

Breastfeeding and Maternal Wellbeing

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Abbreviations: ALSPAC - Avon Longitudinal Study of Parents and Children; EPDS - Edinburgh Postnatal Depression Scale; BF –Breastfeeding;

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What's Known on This Subject

Breastfeeding is associated with maternal depressive symptoms. However, whether postpartum depression influences infant-feeding outcomes or vice-versa remains an equivocal question.

What This Study Adds

We use a longitudinal dataset to explore causality in the relationships between breastfeeding and perinatal depression. Compared to previous studies, we use many more breastfeeding measures and a much larger dataset, we include antenatal maternal mental health, and we control for many more potential confounders.

Abstract

Context

The benefits of breastfeeding for both the mother and the child are well documented, as are the negative health consequences of perinatal depression.

Objective

To explore causality in the relationships between breastfeeding and perinatal depression. In particular the causal effect of breastfeeding on postpartum maternal mental health was investigated together with the causal effect of antenatal maternal wellbeing on breastfeeding intentions, prevalence, and duration.

Methods

We used the Avon Longitudinal Study of Parents and Children (ALSPAC) dataset which offers longitudinal information on mothers and their children. Multivariate linear and logistic regression analyses were performed to explore the effects of any and exclusive breastfeeding initiation and duration on postpartum mental health, measured at different time moments (8 weeks, 8 months, 21 months and 32 months post partum) We also explored the effects of antenatal mental health measured at 18 and 33 weeks pregnancy on the different breastfeeding outcomes.

Results

We found first that, even though there was a strong bivariate relationship between breastfeeding and maternal wellbeing, once potential confounders were controlled for, especially maternal mental and physical health during pregnancy, breastfeeding ceased to exert a significant effect on maternal wellbeing. Therefore apparently breastfeeding did not causally affect maternal postnatal wellbeing. Second, antenatal mental health was positively related to breastfeeding. This effect remained statistically significant after all potential confounders were controlled for with respect to breastfeeding duration, though not for other measures of breastfeeding. Third, the usual screening value for perinatal depression of EPDS greater than 13 may be unnecessarily high. A value of 14 to 15 EPDS was enough to capture the negative impact of prenatal depression on breastfeeding duration.

Conclusion

Depressive symptomatology in the perinatal period negatively influences infant-feeding outcomes. Prenatal identification of depression-prone mothers may allow targeting breastfeeding promotion interventions to this highly vulnerable group.

INTRODUCTION

This paper looks at the association between breastfeeding and maternal wellbeing. Previous research has identified benefits of breastfeeding for both mother and children's health (Ip et al. 2007) and for children's cognitive and noncognitive outcomes (Borra, Iacovou and Sevilla 2012). This is a topic of considerable importance for policy in the UK: The World Health Organization recommends breastfeeding exclusively for six months and alongside solid foods for two years, but in the UK, barely one in three mothers exclusively breastfeed during the first four months after giving birth. On the other hand, approximately, about 13 per cent of women experience post-partum depression within the 14 weeks following giving birth (O'Hara and Swain 1996). If the antenatal period is also considered, as many as 19.2% of women have a depressive episode during pregnancy or the first 3 months postpartum (Gavin et al. 2005). Conditions such as post-natal depression have an immediate impact on mothers and carry long-term risks for their future mental health (Cooper et al. 1993; Horowitz and Goodman 2004; Josefsson and Sydsjö 2007). Depression among mothers has also been found to have a serious negative impact on the cognitive, social and physical development of their children (Pincus and Pettit 2001; Murray et al., 2001). Beyond the immediate concerns for the well-being of mothers and their children, post-natal depression carries substantial costs to the health system (Dennis 2003), as well as being associated with a loss in productivity due to its impact on maternal absenteeism, premature retirement, and long-term unemployment (Knapp et al. 2008).

The limited existing evidence on breastfeeding and perinatal depression (see Dennis and McQueen 2009 for a recent meta-analysis of the subject; Fairlie et al. 2009; Henderson 2003; Kendall-Tackett 2007; Seimyr et al. 2004) has suggested that mothers who did not initiate breastfeeding, or who breastfed for a short time, were more likely than other mothers to become post-natally depressed and

also that women reporting prenatal depressive symptoms were less likely to intend to breastfeed after birth. Most previous studies have generally used small sample sizes, and few studies have controlled for potentially confounding variables such as maternal age and education, family income, or marital status in the multivariate analysis (see Dennis and McQueen 2009 for a detailed discussion on these issues). Thus, it has been extremely difficult to identify whether the observed relationships were causal, as opposed to arising because breastfeeding was more likely to be practiced by mothers whose characteristics (higher social class, higher IQ, higher levels of human capital, etc.) favoured more positive maternal mental attitudes. More importantly, as Ip et al. (2007) have pointed out, most existing studies have not controlled for pre-existing mental health conditions – so the extent to which breastfeeding influenced mental health, as opposed to mental health driving breastfeeding, was not clear. The aim of this study was to examine explicitly whether maternal mood affected breastfeeding outcomes or vice-versa.

METHODS

Data Source and Analytic Variables

The Avon Longitudinal Survey of Parents and Children (ALSPAC) is a longitudinal study of around 12,000 children born in the Avon area in the early 1990s (Golding et al. 2001). Mothers were recruited into the sample at the point at which they first reported their pregnancy to their doctors. Data were collected at four points during pregnancy and at several points following birth – from both parents, from the child him/herself, and from the child's teacher and school.

For our analysis, we considered a sample of mothers to children in the “core sample” of ALSPAC. This sample consisted of 14,541 pregnancies that resulted in 14,676 known fetuses of which 14,062 were live births and 13,988 were alive at 1 year. The number of children for which the mother enrolled in the ALSPAC study and had either returned at least one questionnaire or attended a “Children in Focus”

clinic by 19/07/99, and returned at least one post-birth questionnaire is 12,268. We employ a maximizing strategy with respect to sample size which implies using as many observations as possible for each outcome-effect duet in each analysis. Sample sizes thus vary depending on the research question actually investigated. Table A.1 in the Appendix shows the different sample sizes in each association.

