Breastfeeding is negatively affected by prenatal depression and reduces postpartum depression

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Background. This prospective cohort study explored the effects of prenatal and postpartum depression on breastfeeding and the effect of breastfeeding on postpartum depression.

Method. The Edinburgh Postpartum Depression Scale (EPDS) was administered to 145 women at the first, second and third trimester, and at the neonatal period and 3 months postpartum. Self-report exclusive breastfeeding since birth was collected at birth and at 3, 6 and 12 months postpartum. Data analyses were performed using repeated-measures ANOVAs and logistic and multiple linear regressions.

Results. Depression scores at the third trimester, but not at 3 months postpartum, were the best predictors of exclusive breastfeeding duration ($\beta = -0.30$, $t = -2.08$, $p < 0.05$). A significant decrease in depression scores was seen from childbirth to 3 months postpartum in women who maintained exclusive breastfeeding for $\geqslant 3$ months ($F_{1,65} = 3.73$, $p < 0.10$, $\eta_{\mathrm{P}}^2 = 0.05$).

Conclusions. These findings suggest that screening for depression symptoms during pregnancy can help to identify women at risk for early cessation of exclusive breastfeeding, and that exclusive breastfeeding may help to reduce symptoms of depression from childbirth to 3 months postpartum.

Introduction

The World Health Organization (WHO, 2003), the European Commission Directorate for Public Health (EC-Public Health, 2002) and the American Academy of Pediatrics (AAP; Gartner *et al.* 2005) all recommend exclusive breastfeeding for the first 6 months of life. Despite the established benefits of breastfeeding, rates are still low, and even though rates of breastfeeding initiation are high, there is a marked decline in breastfeeding during the first few weeks, and exclusive breastfeeding at 6 months postpartum is rare (Chalmers *et al.* 2009; Barnes *et al.* 2010). Identification of women at risk for early cessation of breastfeeding is a recognized health priority (EC-Public Health, 2002; WHO, 2003; AAP, 2005). Depression during pregnancy could serve this proposal, as pregnant depressed women are less likely to intend to breastfeed (Fairlie *et al.* 2009; Insaf *et al.* 2011), to initiate (Green & Murray, 1994; Seimyr *et al.* 2004) or to maintain breastfeeding during the postpartum period (Field *et al.* 2002;

Seimyr *et al.* 2004; Pippins *et al.* 2006; Kehler *et al.* 2009; Ystrom, 2012).

Literature reviews suggest that breastfeeding is also less common among postpartum depressed mothers, even though their infants benefit from breastfeeding (e.g. Field, 2008). However, the pathway of the association between breastfeeding and postpartum depression remains equivocal (e.g. Dennis & McQueen, 2009).

Some studies suggest that postpartum depression may cause early cessation of breastfeeding, and depression symptoms have been noted to precede the cessation of breastfeeding (Cooper *et al.* 1993; Galler *et al.* 1999; Henderson *et al.* 2003; Taj & Sikander, 2003; Hatton *et al.* 2005; Dennis & McQueen, 2007; Akman *et al.* 2008; Gagliardi *et al.* 2012), whereas other studies show that postpartum depression may result from breastfeeding cessation and breastfeeding cessation has been noted to precede postpartum depression (Astbury *et al.* 1994; Mezzacappa & Endicott, 2007; Ystrom, 2012).

For example, a recent study showed that mothers with greater levels of depressive symptoms immediately after delivery have a higher likelihood of bottle-feeding their infants at 3 months postpartum (Gagliardi *et al.* 2012). An association between higher levels of depressive symptoms 1 month after delivery

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and breastfeeding cessation at 4 months postpartum was also obtained in an earlier study (Akman *et al.* 2008). Compared to mothers with lower depression scores, mothers with higher depression scores were more likely not to breastfeed at 4 months postpartum.

By contrast, another recent study also showed that breastfeeding cessation predicted higher levels of postpartum anxiety and depression (Ystrom, 2012). Anxiety and depression levels during pregnancy and at 6 months postpartum were related to breastfeeding cessation: baseline levels of anxiety and depression were increased at 6 months postpartum by the effect of breastfeeding cessation (Ystrom, 2012). Empirical data have shown that mothers who do not initiate or maintain breastfeeding are at risk for depression during the postpartum period and that early cessation of breastfeeding may contribute to postpartum de-pression (Astbury *et al.* 1994; Mezzacappa & Endi-cott, 2007; Ystrom, 2012).

