Original Article

Breastfeeding and infant hospitalisation: analysis of the UK 2010 Infant Feeding Survey

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Abstract

To investigate the contributions of overall breastfeeding duration and exclusive breastfeeding in reducing the risk of hospitalisation for infectious causes, we analysed data from a three-stage survey on infant feeding practices and health outcomes in over 10 000 UK women in 2010–2011. The main outcome measures were risk of overnight hospital admission in the first 8–10 months of infancy. A graded beneficial effect was found between longer duration of any breastfeeding and hospital admission for infectious causes and for respiratory tract infections, with a significantly lower risk in infants breastfed for at least 3 months compared with those never breastfed. The effects were stronger in the subgroup who was also exclusively breastfed. For example, among infants breastfed for 3–6 months, the reduction in risk for infectious causes for those who were also exclusively breastfed for at least 6 weeks was 0.42 (95% CI: 0.22–0.81) and for those not exclusively breastfed for 6 weeks 0.79 (95% CI: 0.49–1.26). Likewise, among infants breastfed for 6 months or more, the odds ratio for those who were also exclusively breastfed for at least 6 weeks was 0.48 (95% CI: 0.32–0.72) and for those not exclusively breastfed for 6 weeks 0.72 (95% CI: 0.48–1.08). The apparent protective effect of any breastfeeding for a long duration may in part be driven by a prolonged period of exclusive breastfeeding. Exclusive breastfeeding in the initial weeks after childbirth and continuing to breastfeed (either exclusively or partially) for at least 3 months, preferably 6 months, may reduce morbidity due to infectious illness in infants.

Keywords: breastfeeding, infant feeding, hospitalisation, respiratory tract infections, infections.

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Introduction

The benefits of breastfeeding, to infant and mother, are widely accepted and are supported by a comprehensive body of evidence. Numerous studies, both in developed and developing country settings, have shown positive effects of breastfeeding on rates of infectious illness in infants, in particular gastrointestinal infections (Quigley *et al.* 2007; Quigley *et al.* 2006; Fisk *et al.* 2011; Howie *et al.* 1990; Kramer *et al.* 2001; Ip *et al.* 2007; Baker *et al.* 1998; Monterrosa *et al.* 2008; Kramer *et al.* 2003; Ladomenou *et al.* 2010; Ajetunmobi *et al.* 2015) and respiratory infections (Quigley *et al.* 2007; Fisk *et al.* 2011; Ip *et al.* 2007; Ladomenou *et al.* 2010; Bachrach *et al.* 2003; Duijts *et al.* 2009; Tarrant *et al.* 2010; Chantry *et al.* 2006; Barsam *et al.* 2013; McNeil *et al.* 2010; Oddy *et al.*

2003), including significant cost benefits (Renfrew *et al.* 2012). Several studies have demonstrated statistically significant benefits of exclusive breastfeeding (EBF) (Kramer & Kakuma 2012; McNeil *et al.* 2010; Quigley *et al.* 2007; Paricio Talayero *et al.* 2006; Chantry *et al.* 2006; Kramer *et al.* 2003; Ladomenou *et al.* 2010; Rebhan *et al.* 2009); however, the evidence base is less conclusive regarding the effect of non-EBF – with some recent studies showing a significant protective effect (Baker *et al.* 1998; Tarrant *et al.* 2010; Tarrant *et al.* 2012) and others showing no significant effect (Quigley *et al.* 2007; Ladomenou *et al.* 2010). However, few studies have attempted, or been large enough, to look at the separate effects of duration of any breastfeeding (defined as partial or EBF and referred to henceforth as ‘breastfeeding’) and duration of EBF (defined as infant receiving breast milk only) to understand the

contributions of each of these elements to the potential benefit.

The World Health Organization (WHO) recommends that all infants should be exclusively breastfed for the first 6 months of life (WHO 2001). In the UK, only a very small proportion of women (1%) currently achieve this, with only 23% still exclusively breastfeeding at 6 weeks (McAndrew *et al.* 2012). In comparison, national surveys in Canada and Australia show that 52% and 56% of mothers respectively were still exclusively breastfeeding at 3 months (Chalmers *et al.* 2009; Baxter 2014).

While the goal of exclusively breastfeeding for 6 months remains desirable, with so few women in the UK exclusively breastfeeding for even 3 months, it is important to differentiate between the benefit of longer duration of EBF and longer duration of any breastfeeding. In this study, we aim to investigate the effect of breastfeeding on hospitalisation rates for infection among infants in the UK and to understand how the distinct components of 'duration of breastfeeding' and 'duration of EBF' contribute to any health benefits conferred.

