BMJ open

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Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-002765
Article Type:	Research
Date Submitted by the Author:	20-Feb-2013
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Primary Subject Heading:	Public health
Secondary Subject Heading:	Nutrition and metabolism
Keywords:	Breastfeeding, PUBLIC HEALTH, NUTRITION & DIETETICS

Factors associated with breastfeeding in England: an analysis by primary care trust

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ABSTRACT

Objectives: To identify the socio-demographic factors associated with variation in area-based breastfeeding in England; to calculate predicted breastfeeding rates adjusted for socio-demographic variations.

Design: Ecological analysis of routine data using random effects logistic regression.

Setting: All 151 primary care trusts (PCTs) in England 2010-11.

Outcome measures: PCT level data on breastfeeding: initiation, any and exclusive breastfeeding at 6-8 weeks.

Results: There was considerable variation in breastfeeding across the PCTs (breastfeeding initiation mean 72%, range 39-93%; any breastfeeding at 6-8 weeks mean 45%, range 19-83%; exclusive breastfeeding at 6-8 weeks mean 32%, range 14-58%), with London PCTs reporting markedly higher rates. Maternal age was strongly associated with area-based breastfeeding, with a 4-6% increase in odds of breastfeeding associated with a unit increase in the percentage of older mothers. Outside London, the proportion of the local population from a Black and Minority Ethnic background was associated with higher breastfeeding (1-3% increase in odds per unit increase), and area-based deprivation was associated with reduced odds of breastfeeding (21-32% reduced odds comparing most deprived quintile to least deprived). Weaker associations were observed between socio-demographic factors and breastfeeding in London PCTs. Very few PCTs reported breastfeeding figures substantially above or below the national average having adjusted for variations in socio-demographic factors.

Conclusions: Our results show striking associations between socio-demographic factors and breastfeeding at the area level. Given these effects, breastfeeding services which are tailored to the needs of the local population are required. Our findings could be used to inform the commissioning of appropriate area-level breastfeeding interventions. While area breastfeeding rates vary enormously, much of the variation is explained by the socio-demographic profile of the area. However, there is little room for complacency; while some areas in England have high rates of breastfeeding initiation; all have low duration rates, particularly of exclusive breastfeeding.

Article focus

- The primary aim of the reported study was to identify the socio-demographic factors independently associated with variation in area-based breastfeeding in England (breastfeeding initiation, any and exclusive breastfeeding rates at 6-8 weeks).
- The secondary aim was to calculate predicted area-based breastfeeding rates adjusted for socio-demographic variations using multivariable modelling.

Key messages

- Striking associations between socio-demographic factors and breastfeeding at the area level explain much of the variation in breastfeeding rates between areas. These associations were strongest in PCTs outside London; for London PCTs the associations were less consistent.
- After adjustment for socio-demographic factors most PCTs have breastfeeding rates in line with those expected given overall trends, however, breastfeeding rates are still comparatively low, especially for exclusive breastfeeding.
- The findings of this study confirm the importance of socio-demographic context and support the view that breastfeeding interventions need to be tailored to the needs of a particular setting. Our results can be used to compare breastfeeding across areas with similar socio-demographic characteristics and to inform service commissioning.

Strengths and limitations

- To our knowledge this is the first UK study investigating the relationship between socio-demographic factors and breastfeeding at an area-based level. We used good quality routine data to look at breastfeeding prevalence and socio-demographic factors, and our analysis covers all English PCTs.
- This is an ecological study and as such our results are subject to the usual limitation that causality cannot be inferred. It is possible that variations in breastfeeding rates may be partially explained by area-level factors not measured in this study.
- The small sample number of PCTs in London may affect our confidence in the results from our analysis of London PCTs.

INTRODUCTION

Breastfeeding confers multiple benefits on both infants and mothers, with evidence linking breastfeeding to a lower risk of many adverse outcomes[1 2] including gastroenteritis[3 4], respiratory disease[4 5], necrotising enterocolitis[6] and otitis media[1 5] in infants, and a lower risk of breast cancer in mothers[1 2 7]. Breastfeeding has also been linked to other health, social and cognitive outcomes including childhood obesity and cognitive development[8 9].

Current UK guidance recommends that infants are exclusively breastfed to six months of age[10]. In England, just over four out of five (83%) mothers now start breastfeeding[11] but the recent improvements in initiation have not been reflected to the same extent in duration and exclusivity; by six weeks the proportion breastfeeding has dropped to 57%. Only 36% of mothers are still breastfeeding at 6 months. Twenty-four percent of mothers are breastfeeding exclusively at 6 weeks, and just 13% at 4 months[11]. Percentages are lower still in the other constituent countries of the United Kingdom, and in international comparisons, UK breastfeeding rates compare poorly with those of other European countries[12].

A recent report estimated that a moderate increase in breastfeeding rates in the UK could save over £17 million a year as a result of reduced costs for treating four acute infant diseases, with further savings accrued from the resulting reduction in breast cancer cases[2]. In the UK breastfeeding is a major factor in inequalities in health; not being breastfed is both a cause and a consequence of social inequalities[2]. Improving breastfeeding rates in the UK has been a key focus of successive governments over the last decade[13 14]; with the recent public health outcomes framework for England identifying breastfeeding as a key indicator for health improvement[15].