Breastfeeding has been associated with numerous positive health outcomes for both the child and the mother. The breastfeeding benefits for children are well known. They include fewer health problems (Shields *et al.* 2006; Horta *et al.* 2007) and better devel-opmental performance (Sacker *et al.* 2006; Kramer *et al.* 2008). Various other benefits have also been reported for the physical (Newcomb *et al.* 1994; Jonas *et al.* 2008) and psychological well-being of the mother, for example an attenuated response to stress (Heinrichs *et al.* 2001; Groer & Davis, 2006; Tu *et al.* 2006) and better sleep patterns (Heinrichs *et al.* 2002; Doan *et al.* 2007). However, more empirical evidence is needed on the relationship between breastfeeding and post-partum depression (Heinrichs *et al.* 2002).

The current study explored: (1) the effects of prenatal and postpartum depression on the initiation, early cessation and duration of exclusive breastfeeding; and (2) the effects of initiation and early cessation of exclusive breastfeeding on postpartum depression.

Method

Sample

In total, 181 primiparous or multiparous women were contacted in an Obstetrics Out-patient Unit (Porto, Portugal) during the first pregnancy trimester. The exclusion criteria were not reading or writing Portuguese and multiple gestations. A sample of 145 (80%) women agreed to participate and were included in the analyses, and 124 (86%) of them completed the Edinburgh Postnatal Depression Scale (EPDS) in all assessment waves.

Nearly all the participants were Portuguese (97%), Caucasian (96%), Catholic (87%), were married or

Table 1. *Sociodemographics for total sample and exclusive breastfeeding groups: exclusive breastfeeding no initiation (0), early cessation (0–3[) and for ⩾3 months ([3)*

	Breastfeeding groups			
	0 (*n*=12)	0–3[(*n*=54)	[3 (*n*=79)	Total (*n*=145)
Age (years)				
⩽19	0	6	7	5
20–29	25	59	47	47
30–39	67	36	54	47
⩾40	8	0	2	1
Schooling (years)				
<9	66	42	39	42
9–12	17	42	32	34
>12	17	16	29	24
Marital status				
Married	75	64	63	65
Cohabiting	25	25	30	29
Single	0	9	5	6
Socio-economic level				
High	29	12	21	21
Medium	57	61	37	50
Low	14	27	42	29
Occupational status				
Employed	70	85	85	86
Unemployed	30	15	15	16
Parity				
Primiparous	33	66	59	60
Multiparous	67	34	41	40
Pregnancy planning				
Planned	70	64	72	70
Not planned	30	36	28	30
Infant's sex				
Male	90	50	60	60
Female	10	50	40	40
Gestational age at delivery				
⩾37 weeks	100	92	95	94
<37 weeks	0	8	5	6
Birthweight				
⩾2500 g	100	92	95	94
<2500 g	0	8	5	6

Values given are percentages.

cohabitating (94%) and between 20 and 39 years old (94%). Women were primiparous (60%) or multiparous (40%). The majority of the women had ⩾9 years of education (58%), had low to middle socio-economic status (79%) and were employed (86%) (see Table 1). None of the participants were receiving treatment or medication for depression.

Measures

Sociodemographic Questionnaire

Information about the participants was collected using a Sociodemographic Questionnaire (Figueiredo *et al.* 2009). This questionnaire on social, demographic and obstetric information included: age, ethnicity, nationality, religion, marital status, occupational status, educational level, pregnancy planning, infant sex, gestational age and birthweight.

Index of Breastfeeding Status (IBS)

Exclusive breastfeeding since birth was determined according to the IBS (Labbok & Krasovec, 1990; Labbok *et al.* 1997), using mother feeding practices recall since birth, at childbirth and at 3, 6 and 12 months postpartum. In this study the IBS was modified to define feeding practices since birth as exclusive breastfeeding *versus* no exclusive breastfeeding/bottle-feeding. Exclusive breastfeeding included Labbock & Krasovec's level 1 (full breastfeeding: exclusive breastfeeding, no other liquid or solid is given) and level 2 (almost exclusive breastfeeding: only vitamins, minerals or water are given in addition to breastfeeding). All other categories that involved any amount of artificial milk or solids (level 3 to 7) were defined as no exclusive breastfeeding/bottle feeding.