Methods

Infant Feeding Survey

The Infant Feeding Survey (IFS) is a UK-wide cross-sectional survey conducted every five years. The survey was despatched (by post and online) in three stages, between September 2010 and August 2011, staggered so that the questionnaire reached mothers when their

infants were around 6 weeks (stage 1), 4–6 months (stage 2) and 8–10 months old (stage 3). A sample of 30760 births was selected from all births registered in the period August to October 2010. All births registered in Wales and Northern Ireland and a random sample of those registered in England and Scotland were selected, with oversampling of mothers from the lowest quintile for area deprivation to ensure adequate representation of these groups. Mothers were only sent the later stage questionnaire if they had responded to the previous stage.

The response rates at various stages of the survey were 51% at stage 1, 80% at stage 2 and 86% at stage 3. Overall, 68% of stage 1 responders completed all three stages of the survey. Data were weighted to correct for differential sampling, differential response rates and non-response bias (McAndrew *et al.* 2012).

Exclusions

Analysis was limited to those who completed all three stages of the survey ($n = 10\,768$). Exclusions were made for infants who were preterm (<37 weeks gestational age) ($n = 577$); 130 non-singleton births; and those for whom data were missing, including where duration of breastfeeding could not be ascertained ($n = 42$), without 6 months of follow-up ($n = 18$) or for whom a complete dataset for potential confounders was unavailable ($n = 253$). Imputation for missing data was not considered necessary as data were only missing for 3% of the total sample, which is well below the accepted threshold (Schafer 1999).

Key messages

- In some developed countries, including the UK, few women achieve the World Health Organization recommendation of exclusive breastfeeding for 6 months. Exclusive breastfeeding is associated with reduced risk of gastroenteritis and respiratory infections in infants but the impact of partial breastfeeding is less clear.
- Any breastfeeding for at least 3 months may reduce the risk of hospitalisation in infants and the population burden of hospital admission, but this risk reduction is greater with a prolonged period of initial exclusive breastfeeding
- In settings where few women exclusively breastfeed for the recommended duration, shorter durations of breastfeeding may still confer significant health benefits.

Breastfeeding

Duration of breastfeeding was derived from questions at all three stages. An infant was considered breastfed if it was given any breast milk, either exclusively or in addition to other milk, drinks or food. EBF was defined as breastfeeding with no other milk, drinks (including water) or solid food given, in line with WHO and UK guidance. We defined exclusivity at 6 months in accordance with the WHO definition, for example, if an infant was introduced to solids and/or formula at 26 weeks (or 180 days) or later, it was considered as breastfed exclusively for 6 months (WHO 2015). This is in contrast to the IFS report which only defines an infant as exclusively breastfed for 6 months if solids and/or formula/drinks were introduced after 6 months (McAndrew *et al.* 2012), meaning that an exclusively breastfed infant introduced to solids at 26 weeks was not considered exclusively breastfed for 6 months. This results in slightly more women being categorised as 'EBF at 6 months' in our analysis than the IFS report (5% vs. 1%). Where data were collected at multiple stages of the survey, the earliest completed data were used. Responses to the same question at subsequent stages were used to fill in for non-response in earlier stages to specific questions. Duration of breastfeeding

and EBF were measured in days or weeks – at later stages of the survey, data were only collected in multiples of weeks. Data was therefore analysed by duration category.

Hospital admission

Mothers were asked at both stages 2 (infants aged 4–6 months) and 3 (infants aged 8–10 months) if their infant had ever been hospitalised overnight and if so, what the cause was. For analysis, causes were categorised to derive the outcome measures 'hospitalised for infectious causes' (IC) and the subset 'hospitalised for respiratory tract infections (RTI)' (including both upper and lower respiratory tract infection) (Table 1). Data on the number of hospital admissions and infant's age at time of hospitalisation were not captured.

Statistical analysis

Statistical analyses were conducted using STATA version 13.1 (Statacorp 2013). Multivariable logistic regression was used to determine associations between duration of breastfeeding (and EBF) and each outcome measure (in separate analyses). Data were collected for a number of variables, which are potentially

Table 1. Definition of outcome measures*

Hospitalisation due to infectious causes (IC)	Hospitalisation due to respiratory tract infection (upper or lower) (RTI)
Chest problems/infection	Chest problems/infection
Bronchitis/bronchiolitis	Bronchitis/bronchiolitis
Croup	Croup
Sore throat/throat infection	Sore throat/throat infection
A cold	A cold
A cough	A cough
Pneumonia	Pneumonia
Respiratory syncytial virus	Respiratory syncytial virus
Sickness or vomiting	
Diarrhoea	
Tummy bug/gastroenteritis	
Ear problems/infection	
Fever	
Viral infection	
Bacterial infection	

