BMC Pregnancy and Childbirth

RESEARCH

Open Access

Effect of gestational anemia on breastfeeding– a prospective follow-up -study

Lotta Kemppinen[1*], Mirjami Mattila[1], Eeva Ekholm[1], Laura Perasto[2,4], Hasse Karlsson[2,3], Kaarin Mäkikallio[1†] and Linnea Karlsson[2,4,5,6†]

Abstract

Background Gestational anemia is a common pregnancy complication that affects approximately 40% of pregnant women globally. The health benefits of breastfeeding are widely acknowledged for both mothers and infants, and recognizing the factors that affect the duration and quality (exclusive / partial) of breastfeeding is therefore of great importance.

Methods Women who participated in the FinnBrain Birth Cohort during 2011–2015 and whose hemoglobin levels were available in the third trimester ($n=1238$) were included in this prospective study. The study group comprised women in the third trimester with an Hb < 110 g/l ($n=150$), while women with an Hb ≥ 110 g/l served as the control group ($n=1088$). The duration of breastfeeding was recorded as a categorical variable in line with the Finnish breastfeeding guidelines, which specify 4 months as the cut-off for exclusive breastfeeding, and as a continuous variable for exclusive and partial breastfeeding. Maternal and neonatal data were collected from the Medical Birth Register and self-reports. The data were adjusted for maternal education, parity, mode of delivery, and maternal depression.

Results The median (range) duration of exclusive breastfeeding was 4 (0–6) months in the study group and 4 (0–10) months in the control group ($p=.461$). Among the women in the study group, 60% reached the recommended goal of exclusive breastfeeding of 4 months, while the proportion was 66% among the women in the control group ($p=.185$). The duration of exclusive breastfeeding was shorter among the women who suffered from depressive symptoms (Edinburgh Postnatal Depression Scale (EPDS) ≥ 12) three months postpartum. The duration of partial breastfeeding was 7 and 8 months in the study and control groups, respectively ($p=.080$).

Conclusions In our prospective study cohort, gestational anemia in the third trimester did not associate with the duration and quality of breastfeeding after adjusting for confounding factors.

†Kaarin Mäkikallio and Linnea Karlsson contributed equally to this work.

*Correspondence:
Lotta Kemppinen
riloke@utu.fi

Full list of author information is available at the end of the article

Keywords Gestational anemia, Iron deficiency anemia in pregnancy, Breastfeeding, Postpartum complications, Maternal depression

Background

Approximately 40% of pregnant women globally suffer from gestational anemia, although the prevalence varies widely between countries [1]. Anemia in pregnancy is defined as having a hemoglobin (Hb) level below 110 g/l, and it is most commonly caused by iron deficiency [2, 3]. Gestational anemia is associated with several pregnancy and delivery complications and adverse neonatal outcomes, such as fetal growth restriction and prematurity [4–7]. The effect of postpartum anemia on duration and quality (exclusive / partial) of breastfeeding has been linked with an early cessation of breastfeeding, and women with anemia at delivery have been reported to initiate breastfeeding less likely than non-anemic women [8]. However, data regarding the relationship between gestational anemia and breastfeeding is scarce. In some studies, gestational anemia has been associated with an increased risk of maternal depression [9], which is known to affect breastfeeding [10].

The benefits of breastfeeding for the mother and infant are widely acknowledged. Breastfeeding decreases the short- and long-term morbidity and mortality of both the mother and infant [11]. The World Health Organization recommends exclusive breastfeeding for all infants until 6 months of age [12], yet few women achieve this goal [13, 14]. The recommendations regarding exclusive breastfeeding vary from country to country. In Finland, almost 100% of pregnant women receive regular primary maternal care and are introduced to Finnish breastfeeding guidelines, which recommend exclusive breastfeeding until 4 months of age and the continuation of breastfeeding with the introduction of complementary foods thereafter.

Breast milk has a low concentration of iron, and the iron stores of newborns are mainly formed in utero [15]. Maternal iron deficiency can have a significant impact on fetal development, as iron is essential for myelination, neurotransmitter function, neuronal energy metabolism, and dendritogenesis during the development of the fetal central nervous system [16]. Gestational iron deficiency anemia has also been linked to iron deficiency anemia in infancy [17]. Iron deficiency anemia as well as iron depletion in infancy can cause poor cognitive and behavioral performance later in life [18].

The identification of the factors that negatively affect breastfeeding is of great importance. In this study, we hypothesized that pregnant women with anemia are more likely to breastfeed their infants for a shorter period than women with no gestational anemia. Specifically, we aimed to evaluate the effect of gestational antenatal anemia on the duration and quality (exclusive / partial) of breastfeeding.

