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The Positive Role of Breastfeeding on Infant Health during the First 6 Weeks: Findings from a Prospective Observational Study Based on Maternal Reports

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Abstract
This study aimed to report on adverse infant and maternal clinical outcomes, and investigate the relationship between infant feeding practice and such adverse clinical outcomes in infants during the first 6 weeks postpartum. From an eligible sample of 450 mother-term infant pairs recruited from the Coombe Women and Infants University Hospital in Dublin, 27.1% of infants (n=122) were maternally reported to have had an illness during the first 6 weeks that necessitated the provision of prescribed medication ± general practitioner/paediatrician attendance ± hospitalisation. Of these, 90 infants had ≥1 episode of infection ± viral ± gastro-intestinal-related condition. After adjustment, 'any' breastfeeding to 6 weeks was protective against such adverse infant outcomes (adjusted odds ratio [aOR] 0.44, P = 0.022). Attendance to the GP/paediatrician for > 1 visit (aOR 3.44, P = 0.000) and multiparity (aOR 1.76, P = 0.041) were also positively associated with such adverse infant outcomes. To decrease infant morbidity rates in Ireland, government investment in breastfeeding promotion, support and research should be a continued public health priority.

Introduction

To ensure optimal infant and maternal health outcomes, the World Health Organisation (WHO)[1] recommends exclusive breastfeeding during the first 6 months of life; a guideline that was adopted by the Irish Department of Health and Children in 2003. Although exclusivity of the practice up to 6 months is a desirable goal, partial breastfeeding as well as breastfeeding for shorter periods of time are also valuable[2]. The evidence for the protective effects of breastfeeding against infant risk of acute otitis media[3], gastro-intestinal[4] and respiratory[5,6] morbidity, is particularly convincing[2]. According to the UK Millennium Cohort Study, an estimated 53% of hospitalisations due to infant diarrhoea could be prevented each month by exclusive breastfeeding and 31% by partial breastfeeding[7]. A meta-analysis by Bachrach et al.[8] showed a 72% reduction in the risk of hospitalisation due to respiratory diseases in exclusively breastfed (to ≥4 months) compared with formula fed term infants in developed settings.

A population-level increase in exclusive and prolonged breastfeeding would be of considerable potential public health benefit for Ireland. However, Irish breastfeeding rates have historically been, and currently remain, among the lowest worldwide[9,10]. Although robust evidence from international studies associate a history of breastfeeding with optimal infant health, to date, no published Irish study has examined the effect of infant feeding practice on adverse clinical outcomes in infants. The present study sought to report on adverse infant and maternal clinical outcomes, and investigate the relationship between type of infant feeding practice and such adverse clinical outcomes in an Irish cohort of term infants during the first 6 weeks postpartum.

Methods

Detailed methods and sample representativeness of this prospective observational study are already described in detail[11]. In summary, from an initial sample of 539 low risk pregnant women recruited from antenatal clinics in the Coombe Women and Infants University Hospital (CWIUH), Dublin, 450 eligible mother-term infant pairs were followed up via face-to-face or telephone interviewer-administered survey at 6 weeks (June 2004-October 2006). Infants who had a congenital abnormality, those who required medical intervention and/or tube feeding, as well as mothers who required medical intervention postpartum were all excluded from this study.

Data on whether an infant or maternal illness was experienced at any stage during the first 6 weeks were elicited from maternal self-reports, and were not verified by medical record review. Both infant and maternal illness was defined as 'any illness that necessitated the provision of prescribed medication ± general practitioner (GP)/paediatrician attendance ± hospitalisation during the first 6 weeks'. Mothers were specifically asked to only detail the illnesses applicable to this definition. Information on the number and type of infant and maternal illness episodes was documented. Mothers were also asked to specify the number of GP/paediatrician attendances regarding their infants during the first 6 weeks. Healthy infants and mothers were those in whom no illness episodes were reported. As relatively few mothers exclusively breastfed during the first 6 months in this study[11], 'any' breastfeeding, defined as those who provided any breast milk to their infants (expressed or via skin-to-skin contact), either exclusively (solely breast milk), or in combination with formula milk ± water, was the breastfeeding category selected for analysis.