*Other causes of hospitalisation listed but not included in either outcome measure: constipation, urinary tract infection, colic, thrush, lack of weight gain, too much weight gain, eczema, rash, haemangioma, milk allergy, jaundice, reflux, pyloric stenosis, hernia, congestion, whooping cough, asthma, breathing difficulties, conjunctivitis, meningitis, heart problems, kidney problems, infected umbilicus, chickenpox, measles, weight loss, blood in excrement, reaction to immunisation, teething, joint/bone problems, 'something else'.

associated with breastfeeding and/or the outcomes (Table 2 and associated footnote), and these variables were tested individually for association with the outcomes; with only those demonstrating a significant association (Wald P -value <0.10) included in the multivariable model. All means, proportions and odds ratio (OR) presented are weighted. Population attributable fractions (PAFs) were estimated for hospitalisation associated with breastfeeding for less than 6 weeks (compared with 3–6 months) and for breastfeeding less than 3 months (compared with breastfeeding for at least 6 months with EBF at least 6 weeks).

This study used anonymised, publically available data from the UK Data Archive, and therefore, ethical approval was not required.

Results

Breastfeeding

The average age of the infants at stage 3 was 260 days (SD: 25; range: 180–392). Of the 9813 infants included in the analysis, 81% (7939) were breastfed at least once, 11% (1083) were breastfed for less than one week and 34% for at least 6 months (Fig. 1a). Just over a quarter of infants (28%) were still breastfed exclusively at 6 weeks, a fifth at 3 months and only 5% at 6 months (Fig. 1b). Of those infants who were breastfed for between 6 weeks and 3 months, 84% were EBF for less than 6 weeks. Even among infants who were breastfed for longer durations, many were EBF for less than 6 weeks – of those who were breastfed for 3–6 months, almost two-thirds were EBF for less than 6 weeks, and among those who were breastfed for at least 6 months, over one-third were EBF for less than 6 weeks.

Duration of any breastfeeding varied greatly according to maternal characteristics. Infants whose mothers were less than 20 years old, who left full-time education before 16 and who had never worked were more likely to have never breastfed (Table 2).

Hospital admission

Eleven percent of infants (1104) had an overnight hospital stay over the reporting period. The most

common individual cause of hospitalisation was ‘chest problems/infection’ for which 360 infants were hospitalised. Other common causes were ‘sickness or vomiting’ ($n=206$), ‘insufficient weight gain’ ($n=155$), ‘diarrhoea’ ($n=103$) and ‘bronchitis/bronchiolitis’ ($n=79$).

Six hundred and sixty-four infants (7%) were hospitalised for infectious causes, with 410 of these being for upper or lower RTI (or symptoms of). Factors that were significantly associated with hospital admission in univariable analysis comprised birth order, gestational age, mother’s level of education and whether special care or a lamp for jaundice were required post birth.

Association between breastfeeding and hospital admission

A graded beneficial effect was found between longer duration of breastfeeding and both the outcome measures of hospital admission for IC and for admission for RTI, before and after adjustment for confounders (Table 3). For IC, breastfeeding for at least 6 months was significantly protective (OR: 0.58, 95% CI: 0.41–0.82) compared with never breastfeeding. Further analysis showed that the significant protective effect was maintained and of greater magnitude for those who breastfed for at least 6 months and also EBF for at least 6 weeks (OR: 0.48 95% CI: 0.32–0.72), but not for those who EBF for less than 6 weeks (OR: 0.72, 95% CI: 0.48–1.08) (Table 3, Fig. 2). Breastfeeding for 3–6 months was also significantly associated with a lower risk of hospitalisation for IC compared with never breastfeeding (OR: 0.64, 95% CI: 0.42–0.99); again, this effect was stronger in those who were EBF for at least 6 weeks (OR: 0.42, 95% CI: 0.22–0.81) than in those who were not EBF for at least 6 weeks (OR: 0.79, 95% CI: 0.49–1.26). The same patterns were observed for RTI (Table 3, Fig. 2).

Population attributable fractions

We estimated that 31% of overnight hospital admissions for IC were attributable to breastfeeding for less than 3 months rather than breastfeeding for at least 6 months including at least 6 weeks of EBF.