EPDS

The Portuguese version (Augusto *et al.* 1996) of the EPDS (Cox *et al.* 1987), a self-report questionnaire comprising 10 items, was used to assess symptoms of depression within the previous 7 days. The EPDS Portuguese version has good internal consistency (Cronbach's $\alpha = 0.85$) and has been used in several studies during pregnancy and the postpartum period (e.g. Figueiredo & Conde, 2011).

Procedures

This prospective cohort study received approval from the Institutional Ethical Commission. Participants were recruited from an Obstetrics Out-patient Unit at their first appointment. The aims and the procedures of the study were explained. After signing an informed consent form, the Sociodemographic Questionnaire and the EPDS were administered to the pregnant women (8–14 weeks gestation). The EPDS was administered again during the second (20–24 weeks gestation) and third trimester (30–34 weeks gestation), at childbirth (between days 1 and 3) and at 3 months (10–14 weeks postpartum). Data on exclusive breastfeeding since birth were collected at birth and at 3, 6 and 12 months postpartum, using mother feeding practices recall since birth.

Statistical analyses

To determine whether prenatal depression scores at the first, second and third trimester were predictors of exclusive breastfeeding and no initiation, logistic regressions (forward stepwise method) were performed. To determine whether prenatal and postpartum depression were predictors of exclusive breastfeeding, no initiation or early cessation and duration, logistic (forward stepwise method) and multiple linear (stepwise method) regressions were performed. In model 1, depression scores at the first, second and third trimester were assessed as predictors. In model 2, depression scores at 3 months postpartum were added. Depression scores were found to be associated with exclusive breastfeeding initiation, breastfeeding no initiation or early cessation and breastfeeding duration at $p < 0.10$ and were included as predictors in the models. The criteria for variables to stay or enter the models were defined as $p < 0.05$.

To determine the effects of exclusive breastfeeding or no initiation and early cessation on postpartum depression, repeated-measures ANOVAs were applied. Analyses were conducted with breastfeeding as the grouping variable: exclusive breastfeeding no initiation, exclusive breastfeeding early cessation, and exclusive breastfeeding for $\geqslant 3$ months. The model included depression scores as a measure of the same within-subjects factor with five levels, corresponding to the first, second and third trimester, childbirth and 3 months postpartum measuring time points. Differences between groups were determined through independent-sample t tests.

Statistical analyses were performed using SPSS version 20 (SPSS Inc., USA). All available data were included in the analyses. Cohen's effect size d was estimated for the independent-sample tests according to Kinnear & Grey's (2010) recommendation ($d = M_1 - M_2 / \sigma_{\text{pooled}}$). In addition, the effect-size measure partial eta squared (η_{p}^2) was estimated for all ANOVAs.

Post-hoc power calculations, performed using the software G*Power (Faul *et al.* 2007), demonstrated that the sample size was adequate to detect small-to-medium effects on the results of the logistic regression [model's odds ratio (OR) 2.13, $p < 0.05$, $n = 126$, power = 0.96], the linear regression (model's effect size $f^2 = 0.08$, $p < 0.05$, $n = 126$, number of predictors = 4, power = 0.93) and the repeated-measures ANOVA (effect size f range = 0.10–0.20, $p < 0.05$, $n = 124$, correlation of the repeated measures = 0.62, power range = 0.88–0.89).

Results

Exclusive breastfeeding

Within the total sample, 12 women did not initiate exclusive breastfeeding (8%), 54 women initiated but ceased exclusive breastfeeding early (breastfed for <3 months) (37%), 55 women breastfed exclusively for >3 months but <6 months (38%), and 24 women (17%) breastfed exclusively for ⩾6 months. No differences were noted between these groups on age (χ_9^2=13.84, N.S.), schooling (χ_6^2=7.81, N.S.), marital status (χ_{12}^2=11.67, N.S.), socio-economic status (χ_6^2=8.12, N.S.), occupational status (χ^2=0.78, N.S.), parity (χ_3^2=4.37, N.S.), pregnancy planning (χ_6^2=4.81, N.S.), infant sex (χ_3^2=4.96, N.S.), gestational age (χ_3^2=0.53, N.S.) and birthweight (χ_3^2=0.29, N.S.).