Previous studies have identified a variety of socio-demographic factors including area of residence, maternal age, socio-economic background, maternal education, ethnicity and smoking behaviour as being associated with breastfeeding in both the UK and other high income countries[11 16-27]. However, these are based on the analysis of individual women and little is known about the factors that are associated with breastfeeding at the area level. In England, breastfeeding data have formed part of the Department of Health Vital Signs Monitoring Return (VSMR) since 2004 and are routinely reported at a number of different aggregate levels. Studies based on area-level data are well placed to make use of routinely collected data such as this, and can help to inform commissioning of services as well as providing a framework with which to evaluate relevant interventions. A recent study by Freemantle and colleagues used an approach similar to the one described here to look at factors associated with PCT level perinatal and infant mortality[28].

The aim of this study was to identify the socio-demographic factors associated with variation in area-based breastfeeding rates in England.

METHODS

We conducted an area-based analysis making use of data routinely collected at the primary care trust (PCT) level. One hundred and fifty one PCTs in England (boundaries as of 2010) were eligible for inclusion.

Outcome measures

In England, breastfeeding status at birth and at the 6-8 week infant review is routinely collected shortly after birth and at the 6-8 week infant review. We focused on three breastfeeding outcomes: breastfeeding initiation at birth, any breastfeeding at 6-8 weeks, and total (exclusive) breastfeeding at 6-8 weeks[29].

Breastfeeding is recorded as being initiated if infants receive any breast milk in the first 24 hours after birth. At 6-8 weeks, infants are classified into one of three categories according to feeding method in the preceding 24 hours: not breastfed; partially breastfed; or totally breastfed (hereafter referred to as "exclusively" breastfed). The last two groups are combined to give the outcome "any breastfeeding". Data on breastfeeding outcomes at these two time points (birth and 6-8 weeks) are released quarterly by the Department of Health (DH). For this analysis, overall figures for 2010-11 were calculated by summing raw quarterly actual data. PCTs were included where reported data for at least two of the four quarters of 2010-11 met DH quality standards (≥95% data coverage for initiation; for 6-8 week data, ≥90% and ≥95% data coverage for quarters 1-3 and quarter 4 respectively).

Explanatory variables

The following area-based socio-demographic indicators were included in our analysis: area-based deprivation, the proportion of births to older (aged >35 years) and younger (aged <20 years) mothers, the prevalence of maternal smoking, and the proportion of the PCT population deriving from Black and Minority Ethnic (BME) backgrounds.

We used the 2010 Index of Multiple Deprivation (IMD) as our indicator of material deprivation[30]. Data on thirty-eight domains contribute to this index and are combined to reflect a broad concept of deprivation. IMD is calculated at the level of "lower super output area" (LSOA), of which there are 32,482 in England. The score for each PCT is the average of the constituent LSOAs.

The estimated proportion of each PCT population from a Black and Minority Ethnic (BME) background was derived from the Office for National Statistics (ONS) Population Estimates by Ethnic Group (PEEG) for 2009[31]. PEEG is calculated using a cohort component methodology using data from the 2001 Census and more recent data on births, deaths and migration. BME was defined as non-White British.

The percentage of women smoking at delivery by PCT is reported quarterly by PCTs in England. In this analysis we used the figures for 2010-11 published by the Department of Health for England [29].

Information on the percentage of births at PCT level occurring to older mothers (women aged older than 35) and younger mothers (women aged less than 20) in 2010-11 were derived from Hospital Episode Statistics (HES) data reported by the Child and Maternal Health Observatory (CHIMAT)[32].

Statistical analysis

The association between socio-demographic variables and all three breastfeeding outcomes was investigated using separate logistic regression models. Random effects logistic regression models were used to take into account the clustered hierarchical nature of the data.

Most explanatory variables were analysed as continuous variables, for example the proportion of births in a PCT to mothers aged less than 20, thus we estimated the effect of a one percentage point increase in each variable on the breastfeeding proportion in the PCT. IMD scores were divided into quintiles for ease of analysis.

Preliminary analyses of the data revealed a striking difference in the socio-demographic profile of London PCTs when compared to PCTs outside London. There was also evidence that the effect of area-based deprivation differed according to whether PCTs were in London or not. For this reason, all analysis was stratified by region (London vs. non-London).

Variables (or any resulting odds ratios for that variable) which were associated ($p < 0.10$ using Wald test for at least one relevant OR) with breastfeeding in univariable analysis were included in multivariable random effects logistic regression models. The final model included all variables which were associated ($p < 0.05$ using Wald test for at least one relevant OR) with the outcome after adjusting for other factors in the model. This strategy was repeated for each relationship under study.

The final multivariable models were used to generate predicted proportions of all breastfeeding outcomes for PCTs in England, assuming fixed effects for the explanatory variables shown in the tables. Differences between observed and predicted proportions were examined by calculating standardized residuals for all PCTS; those with observed proportions that were two or more standardized residuals above or below predicted proportions were highlighted as possible outliers. These figures can be considered to provide a more accurate comparison of the proportion of mothers breastfeeding between areas, as it takes into account the distribution of socio-demographic factors that we know to affect breastfeeding.

All statistical analyses were conducted using STATA version 11 (StataCorp, College Station, TX); all tests were two tailed and a 5% significance level was used unless specified otherwise.

RESULTS

For the time period under study (2010-11), PCTs in England ranged in size from 1,134 to 14,972 births (mean 4,550, sd 2,429) (2010 data). All PCTs were included for the analysis of breastfeeding initiation, but 10 PCTs failed to report 6-8 week data that met DH quality controls for two or more quarters. Therefore, information on breastfeeding initiation was available for 151 PCTs, and for breastfeeding status at 6-8 weeks, data were available for 141 PCTs.

