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*Arch. Dis. Child.* published online 3 Aug 2006;  
doi:10.1136/adc.2006.096826

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## Breast feeding and resilience against psychosocial stress

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**Keywords:** breast feeding; resilience; stress; longitudinal; HPA axis

## **Abstract**

**Objective** – Some early life exposures may result in a well controlled stress response, which can reduce stress-related anxiety. Breast feeding may be a marker of some relevant exposures, so we assessed whether it was associated with modification of the relationship between parental divorce and anxiety.

**Design** – Observational study using longitudinal birth cohort data. Linear regression was used to assess whether breast feeding modifies the association of parental divorce/separation with anxiety using stratification and interaction testing

**Setting** – The 1970 British Cohort Study is following the lives of those born in one week in 1970 and living in Great Britain. This study uses information collected at birth and at ages 5 and ten years for 8958 subjects.

**Main outcome measure** – Class teachers answered a question on anxiety among 10-year olds using an analogue scale (range 0-50) that was log-transformed to minimise skewness.

**Results** – Among 5672 non-breast-fed subjects, parental divorce/separation was associated with a statistically significantly raised risk of anxiety, with a regression coefficient (95% confidence interval) of 9.4 (6.1, 12.8). Among the breast-fed group this association was much lower: 2.2 (-2.6, 7.0). Interaction testing confirmed statistically significant effect modification by breast feeding, independent of simultaneous adjustment for multiple potential confounding factors, producing an interaction coefficient of -7.0 (-12.8, -1.2) indicating a 7% reduction in anxiety after adjustment.

**Conclusions** – Breast feeding is associated with resilience against the psychosocial stress linked with parental divorce/separation. This could be because breast feeding is a marker of exposures related to maternal characteristics and parent-child interaction.

## Introduction

A variety of exposures in infancy and childhood may influence how a child responds to psychosocial stress: parental and family characteristics are likely to be critical in this respect. Several components of maternal contact are likely to be important and one potential effect of positive maternal contact has been demonstrated by animal studies. Early maternal contact may influence the development of neuroendocrine systems involved in the stress response:<sup>1</sup> rats that experienced a greater frequency of maternal contact during nursing in the first 10 days after birth, such as licking and grooming, showed a lower magnitude hypothalamic-pituitary-adrenal (HPA) response to acute stress as adults, due to enhanced feedback mechanisms.<sup>2</sup> A more controlled response to stress such as this enhances the ability to cope with stressful events.<sup>3</sup> Breast feeding in humans may also indicate a variety of indirect and perhaps some direct exposures that result in a more controlled stress response in offspring. Potentially, these could operate through a number of mechanisms associated with factors such as maternal characteristics, development of the mother-child bond and early mother-child interactions.

Medical research is generally concerned with 'risk': whether an exposure is directly associated with an increased or decreased risk of disease or other outcome. In contrast, this paper is concerned with *resilience*, defined here as a factor associated with modification of the relationship between an adverse exposure and the outcome (effect modification), for example as childhood factors modify the association of chronic adult stress with systolic blood pressure.<sup>4</sup> For the current study, the adversity is chronic psychosocial stress in childhood indicated by parental divorce<sup>5</sup> and the outcome is the child's tendency to exhibit signs of chronic anxiety at age 10 years. Our *a priori* hypothesis is that children who were breast-fed are more resilient to psychosocial stress, here defined by parental separation or divorce.

## Subjects and methods

The 1970 British Cohort Study (BCS70) is following the lives of everyone born between 5 and 11 April 1970 living in Great Britain, comprising approximately 16500 members.<sup>6</sup> A total of 12665 subjects had responses to our outcome measure from the 10-year sweep (those in special education excluded). Subjects with data missing for any variable used by the main analysis were excluded, reducing the number to 8958 (71%). Despite attrition, the 10-year sweep is broadly representative of the birth cohort with somewhat greater loss from the most disadvantaged families.<sup>7</sup> This study involved secondary analysis of a publicly-available data set which is stripped of all information that would allow identification of any individual. Ethical permission to collect this material was obtained by the original investigators prior to data collection.