The commonly-used measure of maternal mental health, the Edinburgh Post-natal depression score (EPDS), was used. This measure was collected in ALSPAC pre-natally at 18 and 32 weeks' gestation, as well as post-natally at 8 weeks, 8 months, 18 months and 33 months. The EPDS was designed by Cox et al. (1987) to screen for postpartum depression. The EPDS is the most frequently used screening questionnaire for postpartum depression, has shown sensitivity to changes in depression over time, and has demonstrated validity and reliability for not only this condition but also antenatal depression (Cox et al., 1987, Eberhard-Gran et al. 2001; Horowitz and Goodman 2004; Matthey et al. 2006). The instrument consists of 10 statements describing depressive symptoms with four possible responses, each graded according to severity or duration. Scores on the EPDS range from 0 to 30. As commonly done in the literature, all scores were standardized to have mean zero and standard deviation 1; thus, all the results we present may be interpreted as proportions of a standard error. The authors of the EPDS have suggested that mental health referral is indicated whenever a woman scores 13 or higher during the post-partum period (Cox et al. 1987) and 15 or more during pregnancy (Murray and Cox 1990). Therefore, besides the standardized variable, an indicator of depression symptomatology was constructed for all mothers with $EPDS > 14$ in the pre-natal assessments and > 12 in the postpartum assessments (Dennis and Mc Queen 2007)¹.

¹ Two other studies using prenatal EPDS scores (Chittleborough et al. 2012; Fairlie et al. 2009) used a non-validated cut-off point of 13 or more, whereas still other (Seimyr et al. 2004) used 10 or more. Therefore we performed a sensitivity analysis in order to adequately assess our findings.

At intervals following their child's birth, mothers were asked how they were feeding their babies, including the stages at which infant formula and solid foods were introduced. From this information, we were able to compute different variables. To facilitate comparison of research results, we studied 6 breastfeeding indicator variables and 2 continuous variables. The first indicator measured intention to breastfeed during pregnancy. Breastfeeding initiation was defined as putting the baby to breast at least once. The other four indicators measured breastfeeding and exclusive breastfeeding at 1 and 4 weeks after birth. The continuous variables appraised the duration of breastfeeding and exclusive breastfeeding.

When analyzing the effect of breastfeeding on post-partum depression, we considered three specifications. Model A controlled only for the child's sex and parental education. Model B additionally controlled for prenatal EPDS values. And Model C controlled for all the variables shown in Table 2. The rationale behind comparing estimates from Models A and B was to show the impact of controlling for previous mental health conditions on the outcomes of interest. Including this prenatal information eliminated the potential reverse causality arising from the fact that previously depressed mothers may decide to breastfeed less. The rationale behind comparing models B and C was to obtain causal relationships as closely as possible by means of controlling for every potential confounder. Given the decisive influence of prenatal scores on these results, we also conducted a heterogeneity analysis distinguishing mothers over and under the suggested antenatal cut-off score of EPDS of 15 or more.

In order to measure the effect of maternal mood on breastfeeding outcomes, only information on prenatal depression symptoms was employed. Using postnatal information on maternal mood could generate reverse causality biases, given that breastfeeding may also influence postpartum depression.

We used two specifications, corresponding to Models A and C explained above, with the aim of approaching the causal relationship as closely as possible.

RESULTS

Outcome variables

Prevalence rates of antenatal depressed mood for a cut-off of EPDS >14 were 7 and 8 % at 18 and 32 weeks pregnancy, respectively, similar to those reported in previous studies (Choi et al. 2012). Post partum depression prevalence rates were between 9 and 12 %, which may also be consider similar to those from previous studies (O'Hara and Swaine 1996). (Table 1)

Figure 1 shows the estimated Kaplan-Meier survival function for breastfeeding duration, that is, the probability that breastfeeding lasts longer than a determined number of weeks. The probability of breastfeeding initiation was more than 80%. However, by four weeks only about 65% of all mothers were expected to breastfeed at all, and fewer than one third were expected to breastfeed exclusively. By 4 months (18 weeks, the recommended duration of exclusive breastfeeding by the World Health Organization before 2001), only about one third of mothers were breastfeeding at all, and hardly any were breastfeeding exclusively. Mean values for the 8 different breastfeeding measures used in the analyses are also presented in Table 1.

As a first approximation to our research questions, Table 2 shows the raw relationships between breastfeeding duration, exclusive and non-exclusive, and maternal depression symptomatology, as measured by EDPS scores, both during pregnancy and after the child's birth. There was a clear negative association between maternal depression symptoms and breastfeeding duration. And this was true when symptoms developed either antenatal- or postnatally. It is also worth mentioning the high correlation between postnatal and antenatal EPDS scores. This finding supports our estimation strategy.

Sample characteristics

Socio-demographic characteristics for the subjects in the sample are presented in Table A.3. The mean age of participants was 28.3 years (SD= 4.8). Ninety-five percent of the women were white, eighty-six percent were married, forty-two percent had completed secondary education (O-level), and seventy-four percent owned the house they lived in. In relation to pregnancy and birth, sixty-four percent felt usually well, fifty-five percent were working while pregnant, forty-five percent were primiparous, and only nine percent delivered via C-section. Average gestation was 39.5 weeks (SD=1.8). In addition forty-eight percent of mothers were breastfed themselves, as well as thirty-seven percent of the fathers.

Influence of breastfeeding on maternal mental health

Table 3 reports the results of regressions estimating the effect of different dichotomous definitions of breastfeeding on our post-partum mental health measures. In model A, the effect was only adjusted for the child's sex and parental education. For all breastfeeding measures and for most EPDS assessments breastfeeding exerted a significant reduction in measured post-partum depression symptoms. The influence was larger the longer the cut off point for breastfeeding was considered (for instance -0.09 (95% CI: -0.13,-0.05) for any breastfeeding at 4 weeks on EPDS measured at 8 weeks post-partum versus -0.07 (95% CI: -0.11,-0.02) for breastfeeding initiation on the same post-partum assessment), and the more exclusive breastfeeding was considered (for instance -0.12 (95% CI: - 0.16,-0.08) for exclusive breastfeeding at 4 weeks versus -0.09 (95% CI: -0.13,-0.05) for any breastfeeding at 4 weeks, both for EPDS measured at 8 weeks). Also the effect was consistently larger the earlier the assessment period (for instance exclusive breastfeeding at 4 weeks showed an effect of -0.12 (95% CI: - 0.16,-0.08) when the EPDS score was measured at 8 weeks whereas only an effect of -0.07 (95% CI: -0.11,-0.03) at 33 months), with effects even turning nonsignificant in many cases after 21 months, specially for breastfeeding definitions that considered shorter, less exclusive treatments.