Sociodemographic variables

Sociodemographic variables (mother's age, occupational status, pregnancy planning, gestational age at delivery and infant's birthweight and gender) were assessed as potential predictors. These variables were not associated at $p < 0.10$ with exclusive breastfeeding initiation, no initiation or early cessation and duration, and therefore were not eligible to be included in the regression models.

Effects of prenatal and postpartum depression on breastfeeding

Exclusive breastfeeding initiation

Depression scores at the first, second and third trimester were assessed as predictors of exclusive breastfeeding or no initiation. The regression model was not statistically significant (χ_3^2=2.70, N.S.).

Exclusive breastfeeding, no initiation or early cessation

Depression scores at the first, second and third trimester were assessed as predictors of exclusive breastfeeding at 3 months postpartum (Table 2, model 1). The regression model emerged as statistically significant (χ^2=9.12, $p < 0.05$), with a goodness of fit of 60%. The model had a sensitivity of 46% and a specificity of 72%. The area under the curve (AUC) in the receiver operating characteristic (ROC) curve was 0.62 [$p < 0.05$, 95% confidence interval (CI) 0.53–0.71]. Variability was explained by depression scores at the first, second and third trimester in the range 7.0–9.3% (Cox & Snell R^2=0.07, Nagelkerke R^2=0.09). Depression scores at the first trimester were the best predictor of exclusive breastfeeding at 3 months postpartum (β=−0.14, Wald=4.50, $p < 0.05$). Women with higher depression scores at the first trimester had 0.87 times the chance

Table 2. *Prenatal and postpartum depression as predictors of exclusive breastfeeding at 3 months postpartum*

	β	Wald	OR	95% CI
Model 1: χ_3^2=9.12, $p < 0.05$				
EPDS scores first pregnancy trimester	−0.14	4.50	0.87	0.77–0.99*
EPDS scores second pregnancy trimester	0.12	2.97	1.13	0.98–1.92
EPDS scores third pregnancy trimester	−0.97	1.98	0.91	0.79–1.04
Model 2: χ_4^2=6.42, $p < 0.05$				
EPDS scores first pregnancy trimester	−0.15	4.78	0.86	0.76–0.99*
EPDS scores second pregnancy trimester	0.11	2.64	1.12	0.98–1.29
EPDS scores third pregnancy trimester	−0.12	2.30	0.89	0.77–1.03
EPDS scores 3 months postpartum	0.04	0.35	1.04	0.91–1.18

EPDS, Edinburgh Postnatal Depression Scale; OR, odds ratio; CI, confidence interval.

*$p < 0.05$.

of not initiating or ceasing exclusive breastfeeding early (OR 0.87, 95% CI 0.77–0.99).

When depression scores at 3 months postpartum were added to the regression model (Table 2, model 2), the goodness of fit increased to 63% (χ_4^2=9.48, $p < 0.05$). Nevertheless, model 2 was not found to be statistically different from model 1 (χ_1^2=0.71, N.S.). This model had a sensitivity of 53% and a specificity of 72%. The AUC in the ROC curve was 0.65 ($p < 0.01$, 95% CI 0.56–0.75). Variability was explained by depression scores at the first, second and third trimester and at 3 months postpartum in the range 7.2–9.7% (Cox & Snell R^2=0.07, Nagelkerke R^2=0.10). In this model, depression scores at the first trimester were the best predictor of exclusive breastfeeding at 3 months postpartum (β=−0.15, Wald=4.78, $p < 0.05$). Women with higher depression scores at the first trimester had 0.86 times the chance of not initiating or ceasing exclusive breastfeeding early (OR 0.86, 95% CI 0.76–0.99).