Breastfeeding initiation varied across the PCTs from 39% to 93%, with a mean of 72% (Table 1). For breastfeeding status at 6-8 weeks, the mean percentage of any breastfeeding was 45% (range 19-83%) and for exclusive breastfeeding, 32% (range 14-58%). On average, one in five (19%) births in each PCT were to women aged over 35 (range 9-42%) and 6% were to women aged under 20 (range 1-12%). The mean proportion of mothers who were smoking at the time of delivery was 15% (range 3-33%). The proportion of the PCT population from a BME background averaged 19% across all PCTs (range 4-67%).

The profile of London PCTs differed markedly from PCTs in the rest of England. Breastfeeding tended to be more common in London PCTs, with average breastfeeding initiation at 86%, compared to 69% for PCTs outside London. Equivalent figures for any and exclusive breastfeeding at 6-8 weeks in London were 68% and 43%, and outside London, 40% and 29%. London PCTs also had a higher proportion of births to older mothers (25% vs. 18%), a higher proportion of residents from a BME background (40% vs. 13%), a lower proportion of births to teenage mothers (3% vs. 7%) and a lower prevalence of maternal smoking at delivery (7% vs. 17%). The deprivation profile was similar when comparing London and non-London PCTs. All further results are shown separately for PCTs outside and inside London.

PCTs outside London

The relationship between any breastfeeding at 6-8 weeks and each of the five socio-demographic variables under study is presented in a series of scatter plots in Figure 1, with data points for non-London PCTs highlighted with solid blue markers. There are striking associations between breastfeeding and most of the socio-demographic variables: at the PCT level, the percentage of mothers breastfeeding tends to decrease as deprivation increases, and as the proportion of both younger mothers and maternal smoking increases. In general, breastfeeding rises in line with increases in the proportion of older mothers and the proportion of the population from BME background. Scatter plots for breastfeeding initiation and exclusive breastfeeding at 6-8 weeks showed similar patterns (see Table S1 – supplementary table).

Odds ratios for the association between these socio-demographic factors and each of the three breastfeeding outcomes are shown in Table 2. In univariable analysis, breastfeeding (all outcomes) was significantly higher in those PCTs with a higher proportion of older mothers and a higher BME population. Lower breastfeeding at birth and 6-8 weeks was observed in PCTs with increased deprivation and those areas with a higher prevalence of maternal smoking or teenage mothers.

In multivariable analysis, the following variables were independently associated with breastfeeding (all outcomes): area-based deprivation, the proportion of births to older women, and BME population (Table 2). The effect of deprivation was somewhat attenuated by adjustment for other factors, although when compared to the least deprived quintile, a significant decrease in odds was still observed in quintiles 4 and 5 for exclusive breastfeeding at 6-8 weeks, and quintile 5 for breastfeeding initiation and any breastfeeding at 6-8 weeks. For breastfeeding initiation, the most deprived quintile (quintile 5) was associated with a reduction in the odds of 32% (adjusted OR 0.68) when compared with the least deprived. Areas with higher proportions of older mothers, and increased BME population all had higher odds of breastfeeding at birth and 6-8 weeks. Of these two factors, the strongest association was with older maternal age, where a unit increase in the percentage of mothers aged 35 or over was associated with a six percent increase in the odds of any breastfeeding at 6-8 weeks (adjusted OR 1.06) and a five percent increase in the odds of breastfeeding initiation or exclusive breastfeeding at 6-8 weeks (adjusted OR 1.05).

London PCTs

The same striking associations between breastfeeding and the socio-demographic variables are evident in the London PCTs (Figure 1, highlighted with hollow blue markers). The only exception was area deprivation which was not strongly associated with breastfeeding. These figures also provide strong evidence of the difference in both the socio-demographic and the breastfeeding profile of London PCTs compared to non-London PCTs.

Univariable analysis of the London PCTs showed significant associations between all breastfeeding outcomes and the maternal age profile of PCTs, the proportion of a PCT population from a BME background, and maternal smoking (Table 3). Area-based deprivation showed no or little significant association with breastfeeding in London.

In the multivariable analysis, factors independently associated with breastfeeding initiation were area deprivation, older maternal age and maternal smoking (Table 3). Increased maternal smoking at delivery was associated with lower breastfeeding initiation, and in line with the results for PCTs outside London, increased prevalence of older mothers was associated with higher breastfeeding initiation. However, contrary to the results observed outside London, increased deprivation appeared to be independently associated with *higher* breastfeeding initiation. Quintiles 3-5 had a significantly increased odds ratio compared to the least deprived quintile 1; for quintile 5 (most deprived PCTs) the adjusted odds ratio was 1.71.

After adjustment for other factors, deprivation was not independently associated with breastfeeding at 6-8 weeks in London PCTs. Older maternal age was associated with both measures of breastfeeding at 6-8 weeks, with a one percent increase in the proportion of older mothers being associated with an odds ratio of 1.06 for both any and exclusive breastfeeding. BME population was

independently associated with any breastfeeding at 6-8 weeks (OR 1.03 per unit change), and maternal smoking associated with increased exclusive breastfeeding.

Observed and predicted proportions

Figure 2 shows the breastfeeding proportions observed in each PCT plotted against the breastfeeding proportion that would be predicted based on the multivariable models shown in Tables 2 and 3. The vast majority of PCTs reported proportions consistent (within two standardized residuals) with the proportions predicted by the models. Three PCTs (all non-London) reported breastfeeding initiation as considerably higher than predicted, and two PCTs (both non-London) reported figures lower than predicted (outliers are highlighted in Figure 2). Three PCTs (all non-London) and four PCTs (three non-London, one London) reported proportions of any and exclusive breastfeeding higher than predicted. One London PCT reported the proportion of any breastfeeding at 6-8 weeks as lower than expected. Table S2 shows the observed and predicted breastfeeding proportions for each PCT.