Statistics were computed by using Statistical Package for the Social Sciences (SPSS Inc.; Chicago, USA, version 19). Data are presented using numerical descriptive statistics, including percentages for categorical data, and means with standard deviations (SD) or medians with interquartile ranges (IQR) for continuous data, as appropriate. Comparison between groups was performed using the Student's t-test, Mann-Whitney U test or one-way between-groups ANOVA for continuous variables; the Chi-square test was employed for categorical variables. Significance was set at P<0.05. Binary logistic regression analysis was used to explore the factors associated with the dependent variable risk of ≥1 episode of infection ± viral-related ± gastro-intestinal-related condition in infants during the first 6 weeks. Adjusted odds ratios (aOR) and 95% confidence intervals (CI) were calculated for each factor in the final model. The Ethics Boards of the CWIUH and the Dublin Institute of Technology approved this study.

Results

Sample characteristics

The median age of infants at the 6 week follow-up was 6.57 weeks (IQR 6.1-7). Almost half of the sample of infants (n=222; 49.3%) were formula fed from birth (Table 1). Although breastfeeding was initiated by 228 mothers (50.6%), only 162 mothers (36%) were providing 'any' breast milk to their infants for > 2 weeks postpartum[11]. Infants who were reported to have had ≥ 1 illness that necessitated the provision of prescribed medication ± GP/paediatrician attendance ± hospitalisation (n=122; 27.1%) compared with the healthy group (n=328) were significantly more

Table 1 Characteristics of the total sample, including the healthy infants and the infants who were reported to have been ill* during the first 6 weeks postpartum

Characteristic	Total (n=450)	n (%) Healthy infants (n=328)	Infant illness* group (n=122)	P value†
Maternal age, years				
< 25	98 (21.8)	72 (22)	26 (21.3)	
25-34	267 (59.3)	190 (57.9)	77 (63.1)	
> 34	85 (18.9)	66 (20.1)	19 (15.6)	0.498
Highest maternal education qualification				
Primary/secondary	177 (39.3)	132 (40.2)	45 (36.9)	
Vocational/training course	124 (27.6)	89 (27.1)	35 (28.7)	
Third level degree/ postgraduate level	149 (33.1)	107 (32.6)	42 (34.4)	0.810
Marital status				
Married/cohabitating	407 (90.4)	297 (90.5)	110 (90.2)	
Single	43 (9.6)	31 (9.5)	12 (9.8)	1.000
Nationality				
Non-Irish national	49 (10.8)	43 (13.1)	6 (4.9)	
Irish national	401 (89.1)	285 (86.9)	116 (95.1)	0.021
Smoking during pregnancy				
Yes	94 (20.9)	74 (22.6)	20 (16.4)	
No	356 (79.1)	254 (77.4)	102 (83.6)	0.194
Parity				
Primiparous	213 (47.3)	158 (48.2)	55 (45.1)	
Multiparous	237 (52.7)	170 (51.8)	67 (54.9)	0.633
Season of year at the timing of infant's birth				
Spring/summer	176 (39.1)	132 (40.2)	44 (36.1)	
Autumn/winter	274 (60.9)	196 (59.8)	78 (63.9)	0.485
Infant birth weight (kg) (mean ± SD)	3.55 ± 0.52	3.55 ± 0.54	3.56 ± 0.48	0.858
Gestational age at birth (wks) (mean ± SD)	40.1 ± 1.29	40.2 ± 1.3	40 ± 1.27	0.433
Attendance to the GP/paediatrician regarding the infant during the first 6 wks§ (no. of visits)				
0-1	247 (54.9)	203 (61.9)	44 (36.1)	
> 1	203 (45.1)	125 (38.1)	78 (63.9)	0.000
Infant feeding practice during the first 6 wks				
Formula fed from birth	222 (49.3)	158 (48.2)	64 (52.4)	
'Any' breastfeeding for 2 wks	66 (14.7)	42 (12.8)	24 (19.7)	
'Any' breastfeeding for > 2 wks	162 (36)	128 (39)	34 (27.9)	0.044
Median no. of 'any' breastfeeding days (IQR) during the first 6 wks (n=228)	49 (14-49)	49 (15.5-49)	32.5 (4.7-49)	0.048
Maternal illness during the first 6 wks post partum				
Yes	119 (26.4)	76 (23.2)	43 (35.2)	
No	331 (73.6)	252 (76.8)	79 (64.8)	0.014