Exclusive breastfeeding duration

Depression scores at the first, second and third trimester were tested as predictors of the exclusive breastfeeding duration (Table 3, model 1). The regression model explained 7.7% of the variance (adjusted R^2=0.06, $F_{3,122}$=3.41, $p < 0.01$). Depression scores at the third trimester were the best predictor of exclusive

Table 3. *Prenatal and postpartum depression as predictors of exclusive breastfeeding duration*

	R^2 (adj R^2)	$F_{3,122}$	B	t
Model 1				
EPDS scores first pregnancy trimester	0.08 (0.06)	2.32	−0.17	−1.50
EPDS scores second pregnancy trimester	0.08 (0.06)	2.32	0.13	0.97
EPDS scores third pregnancy trimester	0.08 (0.06)	2.32	−0.23	−1.80*
Model 2	R^2 (adj R^2)	$F_{4,12}$	B	t
EPDS scores first pregnancy trimester	0.09 (0.06)	1.93	−0.20	−1.73
EPDS scores second pregnancy trimester	0.09 (0.06)	1.93	0.11	0.80
EPDS scores third pregnancy trimester	0.09 (0.06)	1.93	−0.30	−2.08**
EPDS scores 3 months postpartum	0.09 (0.06)	1.93	0.14	1.06

EPDS, Edinburgh Postnatal Depression Scale; adj R^2, adjusted R^2.

$R^2_{\text{change}}=0.008$, $F_{1,121}=1.12$, not significant (N.S.).

* $p<0.01$, ** $p<0.05$.

breastfeeding duration ($\beta=-0.23$, $t=-1.80$, $p<0.05$). The results indicate that women with higher depression scores at the third trimester breastfed for a shorter period of time. When depression scores at 3 months postpartum were added to the regression analysis (Table 3, model 2), the model explained 8.6% of the variance (adjusted $R^2=0.06$, $F_{4,121}=2.84$, $p<0.05$). Depression scores at the third pregnancy trimester were the best predictor of exclusive breastfeeding duration ($\beta=-0.30$, $t=-2.08$, $p<0.05$). Depression scores at 3 months postpartum did not add to the variance in the exclusive breastfeeding duration when the effects of depression scores at the first, second and third trimester were controlled statistically ($R^2_{\text{change}}=0.008$, $F_{1,121}=1.12$, N.S.).

Effects of breastfeeding on postpartum depression

Exclusive breastfeeding

Women who initiated exclusive breastfeeding had lower depression scores at the first, second and third pregnancy trimester, and also at childbirth and at 3 months postpartum, compared with women who did not initiate exclusive breastfeeding. However, these differences were not significant ($F_{1,122}=1.26$, N.S.). Depression scores differed at different time points for the women who initiated breastfeeding ($F_{4,397}=2.63$, $p<0.05$, $\eta_{\text{p}}^2=0.02$), but not for those who did not initiate breastfeeding ($F_{4,36}=1.37$, N.S.). Tests of within-contrast results suggest that, in the group of women who initiated breastfeeding, depression scores decreased from childbirth to the 3-month postpartum period ($F_{1,113}=4.60$, $p<0.05$, $\eta_{\text{p}}^2=0.04$). Pairwise comparisons revealed that women who initiated breastfeeding had higher depression scores at the first pregnancy trimester than at 3 months postpartum ($p<0.05$), whereas women who did not initiate
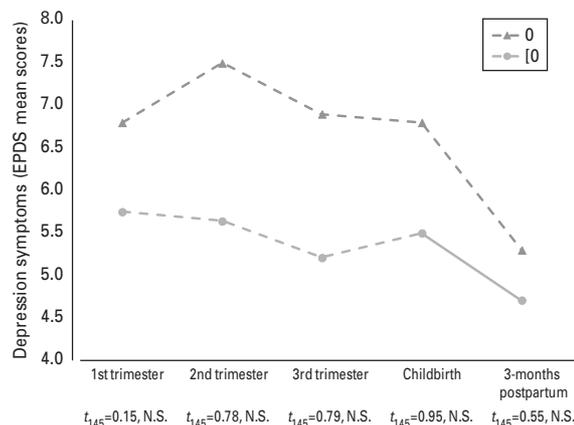

Fig. 1. Depression symptoms [Edinburgh Postnatal Depression Scale (EPDS) range, mean and standard deviation scores] from early pregnancy to 3 months postpartum for women who did not initiate exclusive breastfeeding and women who initiated exclusive breastfeeding. Significant differences are presented with a continuous line.

breastfeeding had no significant differences in depression scores across the time points (see Fig. 1 and Table 4).