However once previous antenatal depression symptoms were controlled for, as shown in Model B, most of the effect vanished. Only breastfeeding exclusively for at least 4 weeks decreased depression symptoms assessed at 8 weeks post partum (β -0.05; 95% CI -0.08,-0.01). Controlling for the rest of confounding factors of table A.3 (Model C) did not virtually change this result. We also found a few counter-intuitive results. Apparently breastfeeding initiation, and any breastfeeding for 1 week or 4 weeks were associated with increases in EPDS scores measured at 21 and 32 months after birth (Model C), with impacts ranging from 0.08 (%95 CI: 0.03,0.14) to 0.05 (%95 CI: 0.01-0.09).

Table 4 presents regression results of the effect of the continuous definitions of breastfeeding on our post-partum mental health measures. The estimated coefficients of Model A also showed a clear effect of the duration of breastfeeding on EPDS scores. In all cases an increase in breastfeeding decreased depression symptoms, but at a decreasing rate. However, once antenatal depression symptomatology (Model B) and other potential confounders (Model C) were controlled for, the effect vanished no matter the time of measurement of EPDS or the degree of exclusivity of breastfeeding. Again a few counterintuitive effects appeared indicating that longer exposures to breastfeeding increased mothers' EPDS scores at 21 months after giving birth.

Heterogenous effects in the influence of breastfeeding on post natal EPDS scores by prenatal mental status

Matthey et al. (2006) emphasized the screening nature of EPDS scores in signalling likely perinatal depression cases. They recommended the use of a validated EPDS score of 15 or more to report probable antenatal depression in English-speaking women. In order to analyze the potentially heterogeneous effects of breastfeeding in mothers at risk and not at risk of postpartum depression we divided our sample into two groups: mothers with prenatal depression EPDS scores levels at 18 or 32 weeks pregnancy and mothers below prenatal depression EPDS scores. Results from multivariate

regression analysis, adjusted for all variables in Table A.3, are presented in Tables 5 and 6 for our dichotomous and continuous definitions of breastfeeding, respectively. Breastfeeding was associated with higher EPDS scores of mothers not at risk of depression. The effect was only found when breastfeeding was not exclusive and was largest for breastfeeding initiation on EPDS measured at 33 months after birth (β 0.08; 95% CI: 0.03, 0.14). When effects were assessed for potentially depressed mothers, breastfeeding actually reduced EPDS scores, thus contributing to diminished postpartum depression symptoms. This effect was only found for exclusive breastfeeding in two of its definitions: exclusive breastfeeding for at least 4 weeks (β -0.20; 95% CI: -0.34,-0.06) and duration of exclusive breastfeeding (β -0.17; 95% CI: -0.32,-0.01). The continuous effect was in fact non-linear with exclusive breastfeeding reducing EPDS scores of potentially depressed mothers, but at a decreasing rate. In both cases the effect vanished before the 8th month after birth.

Influence of prenatal mental health on breastfeeding prevalence and duration

Table 7 reports the results of regressions estimating the relationships between antenatal maternal wellbeing, measured as a standardized EPDS score and as the likelihood of having an EPDS score of 15 or more, and different definitions of breastfeeding. Considering first the standardized EPDS measure, when only sex of the child and parental education were controlled for (Model A), breastfeeding was clearly associated with lower EPDS scores. For instance, one percent increase in EPDS scores at 18 weeks pregnancy significantly decreased the probability of exclusive breastfeeding when the child was 4 weeks old (adjusted OR 0.89; 95% CI 0.85,0.92) and significantly reduced the duration of any breastfeeding by 7 days (0.24 months) (adjusted OLS -0.23; 95% CI: -0.31,-0.14). The same was true when the indicator of being at risk of antenatal depression (EPDS>14) was considered. In this case, for instance, mothers showing antenatal depression symptoms at 32 weeks pregnancy were about 25% less likely to be exclusively breastfeeding at 4 weeks postpartum than those under the 15

EPDS score cutoff (Adjusted OR 0.75; 95% CI: 0.64-0.88). Also, showing antenatal depression symptoms at 32 weeks pregnancy reduced the duration of any breastfeeding approximately by 18 days (0.62 months) (adjusted OLS -0.62; 95%CI: -0.93,-0.32). However, when all potentially confounding factors of Table A.3 were controlled for, showing antenatal depression symptoms seemed to influence only breastfeeding exclusively for at least four weeks and the duration of any breastfeeding, and only if assessed at 32, and not 18, weeks pregnancy. Even in these cases, the effects were much smaller; for instance one percent increase in EPDS scores decreased the duration of any breastfeeding by approximately 4 days (-0.12 months; 95% CI:-0.20,-0.04).

No beneficial effects of breastfeeding were found when the indicator EPDS >14 was used. In order to adequately assess the robustness of this finding we performed a sensitivity analysis using different EPDS scores as cut-off points. The results are reported in Table 8. The deleterious effects of maternal depression on breastfeeding prevalence and duration are more clearly captured by lower cut-off scores than those recommended in the literature (Matthey et al. 2006). For instance, with a cut-off score of 11 or more, mothers showing antenatal depression symptoms at 32 weeks pregnancy were about 14% less likely to be exclusively breastfeeding at 4 weeks postpartum than those under the 11 EPDS score cutoff (Adjusted OR 0.86; 95% CI: 0.77-0.96); and showing antenatal depression symptoms at 32 weeks pregnancy reduced the duration of any breastfeeding approximately by 8 days (0.26 months) (adjusted OLS -0.26; 95%CI: -0.45,-0.07).