Methods

In this study, the data from the FinnBrain Birth Cohort were used. Women who attended maternal antenatal clinics in the South-Western Hospital District of Finland and Åland Islands between December 2011 and April 2015 were prospectively recruited for this cohort [19]. To participate, women were required to have a verified pregnancy and sufficient knowledge of either Finnish or Swedish, which are the official languages of Finland. Of the 3808 women in this cohort, 1238 women who had received their primary maternity care in Turku and had accessible laboratory test results were included in this study. According to the Finnish guidelines, Hb should be checked in every trimester with a point-of-care finger stick test, and if needed or a pregnant woman has symptoms of anemia, a venous blood sample is drawn to determine the Hb level and reported to laboratory records.

The study group consisted of pregnant women with an Hb < 110 g/l at > 30 gestational weeks, and women with an Hb level ≥ 110 g/l at > 30 weeks served as the control group. The duration of breastfeeding was recorded as a categorical variable in line with the Finnish breastfeeding guidelines: (1) exclusive breastfeeding for at least 4 months or (2) no exclusive breastfeeding for at least 4 months. Breastfeeding was also analyzed as a continuous variable between the groups by exploring the duration of exclusive breastfeeding (months) and the duration of partial breastfeeding (months).

Maternal self-report was used to collect the data on maternal education, hypertension, diabetes, alcohol consumption (0 = not at all, 1 = yes), and smoking. The data on maternal body mass index, parity, induction of labor, gestational age at delivery, mode of delivery, duration of labor, significant hemorrhage during labor (> 1000 ml in cesarean delivery and > 500 ml in vaginal delivery), maternal red blood cell transfusions, birth weight and gender of the newborn, umbilical cord acid–base values, and care in the neonatal intensive unit were collected from the Medical Birth Register maintained by the National Institute for Health and Welfare (www.thl.fi). Depressive symptoms were assessed using an internationally validated, self-report questionnaire, the Edinburgh Postnatal Depression Scale (EPDS) [20, 21]. In Finland, the EPDS is routinely used to screen for maternal antenatal and postpartum depression [20]. It comprises 10 questions, which are scored on a 4-point Likert scale from 0 to 3, and the total score varies between 0 and

30. An EPDS ≥ 12 indicates major clinical depression [20]. In this study, the EPDS results from the third trimester as well as three months after delivery were used.

An attrition analysis was performed to compare the group of participants who were from Turku and had an Hb measurement in the 3rd trimester ($n = 1238$) with the group who were from Turku but did not have an Hb measurement in the 3rd trimester ($n = 1926$). Mothers who had Hb measured ($n = 1238$) were the same age (mean: 30.0 vs. 29.9, $p = .543$), had the same proportion of highly educated mothers (37.7% vs. 38.3% $p = .869$) and had the same proportion of primiparous mothers (58.9% vs. 64.5%, $p = .051$) as the ones with no Hb measurement ($n = 1926$). Mothers with Hb measurement had slightly lower EPDS sum at 34 gestational week (mean: 4.66 vs. 5.49, $p = .006$) compared to the ones with no Hb measurement. However, no difference was detected in the EPDS sum three months postpartum (mean: 4.19 vs. 4.43, $p = .556$). Mothers with Hb measurement breastfed their neonates exclusively (mean: 3.4 vs. 3.4 months, $p = .099$) and partially (mean: 8.8 vs. 8.4 months, $p = .073$) as long as the mother with no Hb measurement in this cohort.

Statistical analysis

SPSS software (IBM® SPSS Statistics 25.0) was used to conduct the statistical analyses. To detect possible differences in the maternal and neonatal characteristics between the groups, the chi-squared and Fisher's exact tests were used. The distribution of the data was evaluated using a visual assessment and the Kolmogorov–Smirnov and Shapiro–Wilks tests. The independent sample *t*-test was employed if the data were normally distributed. Otherwise, the Mann–Whitney *U* test was applied.

The dependent variable, breastfeeding, was used both as a continuous and categorical variable. Duration of breastfeeding was self-reported as months by the women. A stepwise general linear model was used to assess the relationship between maternal antenatal anemia and the duration of exclusive and partial breastfeeding (months). The covariates included in Step 1 were mode of delivery, parity, level of education, which are all known to affect the duration of breastfeeding [22–24]. Stepwise models that explore the effects of antenatal and postnatal EPDS scores on the duration of breastfeeding were investigated. In Step 2, the EPDS at the third trimester was added to the model, and in Step 3, the postnatal EPDS was inserted into the model. Both the antenatal and postnatal EPDS were used as categorical variables, and an EPDS ≥ 12 was used as the cut-off value for clinical depression. For the categorical dependent variable, a similar stepwise analysis was performed using logistic regression. A two-tailed p-value < 0.05 was considered statistically significant.

List of performed regression models:

Step 1: breastfeeding ~ intercept + anemia + mode of delivery + parity + level of education.

Step 2: breastfeeding ~ intercept + anemia + mode of delivery + parity + level of education + prenatal EPDS.