Exclusive breastfeeding, no initiation or early cessation

Marginally significant differences on depression symptoms (EPDS) scores were found between groups ($F_{1,122}=3.69$, $p<0.10$, $\eta_{\text{p}}^2=0.03$). Women who did not initiate or ceased exclusive breastfeeding early had higher depression symptoms scores both at the first trimester ($t_{143}=1.87$, $p<0.10$, $d=0.31$) and at childbirth ($t_{130}=1.69$, $p<0.10$, $d=0.30$) compared with women who exclusively breastfed for $\geqslant3$ months.

In the group of women who exclusively breastfed for $\geqslant3$ months, depression scores differed at the different

Table 4. *Depression symptoms (EPDS scores) from early pregnancy to 3 months postpartum for women who did not initiated exclusive breastfeeding (0) and women who initiated exclusive breastfeeding ([0)*

	First trimester	Second trimester	Third trimester	Childbirth	3 months postpartum
0 (*n*=12)	6.08 (4.29) 1–17	6.75 (4.11) 1–14	6.55 (4.39) 2–17	7.00 (4.54) 0–15	5.45 (3.83) 0–13
[0 (*n*=133)	5.90 (3.98) 0–19	5.74 (4.33) 0–20	5.45 (4.41) 0–20	5.57 (4.80) 0–27	4.72 (4.26) 0–20
Total (*n*=145)	5.91 (4.00) 0–19	5.83 (4.30) 0–20	5.54 (4.40) 0–20	5.69 (4.78) 0–27	4.78 (4.21) 0–20

EPDS, Edinburgh Postnatal Depression Scale.
Values given as mean (standard deviation) range.

time points ($F_{3,220}$=2.65, $p<0.05$, η_P^2=0.04). Tests of within-contrast effects suggest that depression scores decreased from the second to the third trimester ($F_{1,65}$=6.73, $p<0.05$, η_P^2=0.09) and from childbirth to 3 months postpartum ($F_{1,65}$=3.73, $p<0.10$, η_P^2=0.05), whereas no differences were found in the group of women who did not initiate or ceased exclusive breastfeeding early ($F_{4,228}$=1.91, N.S.). Pairwise comparisons revealed that women who exclusively breastfed for ⩾3 months had lower depression scores at 3 months postpartum when compared to the first ($p<0.001$), second ($p<0.001$) and third trimester ($p<0.05$), and also at childbirth ($p<0.001$), whereas women who did not initiate or ceased exclusive breastfeeding early had lower depression scores at 3 months postpartum when compared to the first pregnancy trimester ($p<0.05$) (see Fig. 2 and Table 5).

t_{145}=1.87, p<.10 t_{145}=0.01, N.S. t_{145}=0.89, N.S. t_{145}=1.69, p<.10 t_{145}=1.18, N.S.

Fig. 2. Depression symptoms [Edinburgh Postnatal Depression Scale (EPDS) mean scores] from early pregnancy to 3 months postpartum for women who did not initiate or ceased exclusive breastfeeding early and women who exclusive breastfed for ⩾3 months. Significant differences are presented with a continuous line.

Discussion

Prenatal depression, but not postpartum depression, predicted both exclusive breastfeeding at 3 months postpartum and exclusive breastfeeding duration. Higher depression scores at the first trimester accounted for early cessation of breastfeeding, and higher depression scores at the third trimester accounted for a shorter period of time breastfeeding.

Other studies have also shown that when women are depressed during pregnancy, they are less likely to maintain breastfeeding (Field *et al.* 2002; Seimyr *et al.* 2004; Pippins *et al.* 2006; Kehler *et al.* 2009; Ystrom, 2012). Results suggest that screening for symptoms of depression during pregnancy could help to identify women at risk for early cessation of breastfeeding. Providing suitable information is a main health priority recommendation; that is the identification of women at risk of failing breastfeeding maintenance (EC-Public Health, 2002; WHO, 2003; Gartner *et al.* 2005). Results also suggest the need to consider prenatal depression when studying the association between breastfeeding and postpartum depression. A few recent studies are consistent with the present
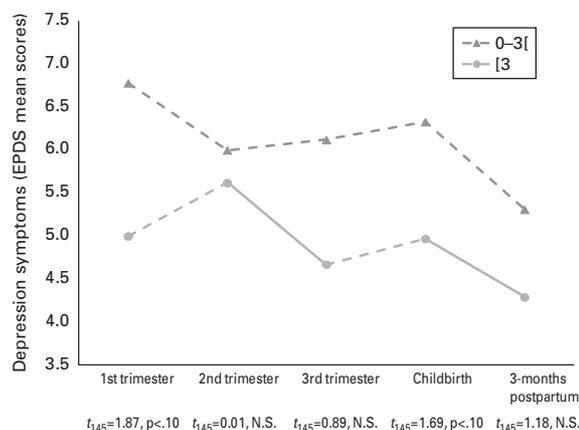
study, concluding that prenatal depression predicted breastfeeding duration even when postnatal depression was considered (Kehler *et al.* 2009; Ystrom, 2012).