DISCUSSION

The aim of this study was to examine the relationships between breastfeeding and perinatal depression symptomatology, with a special emphasis in causality. This study extends previous research by using a large longitudinal dataset, including a large number of confounders, measuring maternal mood at

different time points both before and after delivery, and constructing many more measures of breastfeeding initiation, duration, and prevalence.

Our first result in this study was that the effect of breastfeeding on maternal mood was largely heterogeneous, depending on antenatal maternal mental health conditions. For mothers showing no depression symptoms before birth, breastfeeding increased stress; for mothers with antenatal depression symptoms, breastfeeding exclusively for at least one month had relaxing effects. This result provides a reason for earlier conflicting findings, in which breastfeeding showed no effect on postpartum depression sometimes (Chung et al. 2004), an increasing effect some other times (Alder and Cox 1983, Alder and Bancroft 1988) and a decreasing effect still others (Mezzacappa and Katkin 2002, Hatton et al. 2005, Ystrom 2012). We also found that breastfeeding effects did not last very long and were inexistent from 8 months after birth onwards. The only other longitudinal effect to investigate the effect of breastfeeding on postpartum depression (Hatton et al. 2005) also found a similar result with significant effects at 6 weeks postpartum that disappeared at 12 weeks.

In relation to the effect of maternal mood on breastfeeding, we found that prenatal depression symptoms at 32 weeks pregnancy decreased the likelihood of exclusive breastfeeding for at least one month and the duration of any breastfeeding. This finding is difficult to compare to available evidence given that most previous studies used postpartum depression measures (Taveras et al. 2003, Henderson et al. 2003, Kronborg and Vaeth 2004, Dennis and Mc Queen 2007, Li et al. 2008). Out of those studies including antenatal maternal mood information, only that of Pippins et al. (2006), for breastfeeding for at least one month, and Seimyr et al. (2004), for breastfeeding duration, found similar results. On the contrary Bogen et al. (2010) found no effect of depressive symptom severity during pregnancy on breastfeeding prevalence at 2 and 12 weeks. The studies that included antenatal mental health measures and considered breastfeeding initiation (Seimyr et al. 2004, Pippins et al. 2006, Fairlie et al. 2009,

Bogen et al 2010, Chittleborough et al 2012) found that prenatal depression symptoms was not associated to breastfeeding initiation, and neither did we. It is interesting to note that Chittleborough et al. (2012) also used ASPAC data but did not analyze the effect of antenatal mental health at 32 weeks pregnancy on breastfeeding for at least 4 weeks or breastfeeding duration.

We also found that a more inclusive antenatal EPDS cut-off score than that recommended by the literature (Matthey et al. 2006) showed a better predictive effect with respect to breastfeeding outcomes. In particular if pregnancy EPDS scores were to be used in order to identify women at risk of low breastfeeding durations, a cut-off of 11 or more would be recommended.

We recognize several limitations in these analyses. Although we use the most commonly used measure of depressive symptomatology, we acknowledge that including clinical diagnosis of antenatal and postpartum depression would have increased the value of our findings. Also, using self-report methods to assess breastfeeding outcomes may lead to misclassifications. Finally even though we use a large population-based sample and low loss to follow-up, sampling bias resulting from the voluntary nature of participation in the survey could have influenced results.

CONCLUSION

(1 paragraph)

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Table 1 Characteristics of study variables

	N. Obs.	mean	sd
Maternal Mental Health during pregnancy			
Standarized EPDS at 18 weeks	11275	-0.02	(1.0)
At risk of Antenatal Depression at 18 weeks (EPDS>14)	11275	0.07	(0.3)
Standarized EPDS at 32 weeks	11740	-0.01	(1.0)
At risk of Antenatal Depression at 32 weeks (EPDS>14)	11740	0.08	(0.3)
Maternal Mental Health Post-partum			
Standarized EPDS at 8 weeks	11173	-0.01	(1.0)
At risk of Post-partum Depression at 8 weeks (EPDS>12)	11173	0.10	(0.3)
Standarized EPDS at 8 months	10731	-0.01	(1.0)
At risk of Post-partum Depression at 8 months (EPDS>12)	10731	0.09	(0.3)
Standarized EPDS at 21 months	9907	-0.01	(1.0)
At risk of Post-partum Depression at 21 months (EPDS>12)	9907	0.10	(0.3)
Standarized EPDS at 33 months	9262	-0.01	(1.0)
At risk of Post-partum Depression at 33months (EPDS>12)	9262	0.12	(0.3)
Breastfeeding			
Mother intended to breastfeed	14468	0.54	(0.5)
Initiated breastfeeding	12192	0.79	(0.4)
Breastfed for 1 week	11733	0.72	(0.4)
Breastfed for 4 weeks	12144	0.54	(0.5)
Duration of any breastfeeding (months)	11761	3.84	(4.6)
Exclusively breastfed for 1 week	11733	0.63	(0.5)
Exclusively breastfed for 4 weeks	12144	0.41	(0.5)
Duration of exclusive breastfeeding (months)	12446	0.99	(1.2)

Table 2. Raw correlations among study variables

	Breastfeeding		Maternal Mental Health during pregnancy	
	Duration of any BF (months)	Duration of exc. BF (months)	Std. EPDS at 18 w.	Std. EPDS at 32 w.
Maternal Mental Health during pregnancy				
Standarized EPDS at 18 weeks	-0.07	-0.06	1.00	0.63
Standarized EPDS at 32 weeks	-0.07	-0.07	0.63	1.00
Maternal Mental Health Post-partum				
Standarized EPDS at 8 weeks	-0.05	-0.04	0.53	0.58
Standarized EPDS at 8 months	-0.04	-0.04	0.49	0.55
Standarized EPDS at 21 months	-0.03	-0.03	0.48	0.52
Standarized EPDS at 33 months	-0.02	-0.04	0.47	0.49

Table 3. Effect of breastfeeding on postpartum mental health. Dichotomous variables

