabolism was abnormal. This is important because iron-deficiency anemia has been shown to lower thyroid hormone level and to alter thyroid metabolism in both human and animal studies (18–21,41). Thus, although all of the women were without known comorbidities, low Hb concentration might have accompanied additional health concerns.

In summary, low Hb level at 1 wk postpartum was a significant risk factor for the development of PPD symptomatology in this population. Future studies are required to examine further the relationship between these variables and to determine whether documented use of pre- and postnatal vitamins could reduce the likelihood of a new mother developing PPD.

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LITERATURE CITED