GP, general practitioner; wks, weeks; SD, standard deviation; IQR, interquartile range.
* Includes the infants who were reported to have had ≥1 illness episode that necessitated the provision of prescribed medication ± GP/paediatrician attendance ± hospitalisation (specific illness types are detailed in Table 2).
† Chi-square statistic test was used to examine the significant differences (P value) between the healthy infants and those who were reported to have had ≥1 illness episode during the first 6 weeks postpartum, unless otherwise indicated.
Student's t-test was used for analysis.
§ Total GP/paediatrician visits (n=369): 1 visit (n=166), 2 visits (n=135), 3 visits (n=44), ≥4 visits (n=24).
Mann-Whitney U test was used for analysis.
See Methods Section for definition of 'any' breastfeeding.

likely to have: been formula fed from birth (52.4% vs 48.2%; P = 0.044), attended the GP/paediatrician for > 1 visit (63.9% vs 38.1%; P = 0.000) and to have had mothers who were also ill during the first 6 weeks (35.2% vs 23.2%; P = 0.014).

Adverse infant and maternal clinical outcomes during the first 6 weeks

A total of 149 illness episodes were recorded in the 122/450 infants who were reported by mothers to have had an illness during the first 6 weeks (Table 2). The common cold (n=21, 14%), respiratory infection (n=19, 13%) and oral thrush (n=16, 10.7%) were the most frequently reported infant illnesses. In all, 138 illness episodes were recorded in the 119/450 mothers (26.4%) who reported having an illness during the first 6 weeks, with the most frequently reported illnesses including wound infection (n=34; 24.6%), urinary tract infection (n=16; 11.5%) and mastitis (n=14; 10.1%).

Table 2 Reported adverse clinical outcomes in infants and mothers during the first 6 weeks postpartum

Reported infant illness	n	%	Reported maternal illness	n	%
All infections*: Respiratory (n=19), gastro-intestinal (n=10), eye (n=10), ear (n=2), kidney (n=2), tonsillitis (n=1), throat (n=1)	45	30.2	**All infections:** Urinary tract (n=16), mastitis (n=14), respiratory (n=13), sinus (n=6), vaginal (n=3), throat (n=3), gastro-intestinal (n=2), cholecystitis (n=1)	58	42
Viral-related conditions*: Common cold (n=21) viral infection (n=9)	30	20.1	**Wound infection**	**34**	**24.6**
Gastro-intestinal-related conditions*: Constipation (n=8), gastro-oesophageal reflux disease (n=7), lactose intolerance (n=2), colic (n=13)	30	20.1	**Viral-related conditions:** Cold (n=5), flu (n=5), viral infection (n=4)	14	10.1
Oral thrush	**16**	**10.7**	**High blood pressure**	**12**	**8.6**
Skin / nappy rash	**13**	**8.7**	**Anaemia**	**7**	**5**
Jaundice post delivery	**8**	**5.3**	**Postnatal depression**	**6**	**4.3**
Other: Cord infection (n=2), hypoglycaemia (n=1) & fractured shoulder post delivery (n=1), pyloric stenosis (n=1), faltering growth (n=1), growth hormone deficiency (n=1)	7	4.6	**Other:** Back pain (n=2), haemorrhoids (n=2), unilateral migraine (n=2), skin rash (n=1)	7	5
Total number of illness episodes	**149**	**99.7**	**Total number of illness episodes**	**138**	**99.6**

* 105 illness episodes were recorded in the 90 infants who were reported by mothers to have had an infection ± viral-related ± gastro-intestinal-related condition.