### *Birth*

Midwives interviewed mothers and reviewed medical records. Mother's age at the cohort member's birth was coded into five-year categories: under 16 years, 16-20 years, 21-25 years, 26-30 years, 31-35 years, 36-40 years and over 40 years. Mother's age at leaving full-time education was divided into five categories: leaving school before the minimum age; at the minimum age, remaining at school; further/higher education; and post-graduate education. Father's occupation was coded into the Registrar General's social class, with an additional category where class could not be assigned for reasons such as unemployment. Smoking during pregnancy was defined as non-smoker, stopped prior to pregnancy, stopped during pregnancy, 1-4 cigarettes per day, 5-14 cigarettes per day, or 15 or more cigarettes per day. Prematurity was defined as birth before week 37. Birth weight was recorded in grams.

Puerperal psychosis and depression during pregnancy were recorded. Parity was defined as the number of previous pregnancies and coded: none, one, two, or three or more.

#### *Age 5 years*

Parents were interviewed by health visitors and completed questionnaires. The interview recorded breast feeding duration, using the question ‘Was the child breast fed partly or wholly, even for only a few days?’ and for the main analysis this was dichotomised into yes or no. The Malaise Inventory,<sup>8,9</sup> a 24-question instrument, estimated mothers’ tendency to depression. Assessment for chronic illness or disability in the first year of life indicated suspected morbidity.

#### *Age 10 years*

Cohort members’ class teachers were asked if the child was ‘worried and anxious about many things’ on an analogue scale ranging from 0 to 50 (very anxious). The maternal interview recorded family disruption by parental divorce or parental separation. This measure was limited to events occurring between ages 5 and 10 years to reduce the possibility of confounding where divorce and associated family conflict before age 5 years influenced both the mother’s decision to breast feed and the development of the child’s tendency to anxiety. The medical examination and record review identified chronic illness or disability affecting daily life, as well as evidence of puberty based on: breast development, testicular enlargement, pubic hair, axillary hair, menarche, or penile enlargement.

### STATISTICAL ANALYSIS

The teacher’s assessment of anxiety had a skewed distribution, but the *lnskew0* transformation command provided by Stata software reduced skewness using the equation  $\ln(x-(-12.4))$  which was generated based on the characteristics of the distribution to be transformed. The transformed variable was multiplied by 100 for presentation purposes. This was the dependent variable in linear regression which simultaneously included all measures shown in table 1, as well as maternal age, in the adjusted model. With the exception of birth weight, all of the independent measures were modelled as series of binary dummy variables. As evidence of puberty and puerperal psychosis/depression were not associated with the dependent variable, they were not included in the final model. The Malaise Inventory score offered marginally greater explanatory power modelled as a binary variable (cut-off at eight or more positive responses), than as a continuous score, so the binary measure was used as designed.<sup>9</sup>

#### *Effect modification*

Stratified analysis and interaction testing<sup>10</sup> assessed whether breast feeding modifies the association of parental divorce or separation with childhood anxiety. The regression analysis described above was stratified by breast feeding. A further (non-stratified) model included the interaction term for breast feeding with divorce adjusted for the main effects<sup>10</sup> (breast feeding and divorce), as well as the other measures.

### Results

A strong statistically significant positive association between parental divorce or separation with childhood anxiety was observed (table 1). The following measures were independently associated with a statistically significant raised risk of anxiety: maternal depression at age 5 years, existence of a limiting disability at age 10 years and female sex. Smoking during pregnancy and attendance for disability assessment in the first year of life were associated

with a greater risk of anxiety, but these associations were not independent of the other measures, as statistical significance was lost after adjustment for the other measures ( $p > 0.1$ ).

Higher father's social class, older mother's age at leaving full-time education, a larger number of previous pregnancies and higher birth weight were all independently and statistically significantly associated with a reduced risk of childhood anxiety. Breast feeding was associated with a modest non-statistically significant decrease in the risk of anxiety.