	Model A	Model B	Model C
	Adjusted OLS [95% CI]	Adjusted OLS [95% CI]	Adjusted OLS [95% CI]
Breastfeeding initiation			
Std. EPDS at 8 weeks	-0.07 [-0.11,-0.02]**	-0.00 [-0.04,0.04]	0.01 [-0.03,0.06]
Std. EPDS at 8 months	-0.06 [-0.11,-0.01]*	0.00 [-0.04,0.05]	0.02 [-0.03,0.07]
Std. EPDS at 21 months	-0.06 [-0.11,-0.00]*	0.02 [-0.03,0.06]	0.01 [-0.04,0.06]
Std. EPDS at 33 months	0.02 [-0.03,0.08]	0.08 [0.03,0.13]***	0.08 [0.03,0.14]**
Any breastfeeding for 1 week			
Std. EPDS at 8 weeks	-0.10 [-0.14,-0.05]***	-0.02 [-0.05,0.02]	0.01 [-0.04,0.05]
Std. EPDS at 8 months	-0.06 [-0.11,-0.02]**	0.03 [-0.01,0.07]	0.05 [0.00,0.09]*
Std. EPDS at 21 months	-0.05 [-0.10,0.00]	0.03 [-0.01,0.08]	0.04 [-0.01,0.09]
Std. EPDS at 33 months	-0.01 [-0.06,0.04]	0.07 [0.03,0.11]**	0.07 [0.03,0.12]**
Any breastfeeding for 4 weeks			
Std. EPDS at 8 weeks	-0.09 [-0.13,-0.05]***	-0.03 [-0.06,0.01]	-0.02 [-0.06,0.01]
Std. EPDS at 8 months	-0.08 [-0.13,-0.04]***	-0.01 [-0.05,0.02]	-0.01 [-0.04,0.03]
Std. EPDS at 21 months	-0.02 [-0.06,0.03]	0.05 [0.01,0.08]*	0.05 [0.01,0.09]*
Std. EPDS at 33 months	-0.05 [-0.09,-0.00]*	0.01 [-0.02,0.05]	0.01 [-0.03,0.05]
Exclusive breastfeeding for 1 week			
Std. EPDS at 8 weeks	-0.10 [-0.14,-0.06]***	-0.02 [-0.06,0.01]	-0.01 [-0.04,0.03]
Std. EPDS at 8 months	-0.07 [-0.11,-0.02]**	0.01 [-0.03,0.05]	0.03 [-0.01,0.06]
Std. EPDS at 21 months	-0.04 [-0.09,0.00]	0.03 [-0.01,0.07]	0.04 [-0.00,0.08]
Std. EPDS at 33 months	-0.05 [-0.09,-0.00]*	0.02 [-0.02,0.06]	0.03 [-0.01,0.07]
Exclusive breastfeeding for 4 weeks			
Std. EPDS at 8 weeks	-0.12 [-0.16,-0.08]***	-0.05 [-0.08,-0.01]**	-0.04 [-0.08,-0.01]*
Std. EPDS at 8 months	-0.10 [-0.14,-0.06]***	-0.02 [-0.06,0.01]	-0.02 [-0.06,0.01]
Std. EPDS at 21 months	-0.07 [-0.11,-0.03]**	0.00 [-0.03,0.04]	0.00 [-0.04,0.04]
Std. EPDS at 33 months	-0.07 [-0.11,-0.03]**	-0.00 [-0.04,0.03]	-0.01 [-0.05,0.03]

Table 4. Effect of breastfeeding on maternal mental health. Continuous variables

	Model A		Model B		Model C	
	Duration of bf.	Duration squared	Duration of bf.	Duration squared	Duration of bf.	Duration squared
	Adj. OLS [95% CI]	Adj. OLS [95% CI]	Adj. OLS [95% CI]	Adj. OLS [95% CI]	Adj. OLS [95% CI]	Adj. OLS [95% CI]
Any breastfeeding						
Std. EPDS at 8 w.	-0.03 [-0.05,-0.02]***	0.00 [0.00,0.00]***	-0.00 [-0.02,0.01]	0.00 [-0.00,0.00]	-0.00 [-0.01,0.01]	-0.00 [-0.00,0.00]
Std. EPDS at 8 m.	-0.03 [-0.04,-0.02]***	0.00 [0.00,0.00]***	-0.00 [-0.01,0.01]	-0.00 [-0.00,0.00]	0.00 [-0.01,0.02]	-0.00 [-0.00,0.00]
Std. EPDS at 21 m.	-0.01 [-0.03,0.00]	0.00 [-0.00,0.00]	0.02 [0.00,0.03]**	-0.00 [-0.00,-0.00]*	0.02 [0.01,0.03]**	-0.00 [-0.00,-0.00]**
Std. EPDS at 33 m.	-0.03 [-0.04,-0.01]***	0.00 [0.00,0.00]***	0.00 [-0.01,0.01]	0.00 [-0.00,0.00]	0.00 [-0.01,0.02]	-0.00 [-0.00,0.00]
Exclusive breastfeeding						
Std. EPDS at 8 w.	-0.08 [-0.12,-0.03]***	0.01 [0.00,0.02]**	-0.02 [-0.05,0.02]	0.00 [-0.01,0.01]	-0.01 [-0.05,0.03]	0.00 [-0.01,0.01]
Std. EPDS at 8 m.	-0.07 [-0.11,-0.02]**	0.01 [0.00,0.02]*	-0.02 [-0.06,0.02]	0.00 [-0.01,0.01]	-0.01 [-0.05,0.03]	0.00 [-0.01,0.01]
Std. EPDS at 21 m.	-0.02 [-0.07,0.03]	0.00 [-0.01,0.01]	0.04 [-0.00,0.08]	-0.01 [-0.02,0.00]	0.05 [0.00,0.09]*	-0.01 [-0.02,0.00]
Std. EPDS at 33 m.	-0.06 [-0.10,-0.01]*	0.01 [-0.00,0.02]	0.01 [-0.04,0.05]	-0.00 [-0.01,0.01]	0.01 [-0.04,0.05]	-0.00 [-0.01,0.01]