Table 3 Adjusted factors associated with risk of ≥1 reported episode of infection ± viral-related ± gastro-intestinal-related conditions* in infants during the first 6 weeks using binary logistic regression analysis (n=450)

Variable	Coefficient	Standard Error	Adjusted OR (95% CI)	P value
Infant feeding practice during the first 6 wks postpartum				
Formula fed from birth			1.00†	
Any breastfeeding during the first 2 wks	0.241	0.352	1.27 (0.63-2.53)	0.495
Any breastfeeding to 4 wks	- 0.471	0.688	0.62 (0.16-2.4)	0.494
Any breastfeeding to 6 wks	- 0.814	0.354	0.44 (0.22-0.88)	0.022
Parity				
Primiparous			1.00†	
Multiparous	0.570	0.280	1.76 (1.02-3.06)	0.041
Attendance to the GP/paediatrician regarding the infant during the first 6 wks (no. of visits)				
0-1			1.00†	
> 1	1.236	0.266	3.44 (2.04-5.79)	0.000

OR, odds ratio; CI, confidence interval; wks, weeks.
Model adjusted for maternal education (proxy for socio-economic status), age, smoking status during pregnancy, maternal illness during the first 6 weeks and season of year at the timing of infant's birth (all were non-significant factors in the model, P > 0.05).
* See Table 2 for details on the specific infections ± viral-related ± gastrointestinal-related conditions (n=90).
† 1.00 denotes the reference category.

Independent effect of infant feeding practice on reported adverse clinical outcomes in infants

As illustrated in Figure 1, the mean number of infections ± viral ± gastro-intestinal-related conditions for the formula fed infants was significantly higher than for those breastfed to 6 weeks (mean 0.27, SD 0.54 vs mean 0.13, SD 0.43; P = 0.045). Binary logistic regression analysis indicated that infants who were provided with 'any' breast milk to 6 weeks (compared with the formula feeders from birth) were significantly less likely to have had ≥1 reported episode of infection ± viral-related ± gastro-intestinal-related condition during the first 6 weeks (aOR 0.44; 95% CI 0.22-0.88, P = 0.022) (Table 3). Infants reported to have had ≥1 episode of infection ± viral-related ± gastro-intestinal-related condition were 3.4 times more likely to have been brought to the GP/paediatrician for > 1 visit (compared with 0-1 visit) during the first 6 weeks (aOR 3.44; 95% CI 2.04-5.79, P = 0.000) and were almost twice as likely to have had multiparous mothers (aOR: 1.76; 95% CI 1.02-3.06, P = 0.041).

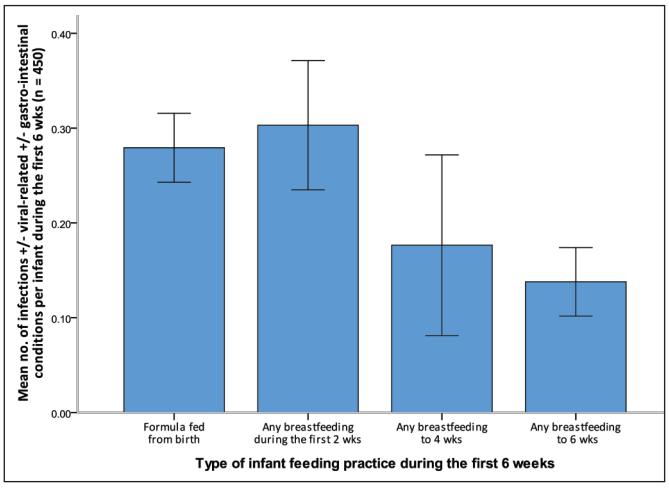

Figure 1 Number of infections +/- viral- +/- gastro-intestinal-related conditions in infants according to type of infant feeding practice during the first 6 weeks (n=450).
*ANOVA used for analysis; P = 0.045
See Methods Section for definition of 'any' breastfeeding; see Table 2 for details on the specific infections, viral and gastro-intestinal conditions.
Error bars are ± one standard error.

Discussion

Consistent with international data[1-8], this study highlights the positive role of breastfeeding on infant health. Even after adjustment for potential confounding variables including season of year at the timing of infant's birth, parity, maternal illness during the first 6 weeks as well as education (proxy for socio-economic status), age and smoking status during pregnancy, infants who were provided with 'any' breast milk to 6 weeks were significantly less likely to have had ≥1 reported episode of infection ± viral-related ± gastro-intestinal-related condition (aOR 0.44; 95% CI: 0.22-0.88, P = 0.022). Although the period of postpartum follow-up was relatively short in this study, notably, 6 weeks, we found that duration of breastfeeding impacted on the degree of protection against ≥1 episode of infection ± viral-related ± gastro-intestinal-related condition in infants, with 'any' breastfeeding to 6, rather than 2 or 4 weeks, exhibiting a significant benefit (P = 0.045). The trend towards increased protection of breastfeeding according to duration is also reported in robust prospective studies from Spain[12], Germany[13], USA[3] and UK[7,14].