DISCUSSION

This is the first UK study to our knowledge designed to investigate the relationship between socio-demographic factors and breastfeeding at an area-based level, an analysis which is important given that services are commissioned and delivered at this level. There was enormous variation in area-based rates of breastfeeding. However, after adjusting for socio-demographic factors, most areas have breastfeeding rates within the expected range of the national average, albeit a relatively low national average (e.g. 45% any breastfeeding at 6-8 weeks). The area-based analysis revealed some striking associations between socio-demographic factors and breastfeeding; these persisted after adjustment for other factors. For example, an increase in the proportion of mothers aged 35 or older from 15% to 20% is associated with a 34% increase in the odds for area-level any breastfeeding at 6-8 weeks.

Limitations

This study used aggregate data and as such is subject to the usual limitation that causality cannot be inferred. It is possible that higher levels of breastfeeding can be partially explained by area-level factors not measured in this study, for example a greater number of accessible breastfeeding services. We included all socio-economic indicators routinely available at the PCT level. There may be other relevant factors that would have been useful to include, such as service provision.

The Department of Health for England does not make raw figures for annual outturn breastfeeding data routinely available. In order to model figures in our regression analysis, we relied on quarterly actual data. These data may differ very slightly from annual outturn data but there is no reason to suspect trends would be different. One advantage of our method (summing breastfeeding data across quarters) was that we were able to include PCTs with one or two data quarters missing, thus minimising data loss. However, a small number of PCTs were excluded due to missing data on

maternal smoking or where breastfeeding data did not meet our stipulated criteria (acceptable data quality for at least two quarters). In addition, the small sample number of PCTs in London may affect our confidence in the results from our analysis of London PCTs: where associations were observed, these were less consistent than those observed in the larger group of PCTs outside London. The observed breastfeeding proportions used in this analysis are likely to be an underestimate of the true number breastfeeding as we mirrored the denominators used by the DH which assumes that those for whom a breastfeeding status was not recorded are not breastfeeding.

Our ethnicity indicator related to the general PCT population rather than the maternal population. Given the high level of missing data on maternal ethnicity from Hospital Episode Statistics (HES) (approximately eight percent in 2009-10[33]), using these data would have resulted in a reduction in our sample size. We compared the general ethnicity data with the HES maternal ethnicity data and noted that it correlated well, although the maternal HES ethnicity data reported higher proportions across all PCTs, probably due to the younger age profile of BME populations. We combined all non-White groups into a single BME indicator. This helped to minimise potential problems due to small numbers of certain ethnic groups in many PCTs. This decision was also supported by strong evidence that all non-White women are more likely to initiate and continue breastfeeding when compared to White women[11]. However, our approach left us unable to examine fully the separate contribution of individual ethnic groups or relevant factors such as migration history or acculturation status[34] to breastfeeding rates.

Interpretation of results

We found convincing evidence to support a strong area effect of older maternal age on breastfeeding, with a one percent increase in the percentage of older mothers in a PCT associated with a 4-6% increase in the odds of breastfeeding. This trend was consistent across all outcomes and in both London and non-London PCTs. Outside London, the proportion of the PCT population from a BME background was associated with breastfeeding, with a unit increase in BME population resulting in a 1-3% increase in the odds of breastfeeding. Area-based deprivation was also associated with breastfeeding. PCTs in the most deprived quintile had a 21-32% reduced odds of breastfeeding compared to PCTs in the least deprived quintile. In London PCTs, results were less consistent after adjustment. Maternal smoking and BME were both associated with one or more breastfeeding outcomes. Area deprivation was associated with breastfeeding initiation, although perhaps surprisingly this association was positive i.e. breastfeeding increased with increasing deprivation.

Our finding that a higher prevalence of older mothers is associated with breastfeeding at the area level is consistent with evidence from 'individual level' studies that older mothers are more likely to initiate and continue breastfeeding[11 24].

Non-white ethnicity has consistently been linked to increased breastfeeding in individual level studies[16 17 20 22 26], although there is some variation between individual ethnic groups and by acculturation status[34]. Existing literature suggests that the strongest overall effect of ethnicity is on

initiation and continuation, with minimal differences by ethnicity in the number of women who breastfeed exclusively[35 36]. We noted that the proportion of the PCT population from a BME background was associated with all breastfeeding outcomes outside London, but only any breastfeeding at 6-8 weeks in London. The fact that we did not identify an independent effect of BME population on initiation in London may be partly due to the high rate of BME in the London PCTs (mean value 40%) making it difficult to detect an independent effect of ethnicity. In addition, it may be that high rates of breastfeeding in ethnically diverse areas supports the concept of "community ethnicity"[20], whereby some groups of White women appear to be more likely to breastfeed if they reside in an area with a high BME population.

The different effect of area deprivation in London compared to the rest of England highlights the complex relationships between ethnicity, socio-economic status and breastfeeding behaviour. BME populations tend to cluster in more deprived neighbourhoods. Women from non-White backgrounds are more likely to breastfeed. In general, mothers from lower socio-economic backgrounds are less likely to breastfeed. There is evidence that this latter trend cannot be generalised to mothers from non-White backgrounds[17]. Several studies have found that the effect of deprivation[17], socio-economic status[19], and income[22], is negligible when looking at breastfeeding among certain minority ethnic groups. Outside London, both deprivation and area level ethnicity remained independent predictors of breastfeeding even after adjusting for the other. Within London, the effect of one appeared to be attenuated by the other, except when looking at exclusive breastfeeding which was not independently associated with either.