Table 2. Characteristics of the sample according to breastfeeding duration[†]

		BF duration					
		Never BF (<i>n</i> = 1874)	<1 week (<i>n</i> = 1083)	1–6 weeks (<i>n</i> = 1303)	6 weeks to 3 months (<i>n</i> = 873)	3–6 months (<i>n</i> = 1301)	≥6 months (<i>n</i> = 3379)
		<i>n</i> , (%)	<i>n</i> , (%)	<i>n</i> , (%)	<i>n</i> , (%)	<i>n</i> , (%)	<i>n</i> , (%)
Maternal characteristics*							
Mother's age	Under 20 years (<i>n</i> = 241)	119 (49)	44 (18)	36 (15)	11 (5)	10 (4)	21 (9)
	20–24 years (<i>n</i> = 1075)	372 (35)	164 (15)	177 (16)	101 (9)	86 (8)	175 (16)
	25–29 years (<i>n</i> = 2611)	521 (20)	328 (13)	400 (15)	238 (9)	328 (13)	796 (30)
	30–34 years (<i>n</i> = 3489)	520 (15)	337 (10)	418 (12)	293 (8)	542 (16)	1379 (40)
	35 years or over (<i>n</i> = 2383)	339 (14)	208 (9)	270 (11)	227 (10)	334 (14)	1005 (42)
Age left full-time education	16 years or under (<i>n</i> = 1342)	517 (39)	197 (15)	175 (13)	101 (8)	131 (10)	221 (16)
	17 or 18 years (<i>n</i> = 2641)	715 (27)	389 (15)	419 (16)	237 (9)	285 (11)	596 (23)
	Over 18 years (<i>n</i> = 5830)	642 (11)	497 (9)	709 (12)	535 (9)	885 (15)	2562 (44)
SEC	Managerial and professional (<i>n</i> = 4366)	453 (10)	380 (9)	550 (13)	407 (9)	718 (16)	1858 (43)
	Intermediate occupations (<i>n</i> = 2066)	457 (22)	279 (14)	299 (14)	184 (9)	237 (11)	610 (30)
	Routine and manual occupations (<i>n</i> = 2200)	645 (29)	304 (14)	329 (15)	179 (8)	207 (9)	536 (24)
	Never worked (<i>n</i> = 473)	177 (37)	43 (9)	37 (8)	29 (6)	54 (11)	133 (28)
Smoking status (pre and during pregnancy)	Not classified (<i>n</i> = 708)	142 (20)	77 (11)	88 (12)	74 (10)	85 (12)	242 (34)
	Never smoked or gave up >1 year before pregnancy (<i>n</i> = 7553)	1187 (16)	767 (10)	947 (13)	660 (9)	1067 (14)	2925 (39)
	Gave up during pregnancy or within before getting pregnant (<i>n</i> = 1234)	294 (24)	174 (14)	188 (15)	129 (10)	156 (13)	293 (24)
	Continued to smoke during pregnancy (<i>n</i> = 847)	357 (42)	120 (14)	143 (17)	66 (8)	50 (6)	111 (13)
	Missing (<i>n</i> = 179)	36 (20)	22 (12)	25 (14)	18 (10)	28 (16)	50 (28)
Ethnicity	White (<i>n</i> = 7195)	1289 (18)	782 (11)	1003 (14)	638 (9)	952 (13)	2531 (35)
	Mixed (<i>n</i> = 93)	13 (14)	3 (3)	6 (6)	10 (11)	15 (16)	46 (49)
	Asian or Asian British (<i>n</i> = 344)	12 (3)	16 (5)	31 (9)	37 (11)	67 (19)	181 (53)
	Black or Black British (<i>n</i> = 188)	7 (4)	0 (0)	8 (4)	11 (6)	39 (21)	123 (65)
	Chinese or other (<i>n</i> = 78)	4 (5)	3 (4)	5 (6)	7 (9)	10 (13)	49 (63)
Deprivation (IMD)	Missing (<i>n</i> = 1915)	549 (29)	279 (15)	250 (13)	170 (9)	218 (11)	449 (23)
	1 (most deprived) (<i>n</i> = 1839)	536 (28)	232 (13)	214 (12)	133 (7)	176 (10)	548 (30)
	2 (<i>n</i> = 1872)	416 (22)	228 (12)	258 (14)	172 (9)	237 (13)	561 (30)
	3 (<i>n</i> = 2025)	391 (19)	236 (12)	289 (14)	182 (9)	252 (13)	675 (33)
	4 (<i>n</i> = 2041)	299 (14)	204 (10)	277 (14)	178 (9)	320 (16)	763 (37)
Country	5 (least deprived) (<i>n</i> = 2029)	232 (11)	183 (9)	263 (13)	207 (10)	315 (16)	829 (41)
	England (<i>n</i> = 4471)	548 (12)	375 (8)	622 (14)	420 (9)	667 (15)	1839 (41)
	Scotland (<i>n</i> = 1931)	404 (21)	204 (11)	211 (11)	151 (8)	250 (13)	711 (37)
	Wales (<i>n</i> = 1678)	389 (23)	234 (14)	237 (14)	150 (9)	191 (11)	477 (28)
	Northern Ireland (<i>n</i> = 1733)	533 (31)	270 (16)	233 (13)	152 (9)	193 (11)	352 (20)
Infant/birth characteristics							
Gestational age (categories)	37–39 weeks (<i>n</i> = 3827)	804 (21)	414 (11)	543 (14)	364 (10)	478 (12)	1224 (32)
	40–42 weeks (<i>n</i> = 5986)	1070 (18)	669 (11)	760 (13)	509 (9)	823 (14)	2155 (36)
Birth weight	<2.5 kg (<i>n</i> = 177)	38 (21)	15 (8)	27 (15)	16 (9)	23 (13)	58 (33)
	2.5–2.99 kg (<i>n</i> = 1188)	256 (22)	122 (10)	170 (14)	107 (9)	144 (12)	389 (33)
	3–3.49 kg (<i>n</i> = 3534)	695 (20)	378 (11)	472 (13)	316 (9)	474 (13)	1199 (34)
	3.5 kg+ (<i>n</i> = 4853)	882 (18)	561 (12)	629 (13)	428 (9)	650 (13)	1703 (35)
Birth order	First born (<i>n</i> = 4800)	714 (15)	586 (12)	778 (16)	452 (9)	645 (13)	1625 (34)