#### *Effect modification*

In the stratified analysis, among those who were not breast-fed there was a large and statistically significant increased risk of anxiety associated with parental divorce independent of the potential confounding factors, (table 2). In contrast, among breast-fed children the magnitude of association between parental divorce or separation and childhood anxiety was much lower and not statistically significant. The substantial difference in the coefficients of association indicates effect modification.<sup>11</sup>

Interaction testing also assessed effect modification.<sup>10</sup> After adjustment for the main effects, breast feeding and parental divorce/separation, the combined interaction term for these factors is statistically significantly associated with a lower estimate of childhood anxiety, with a coefficient (and 95% confidence interval) of  $-7.2$  ( $-13.1, -1.4$ ). Further adjustment for all other measures scarcely alters this estimate of effect modification or its statistical significance, producing a coefficient of  $-7.0$  ( $-12.8, -1.2$ ). This coefficient indicates that the association of divorce with anxiety is lower in breast-fed children, compared with non-breast-fed children. The interaction coefficient can be interpreted<sup>12</sup> as a 7% reduction in the risk of anxiety associated with parental divorce after adjustment for feeding pattern and the other potential confounding factors

Although the measure of breast feeding was dichotomised for the main analysis, we also investigated the various durations of breastfeeding which were recorded: among those who were breast fed, 43% were breast fed for up to one month; 27% were breast fed for over a month to three months; and 29% were breast fed for over three months. Effect modification was assessed through interaction testing among the three breast feeding duration categories (those were not breast fed were excluded) and the two longer durations were compared with the shortest duration. After adjustment for the main effects, the odds ratios for the interaction of divorce with breast feeding duration (durations compared) for their association with anxiety are not statistically significant and do not provide evidence of a dose-response effect:  $-1.5$  ( $-4.9, 1.8$ );  $-1.3$  ( $-4.7, 2.1$ ).

Table 1. Associations with anxiety at age 10 years

	Number	%	Coef.#	P
<b>Parental divorce</b>				
No	7,873	87.9		
Yes	1,085	12.1	7.1	0.000
<b>Social class</b>				
I	408	4.6	-6.6	0.003
II	1,027	11.5	-5.1	0.001
III <sub>nm</sub>	1,109	12.4	-2.8	0.05
III <sub>m</sub>	4,133	46.1	Ref	
IV	1,303	14.6	-1.0	0.5
V	496	5.5	1.6	0.4
Other	482	5.4	3.2	0.1
<b>Mother's age at leaving full-time ed. (years)</b>				
Under 15	574	6.4	1.9	0.3
15	5,427	60.6	Ref	
16	1,461	16.3	-1.0	0.4
17-19	1,086	12.1	-3.5	0.02
20+	410	4.6	-9.5	0.000
<b>Maternal depression</b>				
No	7,410	82.7	Ref	
Yes	1,548	17.3	5.2	0.000
<b>Parity</b>				
0	3,314	37.0	Ref	
1	3,071	34.3	-2.5	0.02
2	1,415	15.8	-0.9	0.5
3 or more	1,158	12.9	-1.8	0.2
<b>Premature</b>				
No	8,645	96.5	Ref	
Yes	313	3.5	4.4	0.08
<b>Smoking in pregnancy</b>				
Non-smoker	3,790	42.3	Ref	
Stopped pre-pregnancy	1,122	12.5	1.0	0.5
Stopped during pregnancy	434	4.8	0.8	0.7
1-4 cigs/day	616	6.9	-0.5	0.8
5-14cigs/day	1,887	21.1	2.6	0.03
15+ cigs/day	1,109	12.4	3.3	0.03
<b>Limiting disability by age 10 years</b>				
None	8,357	93.3	Ref	
Slight	549	6.1	11.3	0.000
Severe	52	0.6	33.6	0.000
<b>Disability ass. in first year</b>				
No	8,647	96.5	Ref	
Yes	311	3.5	6.3	0.01
<b>Breast fed</b>				
No	5,671	63.3	Ref	
Yes	3,287	36.7	-1.2	0.2
<b>Sex</b>				
Male	4,588	51.2	Ref	
Female	4,370	48.8	2.3	0.01
<b>Birth weight</b>	<b>8,958</b>	<b>100</b>	-0.005	0.000

Coefficients generated using linear regression

# Unadjusted

Table 2. The association of parental divorce with anxiety at age 10 years stratified by breast feeding

	Number	%	Coef.#	95% CI		P	Coef.*	95% CI		P
<b>Not breast fed</b>										
<b>Parental divorce</b>										
No	4,937	87.1	Ref				Ref			
Yes	735	12.9	9.4	6.1	12.8	0.000	8.8	5.3	12.2	0.000
<b>Breast fed</b>										
<b>Parental divorce</b>										
No	2,936	89.3	Ref				Ref			
Yes	3,287	10.7	2.2	-2.6	7.00	0.4	1.3	-3.6	6.1	0.6

Coefficients generated using linear regression

# Unadjusted

\* Adjusted for: social class, mother's age at leaving full-time education, maternal depression, parity, prematurity, maternal smoking during pregnancy, limiting disability by age 10 years, whether assessed for disability in the first year of life, sex and birth weight.