Our analysis was designed to explain the variation in breastfeeding between PCTs. Only a handful of PCTs reported breastfeeding figures substantially above or below the proportions predicted by our models. The majority of outliers were PCTs with observed proportions higher than expected based on the national average having adjusted for socio-demographic factors; though two PCTs did report breastfeeding initiation as lower than predicted and one PCT had a lower than expected proportion of any breastfeeding at 6-8 weeks.

Implications

Our results demonstrate that while area-based rates of breastfeeding vary enormously, much of this variation is explained by the socio-demographic profile of the area. Currently, breastfeeding data provided at the PCT level for comparative purposes is unadjusted[37] and may result in misleading assessment of local performance. Adjusted breastfeeding figures as reported in this study may be used to identify areas with higher or lower than expected rates of breastfeeding. For those performing above expected levels, there may be lessons to be learned from examining local service provision.

The socio-demographic context within which a breastfeeding service is implemented or evaluated is clearly important[38]. A 'one size fits all' approach to breastfeeding support is unlikely to demonstrate a strong effect at the population level over and above the 'background noise' of such strong socio-

demographic effects. Interventions which are tailored to the needs of a particular setting are more likely to be effective[39], particularly those that follow local needs assessment. Our findings can be used to help inform the primary focus of an intervention, for example whether the emphasis should be on breastfeeding initiation, duration or exclusivity, or a combination of these outcomes[39]. The size of effects observed in our study may also inform estimates of the likely effect of breastfeeding interventions, in a trial or other setting. In situations where the required trial size is too large to be feasible, other forms of evaluation, such as case studies of high performing PCTs, are likely to be a more suitable approach.

In the new (post-April 2013) NHS structure in England, it is uncertain which organisations will be responsible for commissioning breastfeeding services. However, our results will be relevant to whichever local structures take over this function, particularly given that many of the geographical areas presented here will be recognisable in the new structure. Although most PCTs are performing at the level expected given current trends, overall breastfeeding rates are still low and fall short of UK recommendations for mothers to breastfeed exclusively for the first six months of life.

Conclusion

Our results confirm the importance of socio-demographic indicators of breastfeeding, and provide evidence that these indicators explain much of the heterogeneity between PCTs in terms of the proportion of mothers breastfeeding. However, there is little room for complacency; while some areas in England now have high rates of breastfeeding initiation; almost all have low rates of duration, particularly of exclusive breastfeeding. In order to maximise the likelihood of success, interventions designed to increase breastfeeding at the area level will need to be tailored to the socio-demographic context, and monitoring and assessment of area-based rates will need to take these factors into account.

Contributors

MQ and JK conceived the study and all authors contributed to the design of the study. MQ and LO designed and conducted the analysis. All authors were involved in the interpretation of the data. LO and MQ wrote the initial draft of the manuscript, and all authors contributed to revising consecutive drafts. All authors approved the final version of the manuscript. All authors had full access to all of the data in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. MQ and LO are the guarantors for the study.

Funding

This paper reports on an independent study which is funded by the Policy Research Programme in the Department of Health. The views expressed are not necessarily those of the Department. The funder had no role in: the design and conduct of the study; the analysis and interpretation of the data; and the drafting of the paper and decision to submit the paper for publication.

Competing interests

None.

Data sharing

Observed and predicted breastfeeding rates by PCT are provided as Supplementary Data. For further information please contact the corresponding author.

Ethics approval

Not needed.

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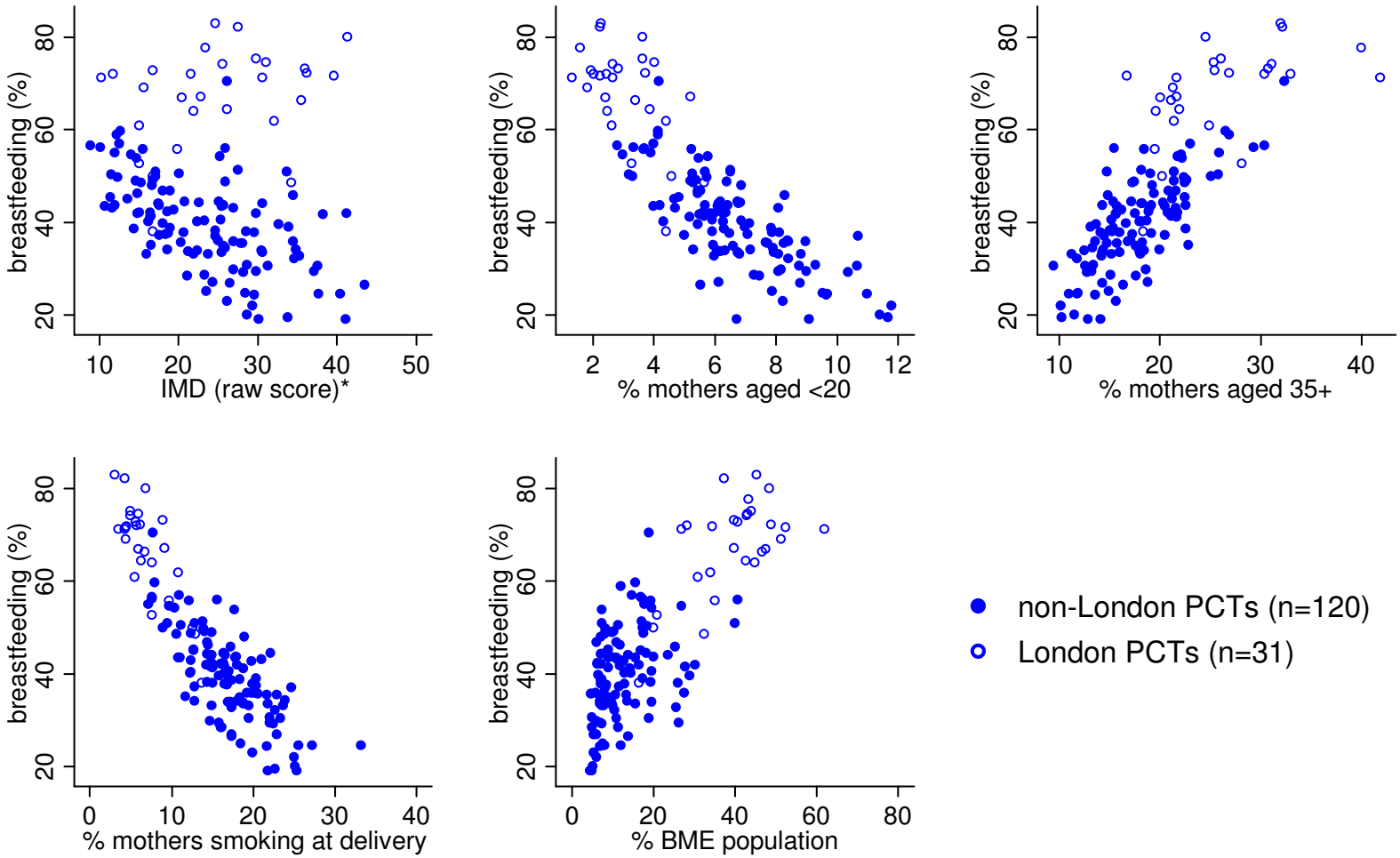
Table 1. Distribution of breastfeeding outcomes and socio-demographic variables by PCT