(Continues)

Table 2. (Continued)

		BF duration					
		Never BF (<i>n</i> = 1874)	<1 week (<i>n</i> = 1083)	1–6 weeks (<i>n</i> = 1303)	6 weeks to 3 months (<i>n</i> = 873)	3–6 months (<i>n</i> = 1301)	≥6 months (<i>n</i> = 3379)
		<i>n</i> , (%)	<i>n</i> , (%)	<i>n</i> , (%)	<i>n</i> , (%)	<i>n</i> , (%)	<i>n</i> , (%)
Special care	Not first born (<i>n</i> = 5013)	1160 (23)	497 (10)	525 (10)	421 (8)	656 (13)	1754 (35)
	Special care or lamp required (<i>n</i> = 669)	103 (15)	79 (12)	115 (17)	67 (10)	77 (12)	228 (34)
	No special care or lamp (<i>n</i> = 9144)	1771 (19)	1004 (11)	1188 (13)	806 (9)	1224 (13)	3151 (34)
Mode of delivery	Normal vaginal (<i>n</i> = 5863)	1131 (19)	602 (10)	722 (12)	500 (9)	784 (13)	2124 (36)
	Delivery with ventouse (<i>n</i> = 618)	94 (15)	64 (10)	86 (14)	60 (10)	91 (15)	223 (36)
	Delivery with forceps (<i>n</i> = 863)	142 (16)	116 (13)	125 (14)	82 (10)	122 (14)	276 (32)
	Caesarean (<i>n</i> = 2456)	506 (21)	299 (12)	369 (15)	231 (9)	301 (12)	750 (31)
Childcare setting (stage 2)	None (<i>n</i> = 9423)	1788 (19)	1039 (11)	1244 (13)	826 (9)	1239 (13)	3287 (35)
	Crèche or nursery (<i>n</i> = 53)	10 (19)	4 (8)	9 (17)	6 (11)	8 (15)	16 (30)
	Nanny or childminder (<i>n</i> = 46)	8 (17)	2 (4)	5 (11)	9 (20)	11 (24)	11 (24)
	Friend or relative (<i>n</i> = 282)	68 (24)	38 (13)	45 (16)	28 (10)	41 (15)	62 (22)

SEC, Socio-economic classification. IMD, Index of Multiple Deprivation. BF, breastfeeding. *Additional variables considered as potential confounders: smoking status post birth; skin-to-skin contact post birth. †Missing values shown only where total missing values is greater than 1%.

Fig. 1. (a) Breastfeeding duration and hospitalisation. Percentage of infants breastfed and percentage hospitalised by breastfeeding duration. (b) Exclusive breastfeeding duration and hospitalisation. Percentage of infants exclusively breastfed and percentage hospitalised by exclusive breastfeeding duration.

Furthermore, 19% of admissions for IC were attributable to breastfeeding for less than 6 weeks or not at all, instead of breastfeeding for 3–6 months (Table 4).

Discussion

The main finding of this study is that any breastfeeding for at least 3 months is protective against hospital admission for IC and particularly RTI, but the magnitude

of this effect is greater in infants who were also exclusively breastfed for a prolonged period (≥6 weeks). Seven percent of infants were hospitalised for IC during the study, and about one-third of these hospital admissions were attributable to breastfeeding for less than 3 months rather than breastfeeding for at least 6 months including at least 6 weeks of EBF.