Ref: Reference category

## Discussion

This paper tested the *a priori* hypothesis that breast feeding is associated with resilience against psychosocial stress, thus reducing the resulting level of anxiety. The analysis found that parental divorce and separation were associated with a greater anxiety among children who were not breast-fed than among breast-fed children. This was confirmed as statistically significant by interaction testing and independent of multiple potential confounding factors. This finding does not prove that breast feeding itself confers resilience as the specific exposures responsible cannot be identified by this analysis. It does indicate that breast feeding is a useful indicator of exposures that confer resilience against stress resulting from the parental divorce and separation.

Parental divorce or separation was chosen as the best available marker of chronic exposure to psychosocial stress in BCS70. Such family disruption and conflict tends to begin some years prior to separation and continues afterwards<sup>5</sup> and is associated with adverse psychological outcomes in children including anxiety and depression<sup>13</sup> extending into adulthood.<sup>14</sup> The chronic and profound nature of the stress caused by family conflict<sup>5</sup> is indicated by its association with slowed childhood growth.<sup>15</sup>

We initially chose to investigate breast feeding as a marker of exposures relevant to the stress response as stimulation associated with maternal contact during nursing may beneficially influence development of neuroendocrine aspects of the stress response as indicated by animal models.<sup>2</sup> However, it must be stressed that breast feeding may indicate many other relevant exposures and influences than just early maternal contact. In animal models, early stimulation enhanced development of the hippocampal glucocorticoid receptors, possibly through the influence of serotonin increasing numbers of glucocorticoid receptors on hippocampal neurons.<sup>16</sup> Adult animals thus stimulated had significantly reduced plasma pituitary adrenocorticotrophic hormone (ACTH) and corticosterone responses to restraint stress<sup>2</sup> due to enhanced negative feedback regulation of the stress response.<sup>17</sup> Enhanced control of the stress response allows more rapid de-arousal and may limit harmful sequelae.<sup>1;1:18</sup> We were unable to test directly the effect of contact-specific stimulation as physical contact associated with breast feeding may be confounded by other maternal



characteristics in an observational study, but our results indicate that some exposures associated with breast feeding may also be associated with development of the stress response in human infants. In animal models only neonatal rather than later stimulation influences HPA axis development<sup>19</sup> and although limited by statistical power, our data also show no evidence of additional protection associated with longer duration breast feeding. Our use of breast feeding to identify early-life maternal stimulation may represent a conservative measure, as some of the stimulation associated with breastfeeding may be mimicked during bottle feeding.<sup>20</sup>

There are potentially several non-mutually exclusive explanations for our results and these do not depend on a direct influence of breast feeding itself. A highly plausible explanation for the observed effect modification is that mothers who breast feed their infants have personal or family characteristics that directly influence the child's stress-repose or anxiety following divorce, such that breast feeding is only a marker of these influences. Despite our adjustment for potential confounding factors, other unmeasured characteristics could still account for the results. Such confounding has been demonstrated for the association of maternal smoking in pregnancy with lower IQ among offspring.<sup>21</sup> It had been suspected that maternal smoking directly influenced the development of IQ, but when there is adequate adjustment for maternal characteristics the association of smoking with offspring's IQ is eliminated.<sup>21</sup> In the current study we observed an association between maternal smoking in pregnancy and anxiety in offspring that was eliminated by adjustment for potential confounding factors, again showing smoking is a marker of maternal characteristics rather than influencing the child directly. Thus, we cannot rule out the possibility that breast feeding is also a marker of other more important but unmeasured maternal characteristics. If breast feeding is important, breast milk itself may influence development,<sup>22;23</sup> relevant to the stress response: leptin in breast milk may reduce stress in infants through its action on the hippocampus, hypothalamus, pituitary and adrenal glands.<sup>24</sup>