	ALL PCTS (n=151)			NON-LONDON PCTS (n=120)			LONDON PCTS (n=31)		
	mean (sd)	median (IQR)	min, max	mean (sd)	median (IQR)	min, max	mean (sd)	median (IQR)	min, max
Breastfeeding									
% initiating breastfeeding	72.3 (11.2)	72.8 (65.2-79.9)	39.0, 92.9	68.7 (9.1)	69.6 (62.5-75.7)	39.0, 85.5	86.3 (6.6)	88.9 (83.1-91.3)	67.7, 92.9
% any breastfeeding at 6-8 weeks[1]	45.3 (15)	42.3 (34.5-54.0)	19.2, 83.1	39.7 (10.0)	39.9 (33.7-45.5)	19.2, 70.5	67.5 (10.6)	71.3 (63.0-73.7)	38.1, 83.1
% exclusive breastfeeding at 6-8 weeks[1]	31.6 (9.1)	31.4 (24.9-37.1)	14.2, 58.2	29.2 (7.4)	29.3 (24.2-33.2)	14.3, 58.2	41.2 (8.8)	42.5 (35.0-48.6)	20.5, 57.5
Socio-demographic									
IMD (raw score)[2]	23.6 (8.4)	23.3 (16.6-29.5)	8.8, 45.3	23.1 (8.3)	22.8 (16.4-28.5)	8.8, 45.3	25.6 (8.8)	25.0 (16.7-31.9)	10.1, 41.8
% mothers aged 35+	19.3 (5.7)	18.4 (15.1-22.0)	9.4, 41.8	17.8 (4.4)	17.6 (14.5-21.2)	9.4, 32.3	25.2 (6.4)	24.5 (20.1-30.4)	15.4, 41.8
% mothers aged <20	5.9 (2.3)	5.8 (4.1-7.4)	1.3, 11.8	6.6 (1.9)	6.3 (5.3, 7.9)	2.8, 11.8	3.1 (1.1)	2.8 (2.2-3.8)	1.3, 5.6
% population BME	18.7 (14.3)	13.0 (7.8-25.9)	4.3, 67.0	13.1 (8.7)	10.9 (7.3-16.9)	4.3, 67.0	40.4 (10.9)	42.9 (33.9-47.5)	16.4, 61.9
% mothers smoking at delivery[3]	14.7 (6.1)	15.0 (10.7-18.8)	3.0, 33.2	16.7 (4.8)	16.5 (13.7,-19.9)	6.1, 33.2	6.6 (2.9)	5.9 (4.4-7.5)	3.0, 13.6

[1]Restricted to 141 PCTs with data on breastfeeding at 6-8 weeks
[2]A high score is indicative of greater deprivation
[3]Restricted to 146 PCTs with data on smoking at delivery

Information on maternal smoking at delivery was unavailable for a number of PCTs, leaving 144 and 137 PCTs included in the complete case analysis for breastfeeding initiation and breastfeeding at 6-8 weeks (115 non-London PCTs and 29 London PCTs; 110 non-London PCTs and 27 London PCTs).

Figure 1. Scatterplots for any breastfeeding at 6-8 weeks by socio-demographic factors (London vs. non-London)



*A high IMD score is indicative of greater deprivation

Table 2. Socio-demographic factors associated with PCT level breastfeeding: univariable and multivariable models for non-London PCTs