Step 3: breastfeeding ~ intercept + anemia + mode of delivery + parity + level of education + prenatal EPDS + postnatal EPDS.

where breastfeeding was continuous or categorical.

Results

The maternal and neonatal characteristics of the groups are described in Table 1. From the total of 1238 women in the FinnBrain cohort who received primary maternal care in Turku and whose Hb values were available, 150 (12%) women had an Hb below 110 g/l at > 30 weeks, while 1088 women with an Hb level ≥ 110 g/l served as the control group. The Hb levels were significantly lower in the group with anemia across all trimesters. Smoking, a lower level of education, multiparity, and prior cesarean delivery were more prevalent in the group with gestational anemia than in the control group. Three out of 150 women (2.8%) in the study group and two out of 1088 women (0.2%) in the control group had pregestational diabetes ($p = .011$). The duration of delivery was shorter, and the newborn birth weight and number of maternal red blood cell transfusions administered after delivery were greater in the group with anemia. The frequency of postpartum EPDS scores ≥ 12 was greater in the study group than the control group (7.5% vs. 4.6%, respectively; $p = .268$), but the difference was not statistically significant.

The duration of exclusive breastfeeding was similar among gestational anemic and non-anemic women (Table 2). Both groups breastfed their infants exclusively for a median of 4 months, with a range of 0–6 months in the study group vs. 0–10 months in the control group ($p = .461$). In the unadjusted analysis, fewer women with gestational anemia reached the recommended goal of exclusive breastfeeding for at least 4 months compared to those in the control group, but the difference disappeared when adjusted for the mode of delivery, parity, and level of education (59.5% vs. 65.6%, respectively, $p = .185$).

When using exclusive breastfeeding as a categorical variable with the Finnish guideline cut-offs, the women with gestational anemia reached the recommended goal of 4 months of exclusive breastfeeding as often as those without anemia. However, the duration of exclusive breastfeeding was shorter among those women who suffered from depressive symptoms (EPDS > 12) three months postpartum, and they reached the goal of exclusive breastfeeding for at least 4 months less frequently (Table 3).

The duration of partial breastfeeding was shorter in the women with gestational anemia. However, when the

Table 1 Maternal characteristics and outcomes in pregnancies with gestational anemia in the third trimester (Hb < 110 g/l) and the control group (Hb ≥ 110 g/l). The values are given as median (range) or n (%)

	Hb < 110 g/l > H30 (*n* = 150)	**Hb ≥ 110 g/l > H30 (*n* = 1088)**	***p*-value**
Maternal factors			
Age at delivery (years)	29 (18–45)	30 (17–44)	0.089
Primiparous	36.7% (54/147)	64.9% (692/1067)	< 0.001*
Body mass index	23 (16–45)	23 (17–46)	0.67
Prior cesarean delivery	10.9% (16/147)	5.5% (59/1067)	0.011*
Hypertension	2.8% (3/109)	2.0% (18 /891)	0.492
Type 1 or 2 diabetes	2.8% (3/109)	0.2% (2/891)	0.011*
Smoking			0.001*
I trimester	12.1% (18/149)	10.2% (110/1081)	
III trimester	11.4% (17/149)	5.6% (60/1081)	
Alcohol consumption			
I trimester	20.6% (22/107)	24.1% (210/873)	0.422
III trimester	12.4% (11/89)	10.8% (84/777)	0.658
Level of education			0.044*
Secondary school	43.1% (47/109)	32.7% (292/893)	
High school or vocational education	28.4% (31/109)	27.8% (248/893)	
University/polytechnic degree or higher	28.4% (31/109)	39.5% (353/893)	
Pregnancy			
Hb at > 30 weeks	106 (87–109)	123 (110–149)	< 0.001*
Gestational diabetes	15.0% (22/147)	13.4% (143/1067)	0.608
EPDS I trimester	5.0 (0–26)	5.0 (0–27)	0.108
EPDS II trimester	4.0 (0–20)	4.0 (0–25)	0.515
EPDS III trimester	4.0 (0–17)	4.0 (0–19)	0.265
EPDS ≥ 12 III trimester	13.5% (12/89)	5.1% (40/781)	0.002*
Delivery and postpartum period			
Induction of labor	24.5% (36/147)	24.3% (259/1066)	0.959
Mode of delivery			
Vaginal delivery	81.6% (120/147)	81.5% (870/1067)	0.978
Cesarean section	18.4% (27/147)	18.5% (197/1067)	
Elective	12 (44.4%)	70 (35.5%)	0.611
Emergency	14 (51.9%)	114(57.9%)	
Crash emergency	1 (3.7%)	13 (6.6%)	
Duration of delivery (minutes)	369 (59–1814)	472 (39–2204)	0.002*
Significant hemorrhage at delivery	12.9% (19/147)	11.8% (126/1066)	0.696
Red blood cell transfusion	6.8% (10/147)	2.7% (29/1066)	0.020*
EPDS 3 months postpartum	4.0 (0–17)	3.0 (0–21)	0.115
EPDS 6 months postpartum	3.0 (0–24)	3.0 (0–22)	0.584
EPDS ≥ 12 3 months postpartum	7.5% (6/80)	4.6% (31/676)	0.268
Neonatal outcome			
Male	50.7% (75/148)	51.2% (553/1081)	0.913
Birthweight (g)	3650 (1560–4950)	3554 (820–5200)	0.041*
GA at delivery (gwks)	40 (34.8–42.1)	40 (29.3–42.4)	0.230
Apgar 5 min	9 (5–10)	9 (3–10)	0.635
Apgar 5 min < 7	1.4% (2/147)	1.5% (16/1066)	1.000
Umbilical artery pH	7.28 (7.05–7.45)	7.27 (6.80–7.54)	0.256
Umbilical vein pH	7.37 (7.13–7.52)	7.35 (6.94–7.52)	0.296
Neonatal intensive care	18.4% (27/147)	13.7% (146/1067)	0.132
Breastfeeding			
Exclusive breastfeeding duration (months)	4.0 (0–6)	4.0 (0–10)	0.461
Partial breastfeeding duration (months)	7.0 (0–22)	8.0 (0–25)	0.080
Breastfeeding duration (categorical)			0.277