In women who initiated breastfeeding, a decrease in depression scores was observed from birth to the 3-month postpartum period whereas there were no significant changes in depression scores in women who did not initiate breastfeeding. This result suggests that breastfeeding may help to reduce mothers' depression symptoms from birth to 3 months postpartum. Other studies have also shown that mothers who initiate or maintain breastfeeding are less at risk for depression during the postpartum period, and that early cessation of breastfeeding may contribute to postpartum depression (Astbury *et al.* 1994; Mezzacappa & Endicott, 2007; Ystrom, 2012).

As suggested previously, breastfeeding may have an antidepressant effect (Field, 2008). Research has shown that breastfeeding decreases hormonal and psychological conditions associated with depression during the

Table 5. *Depression symptoms (EPDS scores) from early pregnancy to 3 months postpartum for women who did not initiate or ceased exclusive breastfeeding early (0–3[) and women who exclusively breastfed for ≥3 months ([3)*

	First trimester	Second trimester	Third trimester	Childbirth	3 months postpartum
0–3[(*n*=66)	6.59 (4.17) 0–19	5.83 (4.29) 0–20	5.90 (4.27) 0–17	6.44 (5.47) 0–27	5.25 (4.54) 0–20
[3 (*n*=79)	5.35 (3.78) 0–19	5.82 (4.34) 0–18	5.24 (4.51) 0–20	5.04 (4.01) 0–21	4.37 (3.89) 0–18
Total (*n*=145)	5.91 (4.00) 0–19	5.83 (4.30) 0–20	5.54 (4.40) 0–20	5.69 (4.78) 0–27	4.78 (4.21) 0–20

EPDS, Edinburgh Postnatal Depression Scale.
Values given as mean (standard deviation) range.

postpartum period. This could explain the decrease in depression symptoms from birth to 3 months postpartum observed in the women who breastfed.

Some authors propose that breastfeeding may have a protective effect on maternal psychological health because it attenuates stress responses (for a review, see Heinrichs *et al.* 2002; Mezzacappa & Katkin, 2002; Kendall-Tackett, 2007). The lactogenic hormones, oxytocin and prolactin, are associated with anxiolytic and antidepressant effects (Mezzacappa & Katkin, 2002). Lactation has been associated with attenuated stress responses, especially that of cortisol (Heinrichs *et al.* 2001; Groer & Davis, 2006; Tu *et al.* 2006). Attenuated cortisol stress responses (Amico *et al.* 1994; Altemus *et al.* 1995; Groer & Davis, 2006), in addition to attenuated total cortisol and free cortisol stress responses (Heinrichs *et al.* 2001), have been noted in lactating compared to non-lactating mothers. These results suggest that lactation attenuates neuroendocrine responses to stress (Altemus *et al.* 1995), a circumstance that has been related to fewer postpartum depression symptoms (Nierop *et al.* 2006; Goyal *et al.* 2009).

In addition, the usual diurnal pattern of cortisol, consisting of high morning levels and gradual decline throughout the day, also associated with fewer postpartum depression symptoms (Taylor *et al.* 2009), was found to be more characteristic of multiparous women who were breastfeeding *versus* those who were not breastfeeding (Tu *et al.* 2006). A diurnal pattern of cortisol, with higher cortisol levels at waking and no increase from waking to ≥30 min, was reported in postpartum depressed women as compared to a significant increase in cortisol levels from waking to ≥30 min found in non-depressed women (Taylor *et al.* 2009). These data support the possibility that postpartum depression may be associated with a dysregulated (hypothalamic–pituitary–adrenal) HPA axis. Breastfeeding might promote a tighter regulation of diurnal basal cortisol secretion (Heinrichs *et al.* 2001; Groer & Davis, 2006; Tu *et al.* 2006) and the stability of diurnal cortisol secretion across days that seems to

lowers the risk of postpartum depression (Taylor *et al.* 2009).