NON-LONDON PCTS	% INITIATING BREASTFEEDING (n=115)				% ANY BREASTFEEDING AT 6-8 WEEKS (n=110)				% EXCLUSIVE BREASTFEEDING AT 6-8 WEEKS (n=110)			
	UNADJUSTED		ADJUSTED[1]		UNADJUSTED		ADJUSTED[2]		UNADJUSTED		ADJUSTED[3]	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Index of Multiple Deprivation												
Quintile 1 (least deprived)	1.00		1.00		1.00		1.00		1.00		1.00	
Quintile 2	0.82	(0.68-1.00)	1.03	(0.88-1.20)	0.74*	(0.60-0.91)	0.98	(0.85-1.12)	0.83*	(0.70-0.98)	1.02	(0.89-1.17)
Quintile 3	0.68***	(0.56-0.83)	0.97	(0.82-1.15)	0.61***	(0.49-0.75)	0.89	(0.77-1.04)	0.67***	(0.56-0.79)	0.94	(0.80-1.10)
Quintile 4	0.56***	(0.46-0.68)	0.84	(0.70-1.01)	0.54***	(0.44-0.67)	0.83*	(0.71-0.98)	0.61***	(0.51-0.72)	0.90	(0.76-1.06)
Quintile 5 (most deprived)	0.50**	(0.41-0.61)	0.68**	(0.54-0.86)	0.51***	(0.41-0.64)	0.69***	(0.57-0.85)	0.54***	(0.45-0.65)	0.79*	(0.64-0.97)
% mothers aged 35+	1.07***	(1.06-1.09)	1.05***	(1.04-1.07)	1.08***	(1.06-1.09)	1.06**	(1.04-0.85)	1.07***	(1.05-1.08)	1.05***	(1.04-1.07)
% mothers aged <20	0.86***	(0.83-0.88)			0.84***	(0.82-0.87)			0.88***	(0.86-0.90)		
% population BME	1.01*	(1.00-1.02)	1.02***	(1.01-1.02)	1.02***	(1.01-1.03)	1.03***	(1.02-1.04)	1.01*	(1.00-1.02)	1.01***	(1.01-1.02)
% mothers smoking at delivery	0.94***	(0.93-0.95)			0.93***	(0.92-0.94)			0.95***	(0.94-0.96)		

*p <0.05 **p <0.01 ***p <0.001

[1]Variables in model: IMD, % births to older mothers, % of population BME
[2]Variables in model: IMD, % births to older mothers, % of population BME
[3]Variables in model: IMD, % births to older mothers, % of population BME

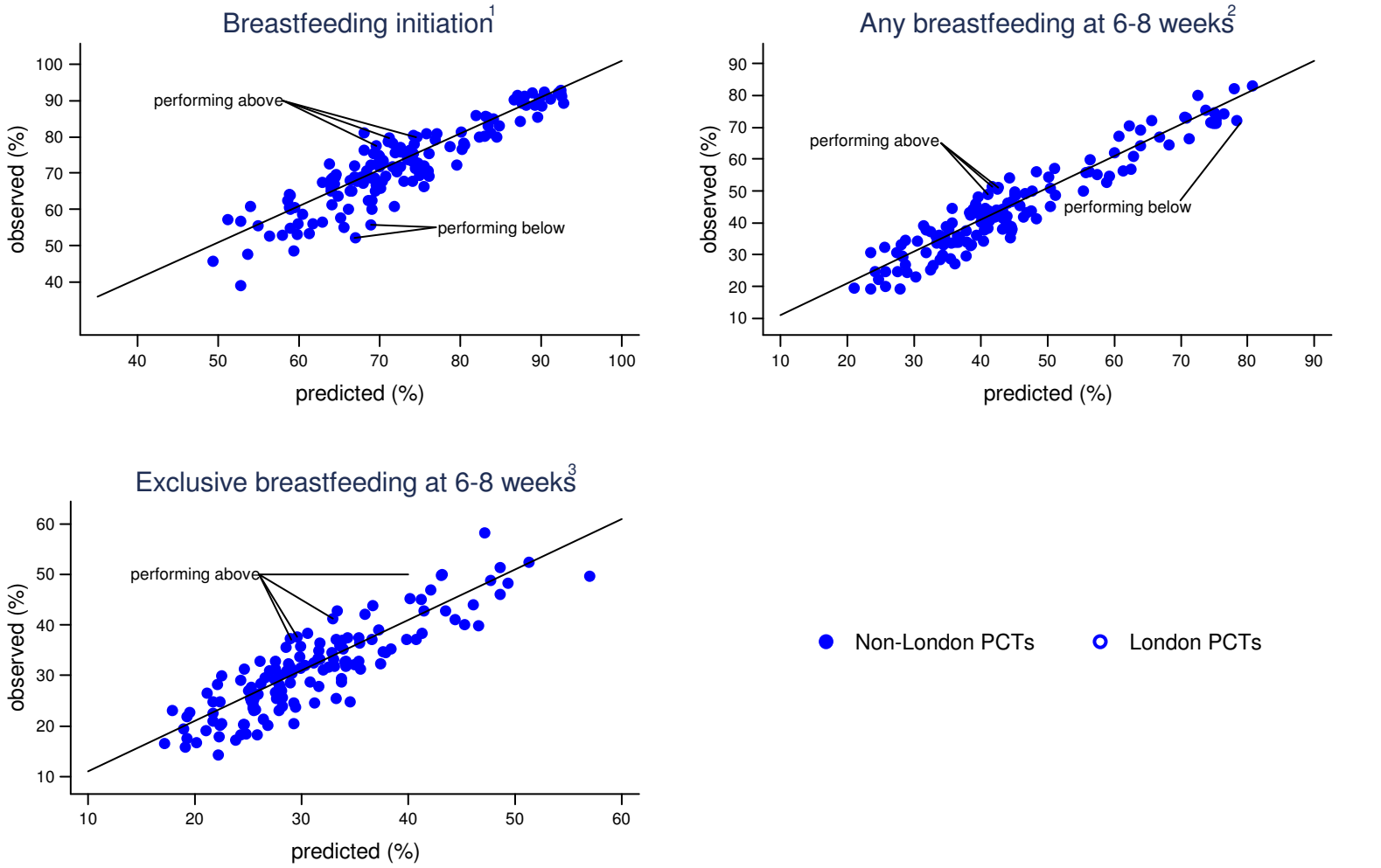
Table 3. Socio-demographic factors associated with PCT level breastfeeding: univariable and multivariable models for London PCTs