Table 1 (continued)

	Hb < 110 g/l > H30 (*n* = 150)	Hb ≥ 110 g/l > H30 (*n* = 1088)	*p*-value
Exclusive breastfeeding ≥ 4 months	59.5% (47/79)	65.6% (451/687)	
Exclusive breastfeeding < 4 months	40.5% (32/78)	34.4% (236/668)	

Given during delivery or puerperium

* $p < .05$

Abbreviations: EPDS, Edinburgh pregnancy depressive symptoms; GA, gestational age; gwks, gestational weeks; Hb, hemoglobin

Table 2 Stepwise associations between gestational anemia (Hb < 110 g/l) and exclusive breastfeeding: results of the linear regression models controlled for mode of delivery, parity and level of education

	Variable	B	95% CI	*p*-value
Step 1	Hb III trimester[a]	−0.38	−0.85; 0.10	0.119
Step 2	Hb III trimester[a]	**−0.50**	**−1.00; -0.01**	**0.049**
	EPDS III trimester[b]	0.14	−0.52; 0.80	0.679
Step 3	Hb III trimester[a]	−0.42	−0.94; 0.09	0.107
	EPDS III trimester[b]	0.24	−0.48; 0.96	0.509
	EPDS 3 months postpartum[b]	**−1.04**	**−1.78; −0.29**	**0.006**

Note: [a] The reference level is Hb ≥ 110 g/l > H30 gwks. [b] The reference level is EPDS < 12. Hemoglobin (Hb), Edinburgh pregnancy depressive symptoms (EPDS), confidence interval (CI), estimated difference in partial breastfeeding between the groups (B). Exclusive breastfeeding was assessed as a continuous variable. All models were adjusted for mode of delivery, parity, and level of education. In Steps 2 and 3, the binary EPDS score at the third trimester and three months postpartum, respectively, were added. Gestational anemia (Hb < 110 g/l) did not impact the duration of exclusive breastfeeding. Statistically significant results are bolded

Table 3 Stepwise associations between gestational anemia (Hb < 110 g/l) and exclusive breastfeeding: results of the logistic regression models controlled for mode of delivery, parity and level of education

	Variable	OR	95% CI	*p*-value
Step 1	Hb III trimester[a]	1.41	0.89; 2.36	0.185
Step 2	Hb III trimester[a]	1.52	0.89; 2.60	0.122
	EPDS III trimester[b]	0.70	0.33; 1.48	0.352
Step 3	Hb III trimester[a]	1.56	0.88; 2.79	0.131
	EPDS III trimester[b]	0.64	0.28; 1.48	0.296
	EPDS 3 months postpartum[b]	**2.67**	**1.16–6.15**	**0.021**

Note: [a] The reference level is Hb ≥ 110 g/l > H30 gwks. [b] The reference level is EPDS < 12. Hemoglobin (Hb), Edinburgh pregnancy depressive symptoms (EPDS), confidence interval (CI), odds ratio (OR). Exclusive breastfeeding was assessed as a binary variable. All models were adjusted for mode of delivery, parity, and level of education. In Steps 2 and 3, the binary EPDS score at the third trimester and three months postpartum, respectively, were added. The women with gestational anemia (Hb < 110 g/l) reached the recommended goal of 4 months of exclusive breastfeeding as often as those without anemia. Exclusive breastfeeding was assessed as a binary variable (the reference level is over 4 months). Statistically significant results are bolded

analysis was adjusted for the EPDS scores three months postpartum, this difference disappeared (Table 4).