Table 5. Heterogeneity by antenatal EPDS scores. Dichotomous definitions

	Mothers at no risk of PPD Adjusted OLS [95% CI]	Mothers at risk of PPD Adjusted OLS [95% CI]
Breastfeeding initiation		
Std. EPDS at 8 weeks	0.01 [-0.04,0.05]	0.02 [-0.14,0.17]
Std. EPDS at 8 months	0.02 [-0.03,0.06]	0.00 [-0.17,0.17]
Std. EPDS at 21 months	0.00 [-0.05,0.05]	0.07 [-0.11,0.25]
Std. EPDS at 33 months	0.08 [0.03,0.14]**	0.15 [-0.03,0.34]
Any breastfeeding for 1 week		
Std. EPDS at 8 weeks	0.01 [-0.03,0.05]	-0.02 [-0.17,0.13]
Std. EPDS at 8 months	0.05 [0.00,0.09]*	-0.02 [-0.18,0.14]
Std. EPDS at 21 months	0.03 [-0.01,0.08]	0.07 [-0.09,0.24]
Std. EPDS at 33 months	0.07 [0.02,0.12]**	0.10 [-0.07,0.27]
Any breastfeeding for 4 weeks		
Std. EPDS at 8 weeks	-0.01 [-0.04,0.03]	-0.12 [-0.26,0.02]
Std. EPDS at 8 months	0.00 [-0.04,0.03]	-0.05 [-0.20,0.11]
Std. EPDS at 21 months	0.05 [0.01,0.09]*	0.06 [-0.09,0.22]
Std. EPDS at 33 months	0.01 [-0.03,0.06]	0.01 [-0.15,0.17]
Exclusive breastfeeding for 1 week		
Std. EPDS at 8 weeks	0.00 [-0.03,0.04]	-0.07 [-0.21,0.07]
Std. EPDS at 8 months	0.03 [-0.01,0.06]	-0.03 [-0.18,0.12]
Std. EPDS at 21 months	0.03 [-0.01,0.07]	0.08 [-0.08,0.23]
Std. EPDS at 33 months	0.03 [-0.02,0.07]	0.04 [-0.12,0.20]
Exclusive breastfeeding for 4 weeks		
Std. EPDS at 8 weeks	-0.02 [-0.06,0.01]	-0.20 [-0.34,-0.06]**
Std. EPDS at 8 months	-0.02 [-0.05,0.02]	-0.08 [-0.23,0.07]
Std. EPDS at 21 months	0.00 [-0.04,0.04]	0.02 [-0.14,0.17]
Std. EPDS at 33 months	-0.01 [-0.05,0.03]	-0.04 [-0.20,0.12]

Table 6. Heterogeneity by antenatal EPDS scores. Continuous definitions

	Mothers at no risk of PPD		Mothers at risk of PPD	
	Duration of bf. Adj. OLS [95% CI]	Duration squared Adj. OLS [95% CI]	Duration of bf. Adj. OLS [95% CI]	Duration squared Adj. OLS [95% CI]
Any breastfeeding				
Std. EPDS at 8 w.	0.00 [-0.01,0.01]	0.00 [-0.00,0.00]	-0.03 [-0.08,0.01]	0.00 [-0.00,0.00]
Std. EPDS at 8 m.	0.00 [-0.01,0.01]	0.00 [-0.00,0.00]	-0.01 [-0.06,0.04]	0.00 [-0.00,0.00]
Std. EPDS at 21 m.	0.02 [0.00,0.03]*	0.00 [-0.00,-0.00]**	0.03 [-0.02,0.08]	0.00 [-0.01,0.00]
Std. EPDS at 33 m.	0.00 [-0.01,0.01]	0.00 [-0.00,0.00]	0.02 [-0.03,0.08]	0.00 [-0.01,0.00]
Exclusive breastfeeding				
Std. EPDS at 8 w.	0.01 [-0.03,0.05]	0.00 [-0.01,0.01]	-0.17 [-0.32,-0.01]*	0.04 [0.01,0.08]*
Std. EPDS at 8 m.	0.00 [-0.04,0.04]	0.00 [-0.01,0.01]	-0.14 [-0.31,0.03]	0.03 [-0.01,0.07]
Std. EPDS at 21 m.	0.05 [0.01,0.09]*	-0.01 [-0.02,0.00]	0.02 [-0.15,0.19]	0.00 [-0.04,0.04]
Std. EPDS at 33 m.	0.00 [-0.04,0.05]	0.00 [-0.01,0.01]	0.02 [-0.17,0.21]	-0.01 [-0.06,0.04]

Table 7. Effect of Antenatal Mental Health on Breastfeeding

	Model A		Model C	
	EPDS at 18 weeks pregnancy Adj. OR/OLS [95% CI]	EPDS 18w preg.>14 Adj. OR/OLS [95% CI]	EPDS at 18 weeks pregnancy Adj. OR/OLS [95% CI]	EPDS 18w preg.>14 Adj. OR/OLS [95% CI]
Indicator variables (OR)				
BF. Intentions	0.90 [0.87,0.94]***	0.90 [0.77,1.05]	0.99 [0.94,1.04]	1.14 [0.96,1.35]
BF. Initiation	0.94 [0.89,0.99]*	0.93 [0.78,1.12]	1.07 [1.01,1.13]*	1.32 [1.07,1.63]**
Any breastfeeding for 1 week	0.90 [0.86,0.94]***	0.82 [0.69,0.97]*	1.01 [0.96,1.07]	1.15 [0.94,1.40]
Any breastfeeding for 4 weeks	0.90 [0.86,0.94]***	0.74 [0.63,0.87]***	1.01 [0.96,1.06]	0.99 [0.83,1.19]
Exc. breastfeeding for 1 week	0.90 [0.86,0.94]***	0.85 [0.73,1.00]	0.99 [0.94,1.04]	1.13 [0.94,1.36]
Exc. breastfeeding for 4 weeks	0.89 [0.85,0.92]***	0.77 [0.65,0.91]**	0.96 [0.92,1.01]	0.97 [0.81,1.17]
Continuous variables (OLS)				
Duration of any BF.	-0.23 [-0.31,-0.14]***	-0.54 [-0.86,-0.21]**	-0.07 [-0.15,0.02]	-0.05 [-0.36,0.26]
Duration of exclusive BF.	-0.03 [-0.05,-0.01]**	-0.04 [-0.12,0.05]	0.00 [-0.02,0.03]	0.06 [-0.02,0.14]
	EPDS at 32 weeks pregnancy Adj. OR/OLS [95% CI]	EPDS at 32w. preg.>14 Adj. OR/OLS [95% CI]	EPDS at 32 weeks pregnancy Adj. OR/OLS [95% CI]	EPDS at 32 w. preg.>14 Adj. OR/OLS [95% CI]
Indicator variables (OR)				
BF. Intentions	0.89 [0.86,0.93]***	0.77 [0.67,0.89]***	0.98 [0.94,1.03]	0.95 [0.81,1.11]
BF. Initiation	0.90 [0.86,0.94]***	0.80 [0.68,0.95]**	1.03 [0.97,1.09]	1.08 [0.89,1.30]
Any breastfeeding for 1 week	0.87 [0.83,0.91]***	0.70 [0.60,0.82]***	0.98 [0.93,1.03]	0.91 [0.76,1.09]
Any breastfeeding for 4 weeks	0.89 [0.85,0.93]***	0.78 [0.67,0.90]***	0.98 [0.93,1.03]	0.99 [0.84,1.17]
Exc. breastfeeding for 1 week	0.88 [0.84,0.92]***	0.77 [0.66,0.89]***	0.96 [0.92,1.01]	0.96 [0.81,1.14]
Exc. breastfeeding for 4 weeks	0.88 [0.84,0.92]***	0.75 [0.64,0.88]***	0.94 [0.90,0.99]*	0.90 [0.76,1.06]
Continuous variables (OLS)				
Duration of any BF.	-0.24 [-0.33,-0.16]***	-0.62 [-0.93,-0.32]***	-0.12 [-0.20,-0.04]**	-0.28 [-0.57,0.01]
Duration of exclusive BF.	-0.05 [-0.07,-0.02]***	-0.09 [-0.17,-0.02]*	-0.01 [-0.03,0.01]	-0.01 [-0.09,0.06]