It is of further interest from this study that infants born to Irish, compared with non-Irish national mothers were significantly more likely to have had a reported illness during the first 6 weeks (95.1% versus 4.9%, P = 0.021). The significantly lower rate of breastfeeding initiation as well as 'any' and exclusive breastfeeding, in the Irish, compared with the non-Irish national mothers throughout the first 6 weeks[11] may be one possible explanation for this infant health disparity. Moreover, the present study found that infants in the illness versus the healthy group were provided with any breast milk for a significantly shorter duration during the first 6 weeks (32.5 days versus 49 days, P = 0.048). Although causal relationships between infant health and feeding practice cannot be concluded from this study, more rigorous evaluation of the degree to which well-defined indicators of infant health outcomes are influenced by both nationality and precise infant feeding practice parameters (e.g. frequency of daily breast milk feeds, inclusion of clear breastfeeding definitions) should be considered in future studies.

While exclusive breastfeeding up to 6 months is a desirable goal[2], mothers should be informed that providing 'any' breast milk to their infants for short durations to even ≥3 months postpartum as reported by Howie et al.,[14] offers a clear advantage to their infants by reducing, in particular, gastro-intestinal and respiratory infection. This is of further clinical and public health importance given that chest/respiratory infection is one of the most frequently reported adverse clinical outcomes among infants in Ireland[15], and internationally[8], as supported by our study. Taken together, findings from the present study should not undermine the WHO[1] recommendation to exclusively breastfeeding until 6 months. Many mothers in Ireland discontinue breastfeeding early due to the frequent feeding routine, tiredness and the perception of an inadequate milk supply[11,15,16]. However, existing data suggest that in such circumstances there would be advantages in continuing to provide 'any' breast milk to their infants for even a short duration. Given that the vast majority of women are capable of breastfeeding[17], all health professionals who engage with lactating mothers should inform them that 'any' breast milk is better than no breast milk, and that it is worthwhile persevering with the practice if they encounter problems during the initial few days, or weeks postpartum.

Multiparity was also significantly associated with risk of ≥1 reported episode of infection ± viral-related ± gastro-intestinal-related condition in this study (aOR 1.76; 95% CI: 1.02-3.06, P = 0.041); other investigators have reported similar findings[18]. It is suggested that infants with older siblings are exposed to more infectious organisms than are first-born children and that this exposure may override the protective effect of breastfeeding on the infant's immune system[18,19]. Nonetheless, despite the significant association between multiparity and risk of adverse infant outcomes in this study, the protective effect of 'any' breastfeeding to 6 weeks still persisted in the adjusted model. To date, no previous Irish prospective study has examined the effect of infant feeding practice, GP/paediatrician attendance regarding the infant on adverse clinical outcomes, taking socio-economic factors into account. Although the design of this study does not provide definitive evidence for a protective effect of breastfeeding, or proving causality, these findings in addition to a wealth of data from existing studies, provide further evidence that breastfeeding, for even a short duration, is a worthwhile practice. As a breastfeeding promotional measure for Ireland, the inclusion of these data in literature, campaigns and strategies aimed at increasing initiation rates and duration should be considered.

Study limitations include lack of objective verification of reported infant and maternal illnesses (including their severity and duration) during the first 6 weeks. Furthermore, our follow-up data relied exclusively on maternal self-reports and re-call. However, maternal[19] or parental[7,13] self-reports are the primary data resource of adverse infant health outcomes in other similarly designed prospective studies. The prospective nature of the study design, high follow-up rate of mother-term infant pairs to 6 weeks, and completeness of data are some of the strengths of this study. In addition, information collected on type of infant feeding practice was comprehensive. In conclusion, our findings demonstrate the positive role of breastfeeding on infant health during the first 6

weeks postpartum. To ensure optimal health for all infants, these data lend support to the clinical and public health importance of investing in the promotion of breastfeeding in Ireland. Mothers should be informed that although exclusive breastfeeding up to 6 months is a desirable goal, the provision of 'any' breast milk to their infants for even a short duration, also confers considerable health benefit.

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