Discussion

The aim of the present study was to determine whether gestational anemia had an effect on the duration of breastfeeding when taking into account several known modifying factors. In this study, maternal anemia during the last trimester did not shorten the duration of breastfeeding after adjusting for known confounding factors.

In our cohort, 12% of the women had anemia in the third trimester despite maternal Hb screening by maternal primary caregivers and iron supplementation. Previously approximately 20% of pregnant women in Finland have been estimated to have anemia [25].

Gestational anemia in the third trimester did not associate with the duration of exclusive and partial breastfeeding. The median duration of exclusive breastfeeding among both the women with anemia and those in the control group was 4.0 months. About 60% of the mothers with anemia fed their infants with breast milk exclusively up to the recommended age of 4 months. The median duration of partial breastfeeding with complementary food was 7 months. In comparison, these figures were 66% and 7 months for the mothers in the control group, respectively, with no statistical difference between the studied groups. This finding is comforting, as gestational anemia remains the most common pregnancy complication worldwide. Only a few studies have explored the connection between maternal anemia and the duration of breastfeeding, and their focus has been on postpartum anemia [26, 27]. In a Canadian questionnaire study of 85 mothers in 1998–1999, severe postpartum anemia with an Hb < 95 g/l was associated with the earlier cessation of breastfeeding [26]. The biological mechanisms explaining the association between anemia and breastfeeding

Table 4 Stepwise associations between gestational anemia (Hb < 110 g/l) and partial breastfeeding: results of the linear regression model controlled for mode of delivery, parity and level of education

	Variable	B	95% CI	*p*-value
Step 1	**Hb III trimester[a]**	**−1.30**	**−2.49; −0.10**	**0.034**
Step 2	Hb III trimester[a]	−1.10	−2.35; 0.14	0.082
	EPDS III trimester[b]	0.59	−1.05; 2.27	0.481
Step 3	Hb III trimester[a]	−1.05	−2.36; 0.25	0.114
	EPDS III trimester[b]	0.47	−1.35; 2.30	0.610
	EPDS 3 months postpartum[b]	−0.42	−2.31; 1.47	0.663

Note: [a] The reference level is Hb ≥ 110 g/l > H30 gwks. [b] The reference level is EPDS < 12. Hemoglobin (Hb), Edinburgh pregnancy depressive symptoms (EPDS), confidence interval (CI), estimated difference in partial breastfeeding between the groups (B). Partial breastfeeding was assessed as a continuous variable. All models were adjusted for mode of delivery, parity, and level of education. In Steps 2 and 3, the binary EPDS score at the third trimester and three months postpartum, respectively, were added. The women with gestational anemia (Hb < 110 g/l) had a shorter duration of partial breastfeeding. Statistically significant results are bolded

are not clear. The effect of anemia and maternal fatigue on breastfeeding has been discussed. Henly et al. has suggested that postpartum anemia (Hb < 100 g/l) is associated with the insufficient development of milk, which would lead to the earlier cessation of breastfeeding [27]. In some studies, anemia at delivery and postpartum has been found to be associated with the later initiation of breastfeeding [8, 28].

In our cohort, gestational anemia in the third trimester was mild to moderate, and the Hb levels in the group with anemia varied between 87 and 109 g/l. The fetal period is extremely important in terms of the newborn's iron stores, as they are mainly formed in utero [15]. Active iron transport from the mother to the fetus is thought to ensure adequate iron stores for the fetus and thus normal fetal neurodevelopment despite mild or moderate maternal iron deficiency anemia [29]. Studies on cord blood serum ferritin concentrations have shown a relationship between maternal and fetal iron stores [30]. During pregnancy, maternal iron supplementation is provided to women with low Hb levels detected during screening, and an effective measure to prevent neonatal anemia is delayed cord clamping, as this allows iron-rich blood to flow from the placenta to the newborn [17, 31, 32]. In high-income countries, the fetus appears to be protected from significant iron deficiency, and iron supplementation for pregnant women is thus not believed to impact the iron status of infants significantly [33]. However, in low- and middle-income countries where high frequencies of malnutrition are associated with severe maternal iron deficiency anemia, iron supplementation seems to improve the iron status of infants [34]. Breast milk is low in iron, but its absorption is high, especially when infants are breastfed exclusively during the first months after birth [12]. A long duration of breastfeeding should always be the goal, as the positive effects include not only the impact on the neurodevelopment of the newborn but also the infant's immune system development, microbiota, metabolic outcomes, and mother–child bonding [35].

In our study, the association between the duration of exclusive breastfeeding and gestational anemia was altered when the maternal depressive symptom score (EPDS) was added to the model as a covariate. This suggests that postpartum depressive symptoms influence breastfeeding together with gestational anemia. The global prevalence of prenatal and postpartum depression is estimated to be around 15% and 17%, respectively [36, 37]. It is of note that in our earlier study, which was conducted with the same cohort, gestational anemia during pregnancy was not associated with an increased risk of maternal depression either prenatally or postpartum [38]. Although we did not primarily query this in the current study, postpartum depressive symptoms are potentially relevant targets for supportive measures on breastfeeding.