We estimated that 31% of overnight hospital admissions for IC could be avoided if those mothers who never breastfed or breastfed for less than 3 months

Table 3. Associations between breastfeeding duration with hospitalisation for 'all infectious causes' and for 'respiratory tract infections', with unadjusted and adjusted* odds ratios

	Hospitalised (%)	IC (UNADJ. OR, 95% CI)	IC (ADJ. OR, 95% CI)	Hospitalised (%)	RTI (UNADJ. OR, 95% CI)	RTI (ADJ. OR, 95% CI)
Breastfeeding duration						
Never breastfed (<i>n</i> = 1874)	8	1	1	5	1	1
<1 week (<i>n</i> = 1083)	9	<i>P</i> = 0.664 1.1 (0.71–1.7)	<i>P</i> = 0.504 1.16 (0.75–1.8)	6	<i>P</i> = 0.425 0.81 (0.48–1.36)	<i>P</i> = 0.649 0.89 (0.53–1.5)
1–6 weeks (<i>n</i> = 1303)	8	<i>P</i> = 0.551 0.89 (0.6–1.31)	<i>P</i> = 0.693 0.92 (0.62–1.38)	5	<i>P</i> = 0.46 0.83 (0.51–1.36)	<i>P</i> = 0.779 0.93 (0.57–1.54)
6 weeks to 3 months (<i>n</i> = 873)	7	<i>P</i> = 0.304 0.79 (0.51–1.24)	<i>P</i> = 0.301 0.79 (0.5–1.24)	4	<i>P</i> = 0.188 0.69 (0.39–1.2)	<i>P</i> = 0.306 0.74 (0.42–1.31)
3–6 months (<i>n</i> = 1301)	5	<i>P</i> = 0.048 0.65 (0.43–1.0)	<i>P</i> = 0.044 0.64 (0.42–0.99)	3	<i>P</i> = 0.033 0.57 (0.34–0.95)	<i>P</i> = 0.048 0.59 (0.36–1.0)
<6 weeks EBF (<i>n</i> = 777)	6	<i>P</i> = 0.374 0.81 (0.51–1.29)	<i>P</i> = 0.313 0.79 (0.49–1.26)	4	<i>P</i> = 0.094 0.61 (0.35–1.09)	<i>P</i> = 0.121 0.63 (0.36–1.13)
≥6 weeks EBF (<i>n</i> = 524)	3	<i>P</i> = 0.009 0.41 (0.21–0.80)	<i>P</i> = 0.01 0.42 (0.22–0.81)	2	<i>P</i> = 0.07 0.50 (0.24–1.06)	<i>P</i> = 0.099 0.53 (0.25–1.13)
6 months or more (<i>n</i> = 3379)	5	<i>P</i> = 0.003 0.59 (0.42–0.84)	<i>P</i> = 0.002 0.58 (0.41–0.82)	3	<i>P</i> = 0.001 0.45 (0.29–0.71)	<i>P</i> = 0.001 0.47 (0.3–0.73)
<6 weeks EBF (<i>n</i> = 1295)	7	<i>P</i> = 0.174 0.75 (0.5–1.13)	<i>P</i> = 0.11 0.72 (0.48–1.08)	4	<i>P</i> = 0.042 0.58 (0.34–0.98)	<i>P</i> = 0.053 0.59 (0.35–1.01)
≥6 weeks EBF (<i>n</i> = 2084)	5	<i>P</i> < 0.001 0.48 (0.33–0.72)	<i>P</i> < 0.001 0.48 (0.32–0.72)	3	<i>P</i> < 0.001 0.37 (0.22–0.61)	<i>P</i> < 0.001 0.38 (0.23–0.63)

CI, confidence interval; UNADJ. OR, unadjusted odds ratio; ADJ. OR, adjusted odds ratio; RTI, respiratory tract infections; EBF, exclusive breastfeeding. *Adjusted for birth order, special care after delivery, age mother left full-time education, gestational age and infant age at survey stage 3.

Fig. 2. Odds ratio for hospitalisation compared with 'never breastfed' by breastfeeding duration.

continued to breastfeed for at least 6 months including at least 6 weeks exclusively and that 19% of admissions could have been avoided if mothers who breastfed less than 6 weeks continued to breastfeed for just

3–6 months. Infections, in particular respiratory tract infections, are among the most common causes of hospitalisation in infants in the UK (DH 2013; Hull *et al.* 2000). Here, we have demonstrated that relatively

Table 4. Adjusted OR and PAF for breastfeeding duration and hospitalisation for infectious causes