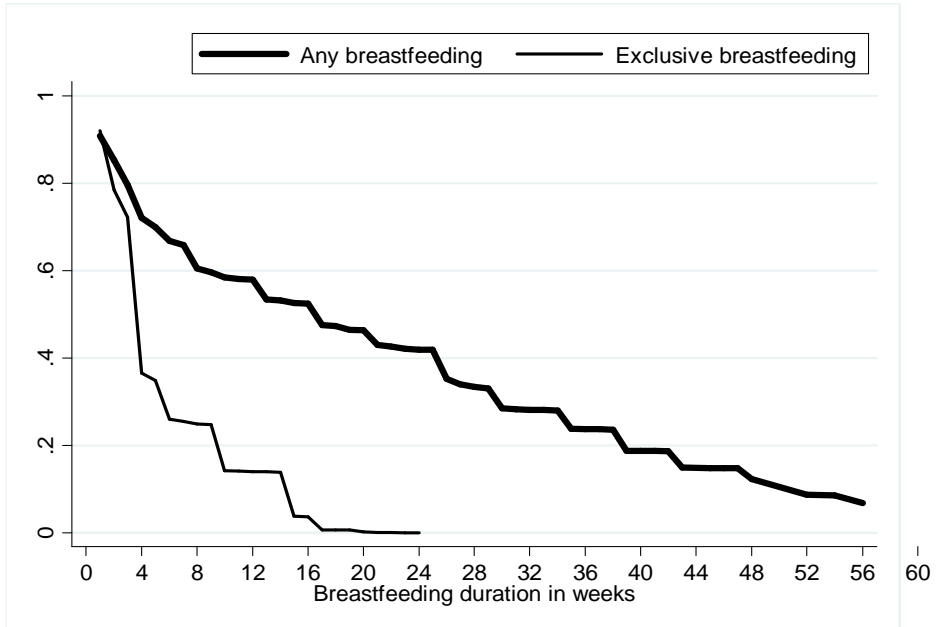
Coefficients for indicator variables in the table (marked OR) are odds ratios from Logit regressions; those marked (OLS) are multivariate regression coefficients.

95% confidence intervals are given in brackets. P-values are indicated by asterisks, with *P < 0.05, **P < 0.01, ***P < 0.001.

Table 8. Sensitivity to EPDS scores cut-off. Effect of Antenatal Mental Health on Breastfeeding

	EPDS at 32 w. preg.>9 Adj. OR/OLS [95% CI]	EPDS at 32 w. preg.>10 Adj. OR/OLS [95% CI]	EPDS at 32 w. preg.>11 Adj. OR/OLS [95% CI]	EPDS at 32 w. preg.>12 Adj. OR/OLS [95% CI]
Indicator variables (OR)				
BF. Intentions	0.92 [0.84,1.02]	0.92 [0.83,1.02]	0.94 [0.84,1.06]	0.96 [0.85,1.09]
BF. Initiation	1.01 [0.89,1.14]	0.99 [0.88,1.13]	1.05 [0.92,1.21]	1.12 [0.96,1.30]
Any breastfeeding for 1 week	0.93 [0.83,1.04]	0.93 [0.82,1.04]	0.95 [0.84,1.09]	1.01 [0.87,1.16]
Any breastfeeding for 4 weeks	0.94 [0.85,1.04]	0.94 [0.84,1.04]	0.97 [0.86,1.09]	0.95 [0.83,1.08]
Exc. breastfeeding for 1 week	0.92 [0.83,1.02]	0.91 [0.82,1.02]	0.95 [0.84,1.07]	0.97 [0.85,1.10]
Exc. breastfeeding for 4 weeks	0.93 [0.84,1.02]	0.86 [0.77,0.96]**	0.89 [0.79,1.00]*	0.87 [0.76,0.99]*
Continuous variables (OLS)				
Duration of any BF.	-0.19 [-0.37,-0.02]*	-0.26 [-0.45,-0.07]**	-0.19 [-0.39,0.01]	-0.20 [-0.43,0.02]
Duration of exclusive BF.	-0.01 [-0.06,0.03]	-0.04 [-0.09,0.01]	-0.03 [-0.08,0.03]	-0.01 [-0.07,0.04]
	EPDS at 32 w. preg.>13 Adj. OR/OLS [95% CI]	EPDS at 32 w. preg.>14 Adj. OR/OLS [95% CI]	EPDS at 32 w. preg.>15 Adj. OR/OLS [95% CI]	EPDS at 32 w. preg.>16 Adj. OR/OLS [95% CI]
Indicator variables (OR)				
BF. Intentions	0.92 [0.80,1.05]	0.95 [0.81,1.11]	0.93 [0.78,1.11]	0.91 [0.74,1.11]
BF. Initiation	1.06 [0.90,1.25]	1.08 [0.89,1.30]	1.14 [0.92,1.41]	1.18 [0.92,1.51]
Any breastfeeding for 1 week	0.94 [0.81,1.10]	0.91 [0.76,1.09]	0.92 [0.75,1.13]	0.98 [0.77,1.25]
Any breastfeeding for 4 weeks	0.95 [0.82,1.10]	0.99 [0.84,1.17]	0.93 [0.77,1.12]	0.92 [0.73,1.15]
Exc. breastfeeding for 1 week	0.98 [0.85,1.13]	0.96 [0.81,1.14]	0.96 [0.79,1.16]	0.99 [0.79,1.24]
Exc. breastfeeding for 4 weeks	0.88 [0.76,1.02]	0.90 [0.76,1.06]	0.86 [0.71,1.04]	0.87 [0.69,1.09]
Continuous variables (OLS)				
Duration of any BF.	-0.26 [-0.51,-0.00]*	-0.28 [-0.57,0.01]	-0.35 [-0.68,-0.02]*	-0.37 [-0.75,0.02]
Duration of exclusive BF.	-0.02 [-0.08,0.05]	-0.01 [-0.09,0.06]	-0.04 [-0.13,0.04]	-0.05 [-0.15,0.05]