Another important associated change during breastfeeding relates to the regulation of sleep and wake patterns for both the mother and the infant, helping the mother to feel less tired, and could possibly also prevent symptoms of depression. Parents of infants who were exclusively breastfed slept an average of 40–45 min more and self-reported less sleep disturbance than parents of infants given formula (Doan *et al.* 2007). Women with postpartum depression have experienced poorer sleep than women without postpartum depression, and sleep quality has worsened with increasing postpartum depression severity (Posmontier, 2008; Dørheim *et al.* 2009; Goyal *et al.* 2009). Thus, although sleep disturbance dysregulation may lead to postpartum depression (Posmontier, 2008; Dørheim *et al.* 2009; Goyal *et al.* 2009), breastfeeding enhances mothers' sleep patterns (Doan *et al.* 2007).

Research has also shown that breastfeeding improves psychological conditions and processes that can reduce postpartum depression. Mothers' emotional involvement with the infant, for example, seems to be enhanced by breastfeeding (Ekström & Nissen, 2006), whereas it is negatively correlated with postpartum depression (Figueiredo & Costa, 2009). Mothers' self-efficacy, a condition that is inversely associated with postpartum depression (Cutrona & Troutman, 1986), has improved in mothers who breastfed (Field *et al.* 2002; Dennis, 2006). In other studies, mothers who breastfed rather than bottle-fed their infants had higher confidence levels and also rated their infants as less alert and less irritable during feeding (Field *et al.* 2002). Breastfeeding mothers were also less likely to have infants with highly reactive temperaments and sleep problems (Field *et al.* 2002; Jones *et al.* 2004), whereas those problems have been linked to mothers' postpartum depression (Cutrona & Troutman, 1986). Infant competencies have been noted to be enhanced by breastfeeding (Hart *et al.* 2003; Sacker *et al.* 2006), and adversely affected by postpartum depression

(e.g. Murray & Cooper, 1997). Breastfeeding also facilitates mother–infant interactions (Field *et al.* 2002, 2010), which are typically more disturbed in depressed mother–infant dyads (e.g. Murray & Cooper, 1997). Breastfed infants have shown more physical contact, vocalizations and positive play, and their mothers have shown more proximal behavior with their infants (Field *et al.* 2002; Jones *et al.* 2004). These results are consistent with those from the present study suggesting that breastfeeding may act as a protective factor against postpartum depression.

Although the prospective design and the time frame from early pregnancy to 12 months postpartum were strengths of this study, the small number of participants in the group who did not initiate breastfeeding was a limitation. Effect sizes were found to be small to moderate. However, the directionality and/or bi-directionality of effects, that is greater depression leading to lack of breastfeeding and/or lack of breastfeeding leading to less depression, would be better tested in a larger sample. Moreover, future research should aim at investigating processes, such as hormonal changes, that underlie and may explain the directionality and/or bidirectionality of effects between depression and breastfeeding.

Exclusive breastfeeding was determined using mother feeding practices recall since birth. This method is highly recommended compared to mother 48-h recall (e.g. Aarts *et al.* 2000; Li *et al.* 2005), as it is more accurate and follows usual exclusive breastfeeding definitions (e.g. WHO, 2003). However, it requires a longer recall period than was used in this study, as we repeated the surveys at birth, 3, 6 and 12 months postpartum.

Depression symptoms were assessed with the EPDS, a self-report measure. Like most self-report measures, there is the possibility for biases of either under- or over-reporting. The potential bias introduced by the absence of data (namely depression) from women who refused to participate (20%) or could not be contacted or refused to complete the EPDS at some of the measuring time points (14%) affects the study validity. It is difficult to make predictions, but we would expect that these are the more depressed women and the less likely to breastfeed.

Although the mean depression scores were below the EPDS cut-offs, they highlight the importance of screening even low-scoring women for predicting the lack of breastfeeding along with the risk of postpartum depression. This study suggests that screening for depression symptoms during pregnancy can help to identify women at risk for both early cessation of exclusive breastfeeding and subsequent postpartum depression. This study provides more empirical evidence that supporting pregnant depressed women and exclusive breastfeeding can be a good measure to improve maternal and child health.

Declaration of Interest

None.

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