Duration	% of infants breastfed	% of cases breastfed	Hospitalisation adjusted OR* (95% CI)	P-value	PAF [†]	Hospitalisation adjusted OR* (95% CI)	P-value	PAF [†]
Never breastfed	19	22	2.07 (1.38–3.11)	<0.001	11% ^a	1.55 (1.01–2.37)	0.046	8% ^d
BF <6 weeks	24	30	2.12 (1.48–3.04)	<0.001	16% ^b	1.58 (1.09–2.31)	0.017	11% ^e
BF 6 weeks to 3 months	9	10	1.64 (1.05–2.57)	0.029	4% ^c	1.23 (0.77–1.95)	0.385	—
BF 3–6 months	13	10	1.34 (0.88–2.03)	0.167	—	1	—	reference
BF ≥6 months (with EBF <6 weeks)	13	13	1.49 (0.99–2.23)	0.053	—	1.11 (0.73–1.70)	0.62	—
BF ≥6 months (with EBF ≥6 weeks)	21	15	1	—	reference	0.75 (0.49–1.13)	0.167	—

OR, odds ratio; PFA, population attributable fraction; CI, confidence interval; BF, breastfeeding; EBF, exclusive breastfeeding. *Models from Table 2 have been refitted with different reference groups. [†]Overall PAF for breastfeeding less than 3 months ($a + b + c$) = 31%; overall PAF for breastfeeding less than 6 weeks ($d + e$) = 19%. PAFs only calculated where the OR is significant (P -value < 0.05). ^aPAF = $[0.22 \times (1.07/2.07)] = 11\%$. ^bPAF = $[0.3 \times (1.12/2.12)] = 16\%$. ^cPAF = $[0.1 \times (0.64/1.64)] = 4\%$. ^dPAF = $[0.22 \times (0.55/1.55)] = 8\%$. ^ePAF = $[0.3 \times (0.58/1.58)] = 11\%$.

small incremental increases in breastfeeding duration can have a substantial impact on the population level burden of hospitalisation because of infection.

The mechanism by which breastfeeding reduces risk of infection in infants is thought to be both through the active immunological protection from breast milk itself and from avoidance of contamination introduced through alternative feeding (Quigley *et al.* 2007; Fisk *et al.* 2011), presenting a biological argument that an extended period of breastfeeding is likely to provide a longer period of protection against infection. Further strengthening this argument, a previous study in the UK showed the protective effect of breastfeeding wears off soon after cessation of breastfeeding (Quigley *et al.* 2007). However, it is important to understand that a long duration of breastfeeding on its own may not necessarily provide protection without a prolonged period of EBF.

These results are consistent with findings from earlier studies, which have shown that partial BF, that is, non-EBF may be beneficial in reducing infectious morbidity in infants. Earlier studies in Scotland (Howie *et al.* 1990) and England (Baker *et al.* 1998) concluded that benefit was conferred from any breastfeeding for at least 3 months, and a recent Irish study found reduced risk of incidence of gastrointestinal illness from as little as 6 weeks of any breastfeeding (Tarrant *et al.* 2012), albeit with small numbers and low rates of breastfeeding. Some authors have concluded that partial breastfeeding provides no significant protection against gastrointestinal or respiratory infections (Quigley *et al.* 2007; Quigley *et al.* 2006; Ladomenou *et al.* 2010); however in these studies, the total duration of breastfeeding among those exclusively or partially breastfeeding was not investigated. It has been demonstrated elsewhere that EBF is associated with a longer duration of breastfeeding overall (Feinstein *et al.* 1986; Hill *et al.* 1997); therefore, it is possible that a lack of protection demonstrated from partial breastfeeding may be due to shorter overall duration of breastfeeding among these mothers. There is potential that the lack of exclusion of EBF in the group defined as ‘any breastfeeding’ in our analysis – in contrast to the studies by Quigley *et al.* (2007) and Ladomenou *et al.* (2010) where infants were categorised as either EBF or partially breastfed – may have biased our results away

from the null, indicating a significant association between long duration of any breastfeeding and hospitalisation; however, we know that only a small proportion of mothers EBF for longer than 3 months, so any impact would be minimal. Only Duijts *et al.* (2010) investigated the separate contribution of EBF, concluding that EBF for 4 months and partial thereafter was significantly protective against incidence of RTIs but that breastfeeding up to 6 months with no EBF or EBF for 4 months then no continued breastfeeding was not beneficial – a similar pattern to our findings, although with a smaller sample size.