The strengths of our study include a large study cohort representative of the general population, a prospective study setting, and intensive data collection of both background and clinical data, including data on maternal depressive symptoms, which were collected repeatedly during the pregnancy and postpartum period via a validated questionnaire [39]. Only very few studies regarding antenatal anemia and breastfeeding in a high-income country with structured antenatal care exist and therefore our large cohort study contributes significantly to the existing research. Furthermore, clinical data on pregnancies and deliveries in Finland are collected prospectively for the national register with a high validity [40].

Notwithstanding, some limitations in our study are acknowledged. From an epidemiological point of view the size of the study cohort is rather small. However, data on the effect of gestational anemia on breastfeeding is scarce and reports exploring postnatal anemia have included 424–3534 women [8, 26–28]. The attrition was large but as our attrition analysis showed it did not affect the results. While the fetal period is the most significant regarding the formation of neonatal iron storages, we focused on gestational anemia. Unfortunately, the data did not include postpartum Hb values, as postpartum Hb

is only screened in the Finnish follow-up program if the maternal condition requires it. However, the Hb values were collected in all three trimesters, which increased the reliability of gestational anemia, and we found no difference between the groups in terms of significant blood loss during delivery. Furthermore, despite the women with gestational anemia received red blood cell transfusions postpartum more frequently than the non-anemic controls, they breastfed their infants as long as their peers in the control group.

Conclusions

In this prospectively collected cohort, gestational anemia in the third trimester of pregnancy did not associate with the duration or quality (exclusive / partial) of breastfeeding after controlling for confounding factors. The women with and without gestational anemia breastfed their infants equally long exclusively and partially, the mean durations being 4.0 months in both groups for exclusive breastfeeding and 7.0 and 8.0 months for partial breastfeeding, respectively.

Abbreviations

EPDS	Edinburgh postnatal depression scale
gwk	Gestational week
Hb	Hemoglobin

Acknowledgements

Not applicable.

Author contributions

Conceptualization: LK, MM, EE, KM, and LKa; Data curation: LK and LP; Formal analysis: LK and LP; Funding acquisition: LKa; Methodology: LK, MM, EE, KM, and LKa; Project administration: KM and LKa; Writing (original draft): LK, MM, EE, LP, KM, and LKa; Writing (review and editing): LK, MM, EE, LP, KM, and LKa. All the authors read and approved the final manuscript.

Funding

Finnish Medical Association, Elämälle-Foundation (LK). The Research Council of Finland (HK, LKa), Signe and Ane Gyllenberg Foundation (HK, LKa, EE), Finnish State Grants for Clinical Research (ERVA) (HK, LKa, EE).

Data availability

Access to data can be inquired by contacting PI Hasse Karlsson or co-PI Linnea Karlsson.

Declarations

Ethics approval and consent to participate

All the study participants provided their written informed consent. This study meets the ethical guidelines and has been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. The Ethics Committee of the Hospital District of Southwest Finland approved the FinnBrain Birth Cohort Study on June 14, 2011 (protocol number: ETMK: 57/180/2011).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

[1]Department of Obstetrics and Gynecology, Turku University Hospital and University of Turku, Lighthouse Hospital, Savitehtaankatu 5, Turku 20520, Finland
[2]Department of Clinical Medicine, FinnBrain Birth Cohort Study, Turku Brain and Mind Center, University of Turku, Turku, Finland
[3]Department of Psychiatry, University of Turku and Turku University Hospital, Turku, Finland
[4]Centre for Population Health Research, Turku University Hospital and University of Turku, Turku, Finland
[5]Department of Public Health, University of Turku, Turku University Hospital, Turku, Finland
[6]Department of Child Psychiatry, Turku University Hospital, Turku, Finland