It may be that the close maternal contact associated with breast feeding, indicates improved parental attachment:<sup>20</sup> mothers who develop a better bond with their offspring due to personal or family characteristics may be more likely to breast feed. The process of breast feeding itself might also contribute to the development of attachment. Parental attachment is relevant as insecurely attached infants may have poorer control of the HPA-mediated stress response.<sup>25</sup> Breast feeding down-regulates the stress response in lactating *mothers*,<sup>24;26-28</sup> and this may theoretically have benefits for the infant either directly or through influences such as reduction in the risk of postnatal maternal depression. A higher quality of mother-child relationship has been identified as protective against some negative consequences of parental divorce,<sup>29</sup> so breast feeding may indicate a better bond between mother and child and therefore resilience against the stress associated with parental divorce or separation.

The measure of childhood anxiety is based on a single question, limiting its reliability, but it has good face validity and as it was reported by the child's teacher it may be less affected by differential reporting bias than, for example, a parental report. Confounding or bias due to the teachers' knowledge of breast feeding in subjects can be ruled out. Similarly, a teacher's report will not be differentially influenced by individual characteristics associated with personal experience of the divorce: for example maternal depression associated with divorce may introduce differential reporting bias. The associations with anxiety for the familial and child's characteristics are largely as expected<sup>30</sup> confirming the reliability of this measure. Markers of disadvantage such as lower mother's age at leaving education and lower social class are risks, as are maternal depression and if the child has a limiting condition at 10 years

of age. Higher birth weight was associated with lower anxiety, consistent with reported associations of greater anxiety and depression with low birth weight.<sup>31</sup>

Breast feeding was not independently associated with divorce so this potential source of confounding is not a concern. As divorce, separation and mental health are patterned by social factors, such as social class and level of education,<sup>32</sup> we adjusted for such factors in our multivariate analysis, as well as for other potentially relevant factors. Maternal depression influences psychological health in offspring<sup>30</sup> and plausibly breast feeding. Although we did not have a perinatal measure of maternal depression, we were able to adjust for maternal depression when the offspring was 5 years of age. We adjusted for maternal smoking during pregnancy which provides more information on perinatal maternal and familial characteristics<sup>21</sup> relevant to development and mental health.<sup>33</sup> Chronic illness or disability with origins in early life may influence both breast feeding and childhood anxiety. To address this, we adjusted for whether the child was assessed for disability or impairment in the first year of life thus identifying high risk children and also adjusted for the presence of limiting conditions at age 10 years, as these have the greatest impact on quality of life.<sup>34</sup> We adjusted for several further potential confounding factors that describe the family. Despite multiple adjustment for a variety of relevant characteristics, the coefficient for the interaction effect was so little influenced by adjustment that confounding these and closely related factors seems unlikely. However, this does not confirm a direct influence of breast feeding, as breast feeding may be associated with a variety of important unmeasured characteristics, such as maternal 'personality' and the quality of mother-child interaction.

The benefits of breast feeding are well-recognised<sup>35</sup> and this study indicates that it may be associated with lower levels of anxiety among children who have had the potentially stressful experience of parental divorce. In this study a minority of children experienced the chronic stress caused by parental divorce by age 10 years, so the resilience against childhood anxiety associated with breast feeding was best demonstrated by effect modification. A number of non-mutually exclusive mechanisms could account for the resilience associated with being breast fed, including maternal and family characteristics, the quality of mother-child interactions and it is possible there may also be a role for exposures more directly associated with breast feeding itself. Research into the mediating factors underlying the resilience indicated by breast feeding should focus on exposures and associations related to early rather than prolonged breast feeding.

### **Acknowledgments**

This project was funded by British Economic and Social Research Council grant L326253061 and forms part of the work conducted by the Capability and Resilience Network.

### **Competing interests:** none

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**What is already known on this topic**

There is evidence that early life exposures influence development of the stress response and the ability to cope with stress

Divorce is a stressful event for many children and is associated with heightened anxiety

**What this study adds**

Children who are breast fed may be more resilient to the stress associated with parental divorce.

Breast feeding may be associated with a variety of exposures and family characteristics that confer resilience against stress related to parental divorce