Our definition of ‘any breastfeeding’ whereby an infant is defined as ‘breastfed’ if it receives any breast milk at all categorises infants who are exclusively breastfed, predominantly breastfed but not exclusively and those who receive predominantly formula and only a small amount of breast milk, together in one group. Although we know that only a small proportion is still exclusively breastfed beyond 3 months, we are otherwise unable to determine the quantity or frequency of breastfeeding among this group. However, research indicates that frequent breastfeeding (even if supplemented with formula) and predominant breastfeeding are both correlated with increased duration of breastfeeding (Feinstein *et al.* 1986), and physiologically, frequent suckling is a key driver in milk production (Jonas & Woodside 2015). Future research in this area should attempt to robustly quantify mixed feeding patterns to better understand the potential benefits from non-EBF.

The strengths of this study are the large sample size, allowing for identification of large and significant effects even with a relatively uncommon outcome and that the primary outcome measure of overnight hospitalisation is both well defined and an indicator of severity of illness, therefore being more robust to recall bias. There are inherent weaknesses in the observational study design, notably misclassification bias, non-response bias and potential residual confounding. Although this survey questionnaire was not validated, studies have shown maternal reporting of breastfeeding duration to be reliable (Li *et al.* 2005; Herrmann *et al.* 2011) and parental recall of hospitalisation in infants to be highly accurate (Spencer & Coe 2000; D’Souza-Vazirani *et al.*

2005). The frequency of the surveys, requiring only short-term recall at each stage, reduces the risk of recall error. Furthermore, hospitalisation rates in our study are comparable with those found elsewhere, suggesting limited impact of misclassification (Quigley *et al.* 2007; Ladomenou *et al.* 2010). There was an indication of slight under-representation in the sample of younger mothers and mothers living in the most deprived areas; therefore, survey data were weighted for differential response rates among different groups of the population to mitigate non-response bias and for potential selection bias from the sampling methodology (McAndrew *et al.* 2012).

It is well established that multiple physiological, psychological and environmental factors impact on both infant feeding patterns and infant illness. Our results were adjusted for several variables known to have an association with breastfeeding and infant morbidity; however, residual confounding, for example, maternal behavioural characteristics intrinsic in the motivation to breastfeed, cannot be ruled out. Moreover, because of the lack of data on the timing of hospitalisation and the impact of hospitalisation on infant feeding, reverse causality cannot be entirely ruled out. There is little published evidence of the impact of infant hospitalisation on the continuation of breastfeeding; therefore, it is difficult to estimate the impact this may have had on our results. UK guidelines published in 2009 by the Royal College of Nursing (Royal College of Nursing 2013) encourage continuation of breastfeeding for hospitalised infants and support for mothers to do so; therefore, there is no indication that hospitalisation itself should necessarily lead to interruption or termination of breastfeeding. However, it is reasonable to assume that in some instances, hospitalisation, in particular for a prolonged period, may lead to interruption of breastfeeding or loss of EBF, and this may have biased our odds ratios away from null. Future studies of this nature should attempt to collect data on timing of hospitalisation to mitigate this issue.

Our results are widely generalisable to other industrialised countries. The low number of infants in our sample who were exclusively breastfed for at least 6 months, reflective of UK rates described elsewhere, (Quigley *et al.* 2007; McAndrew *et al.* 2012) are not unusual and have been reported in other developed

countries (Duijts *et al.* 2010), therefore ought not to limit generalisability. The findings of this study further add to the evidence base by examining the contributions of overall breastfeeding duration and EBF to the reduction in morbidity for infectious diseases in infancy, in a large population-based sample.

Very few women in the UK reach the recommended level of EBF, for a variety of reasons, both structural and personal. Although 6 months of EBF may provide optimal benefit to mother and baby, we have demonstrated that significant benefits may be attainable from an extended period – at least 3 months – of breastfeeding, not necessarily exclusively, when combined with a short initial duration of EBF (at least 6 weeks). From this analysis, however, we cannot quantify how much breast milk is the minimum requirement. While we continue to strive to increase rates of EBF, parents, front-line staff and health service providers need to be aware of the opportunity for benefits from non-EBF but that EBF in the early weeks is likely a key factor in realising these benefits and ought to be strongly encouraged and supported. Significant morbidity, and its associated costs, may potentially be avoided with a population-level increase in exclusive and prolonged breastfeeding among mothers in the UK, and further research is warranted in understanding effective interventions to help mothers breastfeed for longer and in particular to exclusively breastfeed for a prolonged initial period.

Conclusions

Breastfeeding for at least 3 months, with a substantial component of initial EBF may reduce hospital admissions for infectious illness in infants in a developed country. Large and significant public health benefit can be achieved by encouraging more mothers to breastfeed, and exclusively breastfeed, beyond the first weeks after childbirth.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

SP contributed to the conception and design of the study, undertook the analysis and drafted the paper. MQ contributed to the conception and design of the study, contributed to the interpretation of the data and critically reviewed the paper. Both authors have approved the final version to be published.

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