Received: 5 February 2025 / Accepted: 28 May 2025
Published online: 04 June 2025

References

1. WHO. The global prevalence of anaemia in 2011–2015. World Health Organization. (Accessed 16. April 2024).
2. Stevens GA, Finucane MM, De-Regil LM, Paciorek CJ, Flaxman SR, Branca F, et al. Global, regional, and National trends in haemoglobin concentration and prevalence of total and severe anaemia in children and pregnant and non-pregnant women for 1995–2011: A systematic analysis of population-representative data. Lancet Glob Health. 2013;1:16–25. https://doi.org/10.1016/S2214-109X(13)70001-9.
3. Guideline. Daily Iron and folic acid supplementation in pregnant women. World Health Organ. 2012. https://doi.org/10.1055/s-0028-1104741.
4. Jung J, Rahman MM, Rahman MS, Swe KT, Islam MR, Rahman MO, et al. Effects of hemoglobin levels during pregnancy on adverse maternal and infant outcomes: a systematic review and meta-analysis. Ann N Y Acad Sci. 2019;1450:69–82. https://doi.org/10.1111/nyas.14112.
5. Young MF, Oaks BM, Tandon S, Martorell R, Dewey KG, Wendt AS. Maternal hemoglobin concentrations across pregnancy and maternal and child health: a systematic review and meta-analysis. Ann N Y Acad Sci. 2019;1450:47–68. https://doi.org/10.1111/nyas.14093.
6. Rahmati S, Delpishe A, Azami M, Ahmadi MRH, Sayehmiri K. Maternal anemia during pregnancy and infant low birth weight: A systematic review and meta-analysis. Int J Reprod Biomed. 2017;15:125–34. https://doi.org/10.29252/ijrm.15.3.125.
7. Drukker L, Hants Y, Farkash R, Ruchlemer R, Samueloff A, Grisaru-Granovsky S. Iron deficiency anemia at admission for labor and delivery is associated with an increased risk for Cesarean section and adverse maternal and neonatal outcomes. Transfusion. 2015;55:2799–806. https://doi.org/10.1111/trf.13252.
8. Örün E, Yalcin SS, Madendag Y. Factors associated with breastfeeding initiation time in a Baby-Friendly hospital. Turk J Pediatr. 2010;52:10–6. https://doi.org/10.15446/rsap.v25n1.104295.
9. Kang SY, Kim HB, Sunwoo S. Association between anemia and maternal depression: A systematic review and meta-analysis. J Psychiatr Res. 2020;122:88–96. https://doi.org/10.1016/j.jpsychires.2020.01.001.
10. Gagliardi L, Petrozzi A, Rusconi F. Symptoms of maternal depression immediately after delivery predict unsuccessful breast feeding. Arch Dis Child. 2012;97:355–7. https://doi.org/10.1136/adc.2009.179697.
11. Victora CG, Bahl R, Barros AJD, França GVA, Horton S, Krasevec J, et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. Lancet. 2016;387:475–90. https://doi.org/10.1016/S0140-6736(15)01024-7.
12. Kramer MS, Kakuma R. Optimal duration of exclusive breastfeeding. Cochrane Database Syst Rev. 2012, Issue 8. Art. No.: CD003517. https://doi.org/10.1002/14651858.CD003517.pub2
13. Scott JA, Binns CW, Oddy WH, Graham KI, Dip G, Diet N. Predictors of breastfeeding duration: evidence from a cohort study. Pediatrics. 2006;117(4):e646–55. https://doi.org/10.1542/peds.2005-1991.
14. Cai X, Wardlaw T, Brown DW. Global trends in exclusive breastfeeding. Int Breastfeed J. 2012;7:2–6. https://doi.org/10.1186/1746-4358-7-12.
15. Friel J, Qasem W, Cai C. Iron and the breastfed infant. Antioxidants. 2018;7:2–9. https://doi.org/10.3390/antiox7040054.
16. Lozoff B. Early iron deficiency has brain and behavior effects consistent with dopaminergic dysfunction1-3. J Nutr. 2011;141. https://doi.org/10.3945/jn.110.131169.