Figure 1: Breastfeeding survival function. Kaplan-Meier nonparametric method.



Source: ALSPAC Data, core sample.

Appendix A

Table A.1 Sample sizes

	Antenatal		Postnatal			
	EPDS 18 weeks	EPDS 32 weeks	EPDS 18 weeks	EPDS 8 months	EPDS 21 months	EPDS 33 months
Bf Intention	11279	11765	11173	10731	9907	9262
Bf Initiation	10644	11128	10917	10450	9669	9053
Bf for 1 week	10298	10759	10569	10131	9382	8787
Bf for 2 weeks	10309	10772	10583	10141	9393	8799
Bf for 4 weeks	10601	11089	10879	10413	9632	9021
Duration of any Bf	10263	10727	10533	10089	9327	8730
Exc. Bf for 1 week	10298	10759	10569	10131	9382	8787
Exc. Bf for 4 weeks	10601	11089	10879	10413	9632	9021
Duration of exc. Bf	10808	11297	11022	10632	9820	9186

Table A.2 List of variables used in the analysis

Control Variables:

Socio-demographic variables (at or during pregnancy):

Two dummies for house tenure (tenure_own and tenure_rent) that take value 1 if the mother owned the house or rented the house during pregnancy, the number of living rooms in the house during pregnancy (rooms), neighborhood indicators with higher values indicating a better neighborhood (neigh_q), a dummy indicating the mother's race (white); three dummies (mastat) indicating the marital status of the mother at the time of pregnancy (married, cohabiting, or separated/divorce), 5 dummies (M_ed and F_ed) indicating the mother's and father's education level (CSE, Vocational, O level, A level, degree), an indicator variable that takes value 1 if the mother was in local authority care (M_care), an indicator variable that takes value 1 if she had divorced parents by age 17 (M_div17), an indicator variable that takes value 1 if the mother's main carer died by age 17 (M_carer17); and an indicator variable (M_work18w) that takes value 1 if the mother was working at 18 weeks of the pregnancy.

Health, pregnancy and delivery information:

A dummy that takes value 1 if the child is a female (fem), a dummy that takes value 1 if the child is twin (twin); an indicator taking value one if the mother is in bad health status (M_badh), mother's age at birth (M_age_b), number of cigarettes a day (measured at 23 weeks of pregnancy, M_ncigs_AN32w), an indicator variable (M_csec*) that takes value 1 if the mother had a cesarean section; the length of the gestation period (gest); and two measures of the mother's mental health: the adult version of the Nowicki-Strickland locus of control scale (Duke and Nowicki, 1973) and the Total Crown Crisp score (Crown and Crisp 1979).

Table A.3. Socio-demographic Characteristics of Study Population

		Mean (Std.Error)
Pregnancy and birth	Gestation in weeks	39.47 (1.8)
	Mother's age at birth	28.34 (4.8)
	C-section	0.09 (0.3)
	Primiparous	0.45 (0.5)
	Mother works at 18 weeks	0.55 (0.5)
	Cigarettes at 32 w	2.00 (5.1)
	Previous alcohol consumption	2.59 (0.8)
Child characteristics at birth	Female	0.49 (0.5)
	Twin	0.01 (0.1)
	Birth weight	3419.93 (543.9)
	Head circumference	34.84 (1.4)
	Crown-heel length	50.52 (2.2)
Mother's health in pregnancy	Mother health always well	0.29 (0.5)
	Mother health usually well	0.64 (0.5)
	Mother health stm unwell	0.06 (0.2)
	Mother health often unwell	0.01 (0.1)
	Std. Locus/control score	0.00 (1.1)
Socio-economic variables	Owner occupier	0.74 (0.4)
	Private rented	0.07 (0.3)
	Number of rooms	1.59 (0.9)
	Neighbourhood qual.	8.25 (2.2)
Demographic variables	White mother	0.95 (0.2)
	Mother cohabiting	0.20 (0.4)
	Mother single	0.04 (0.2)
Father's education	Degree	0.17 (0.4)
	A-level	0.25 (0.4)
	O-level	0.35 (0.5)
	Vocational	0.08 (0.3)
	CSE	0.15 (0.4)
Mother's education	Degree	0.13 (0.3)
	A-level	0.22 (0.4)
	O-level	0.42 (0.5)
	Vocational	0.10 (0.3)
	CSE	0.14 (0.3)
Breastfeeding attitudes & intentions	Mother was breastfed	0.48 (0.5)
	Father was breastfed	0.32 (0.5)
	Father breastfeeding attitudes	15.39 (2.4)