17. Sundararajan S, Rabe H. Prevention of iron deficiency anemia in infants and toddlers. Pediatr Res. 2021;89:63–73. https://doi.org/10.1038/s41390-020-0907-5.
18. Lozoff B, Beard J, Connor J, Felt B, Georgieff M, Schallert T. Long-lasting neural and behavioral effects of iron deficiency in infancy. Nutr Rev. 2006;64:34–43. https://doi.org/10.1301/nr.2006.may.S34-S43.
19. Karlsson L, Tolvanen M, Scheinin NM, Uusitupa H, Korja R, Ekholm E, et al. Cohort profile: the FinnBrain birth cohort study. Int J Epidemiol. 2018;47:15–j6. https://doi.org/10.1093/ije/dyx173.
20. Cox JL, Chapman G, Murray D, Jones P. Validation of the Edinburgh postnatal depression scale (EPDS) in non-postnatal women. J Affect Disord. 1996;39:185–9. https://doi.org/10.1016/0165-0327(96)00008-0.
21. Cox J, Holden J. Perinatal mental health: A guide to the Edinburgh postnatal depression scale (EPDS). UK: Royal College of Psychiatrists; 2003. (Accessed 16 April 2024).
22. Hobbs AJ, Mannion CA, McDonald SW, Brockway M, Tough SC. The impact of caesarean section on breastfeeding initiation, duration and difficulties in the first four months postpartum. BMC Pregnancy Childbirth. 2016;16:90. https://doi.org/10.1186/s12884-016-0876-1.
23. Thulier D, Mercer J. Variables associated with breastfeeding duration. J Obstet Gynecol Neonatal Nurs. 2009;38(3):259–68. https://doi.org/10.1111/j.1552-6909.2009.01021.x.
24. Pippins JR, Brawarsky P, Jackson RA, Fuentes-Afflick E, Haas JS. Association of breastfeeding with maternal depressive symptoms. J Womens Health. 2006;15(6):754–62. https://doi.org/10.1089/jwh.2006.15.754.
25. Harju M, Pekkanen J, Heinonen S, Keski-Nisula L. Maternal anemia during pregnancy and slightly higher risk of asthma in male offspring. J Obstet Gynaecol Res. 2018;44(4):614–22. https://doi.org/10.1111/jog.13569.
26. Rioux FM, Savoie N, Allard J. Is there a link between postpartum Anemia and discontinuation of breastfeeding?? Can J Diet Pract Res. 2006;67(2):72–6. https://doi.org/10.3148/67.2.2006.72.
27. Henly SJ, Anderson CM, Avery MD, Hills-Bonuyk SG, Potter S, Duckett LJ. Anemia and insufficient milk in first-time mothers. Birth. 1995;22(2):86–92. https://doi.org/10.1111/j.1523-536X.1995.tb00565.x.
28. Park YK, Meier ER, Song WO. Characteristics of teenage mothers and predictors of breastfeeding initiation in the Michigan WIC program in 1995. J Hum Lact. 2003;19(1):50–6. https://doi.org/10.1177/0890334402239734.
29. O'Brien KO, Zavaleta N, Abrams SA, Caulfield LE. Maternal iron status influences iron transfer to the fetus during the third trimester of pregnancy. Am J Clin Nutr. 2003;77:924–30. https://doi.org/10.1093/ajcn/77.4.924.
30. Shao J, Lou J, Rao R, Georgieff MK, Kaciroti N, Felt BT, et al. Maternal serum ferritin concentration is positively associated with newborn iron stores in women with low ferritin status in late Pregnancy1-3. J Nutr. 2012;142:2004–9. https://doi.org/10.3945/jn.112.162362.
31. Andersson O, Hellström-Westas L, Andersson D, Domellöf M. Effect of delayed versus early umbilical cord clamping on neonatal outcomes and iron status at 4 months: A randomised controlled trial. BMJ. 2011;343:1244. https://doi.org/10.1136/bmj.d7157.
32. Mcdonald SJ, Middleton P, Dowswell T, Morris PS. Effect of timing of umbilical cord clamping of term infants on maternal and neonatal outcomes. Evid Based Child Health. 2014;9:303–97. https://doi.org/10.1002/ebch.1971.
33. Domellöf M, Braegger C, Campoy C, Colomb V, Decsi T, Fewtrell M, et al. Iron requirements of infants and toddlers. J Pediatr Gastroenterol Nutr. 2014;58:119–29. https://doi.org/10.1097/MPG.0000000000000206.
34. 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. https://doi.org/10.1093/ajcn/66.5.1178.
35. Pérez-Escamilla R, Tomori C, Hernández-Cordero S, Baker P, Barros AJD, Bégin F, et al. Breastfeeding: crucially important but increasingly challenged in a market-driven world. Lancet. 2023;401:472–85. https://doi.org/10.1016/S0140-6736(22)01932-8.
36. Okagbue HI, Adamu PI, Bishop SA, Oguntunde PE, Opanuga AA, Akhmetshin EM. Systematic review of prevalence of antepartum depression during the trimesters of pregnancy. Open Access Maced J Med Sci. 2019;7:1555–60. https://doi.org/10.3889/oamjms.2019.270.
37. Shorey S, Chee CYI, Ng ED, Chan YH, Tam WWS, Chong YS. Prevalence and incidence of postpartum depression among healthy mothers: A systematic review and meta-analysis. J Psychiatr Res. 2018;104:235–48. https://doi.org/10.1016/j.jpsychires.2018.08.001.
38. Kemppinen L, Mattila M, Ekholm E, Huolila L, Pelto J, Karlsson H, et al. Gestational anemia and maternal antenatal and postpartum psychological distress in a prospective FinnBrain birth cohort study. BMC Pregnancy Childbirth. 2022;22:1–9. https://doi.org/10.1186/s12884-022-05032-z.
39. Navarro P, Ascaso C, Garcia-Esteve L, Aguado J, Torres A, Martín-Santos R. Postnatal psychiatric morbidity: a validation study of the GHQ-12 and the EPDS as screening tools. Gen Hosp Psychiatry. 2007;29:1–7. https://doi.org/10.1016/j.genhosppsych.2006.10.004.
40. Langhoff-Roos J, Krebs L, Klungsøyr K, Bjarnadottir RI, Källén K, Tapper AM, et al. The nordic medical birth registers - A potential goldmine for clinical research. Acta Obstet Gynecol Scand. 2014;93:132–7. https://doi.org/10.1111/aogs.12302.

Publisher's note