LONDON PCTS	% INITIATING BREASTFEEDING (n=29)				% ANY BREASTFEEDING AT 6-8 WEEKS (n=27)				% EXCLUSIVE BREASTFEEDING AT 6-8 WEEKS (n=27)			
	UNADJUSTED		ADJUSTED[1]		UNADJUSTED		ADJUSTED[2]		UNADJUSTED		ADJUSTED[3]	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Index of Multiple Deprivation												
Quintile 1 (least deprived)	1.00		1.00		1.00				1.00			
Quintile 2	0.61	(0.35-1.04)	1.31	(0.94-1.84)	0.70	(0.43-1.15)			0.63*	(0.35-0.93)		
Quintile 3	1.22	(0.71-2.10)	1.38*	(1.03-1.85)	1.39	(0.85-2.28)			1.07	(0.72-1.57)		
Quintile 4	1.34	(0.75-2.37)	1.46*	(1.06-2.00)	1.48	(0.88-2.50)			0.95	(0.62-1.43)		
Quintile 5 (most deprived)	1.10	(0.69-1.75)	1.71***	(1.30-2.25)	1.18	(0.76-1.84)			0.82	(0.58-1.17)		
% mothers aged 35+	1.05***	(1.03-1.08)	1.04***	(1.02-1.06)	1.04**	(1.02-11.07)	1.06***	(1.04-1.07)	1.05***	(1.03-1.06)	1.06***	(1.04-1.07)
% mothers aged <20	0.79**	(0.68-0.92)			0.79**	(0.69-0.91)			0.82***	(0.74-0.91)		
% population BME	1.02*	(1.00-1.03)			1.03***	(1.01-1.04)	1.03***	(1.03-1.04)	1.01	(1.00-1.02)		
% mothers smoking at delivery	0.88***	(0.84-0.91)	0.90***	(0.87-0.94)	0.88***	(0.84-0.91)			0.92***	(0.89-0.95)	0.95**	(0.92-0.98)

*p <0.05 **p <0.01 ***p <0.001

[1]Variables in model: IMD, % births to older mothers, % smoking at delivery
[2]Variables in model: % of births to older mothers, % population BME
[3]Variables in model: % of births to older mothers, % smoking at delivery

Figure 2. Observed vs. predicted proportions of any breastfeeding at 6-8 weeks



N.B. In some cases PCTs classified as potential outliers reported similar breastfeeding figures to PCTs not identified as potential outliers: this discrepancy is due to differences in PCT size.

[1]Performing above: Hampshire, Sheffield, Somerset. Performing below: Dudley, Sefton.

[2]Performing above: Devon, Leeds, Sheffield. Performing below: Brent.

[3]Performing above: City and Hackney, Devon, Leeds, Sheffield

Supplementary tables

Table S1. Breastfeeding outcomes by socio-demographic variables

	% INITIATING BREASTFEEDING AT BIRTH		% ANY BREASTFEEDING AT 6-8 WEEKS		% EXCLUSIVE BREASTFEEDING AT 6-8 WEEKS	
	mean (sd)	min,max	mean (sd)	min,max	mean (sd)	min,max
Index of Multiple Deprivation						
Quintile 1 (least deprived)	77.8 (5.5)	67.7, 91.5	52.7 (9)	38.8, 72.1	37.8 (5.9)	28.8, 49.9
Quintile 2	73.5 (6.2)	60.8, 91.2	44.7 (9.1)	33.3, 72.8	32.2 (5)	23.3, 42.9
Quintile 3	72.8 (11.5)	52.2, 92.2	44.7 (16.2)	25.2, 83.1	31.5 (9.6)	18.2, 57.5
Quintile 4	67.2 (12.4)	48.6, 91.9	40.4 (17.6)	19.2, 82.2	28.4 (10.5)	14.3, 58.2
Quintile 5 (most deprived)	69.6 (15.1)	39, 92.9	44.2 (18.5)	19.2, 80.1	28.3 (9.9)	15.9, 50
% mothers aged 35+						
<15%	60.5 (8.2)	39, 73.6	31.5 (7.7)	19.2, 50.9	23.2 (4.8)	14.3, 32.8
15-<20%	69.8 (8)	52.2, 88.9	41 (9.3)	23.1, 71.7	28.8 (5.6)	17.2, 42.2
20-<25%	78.1 (6.2)	67.7, 92.1	51.6 (11)	35.2, 80.1	35.5 (5.2)	24.9, 50
≥25%	86.5 (5.9)	76, 92.9	67.2 (10.5)	50.1, 83.1	45.5 (6.6)	34.7, 58.2
% mothers aged <20						
<3%	87.7 (4.2)	79.9, 92.2	70.3 (7.8)	54.8, 83.1	44.5 (7.1)	32.1, 57.5
3-<6%	76.5 (7.7)	53.4, 92.9	50.3 (11.5)	26.7, 80.1	34.5 (7.5)	18.3, 58.2
6-<8%	68 (7.9)	39, 81.1	38.4 (6.9)	19.2, 51.4	28.7 (5.1)	15.9, 38.4
≥8%	59.3 (7.2)	45.8, 76.3	30.2 (6.8)	19.2, 45.9	22.3 (4.6)	14.3, 32.8
% population BME						
<10%	65.9 (9.8)	39, 81.1	35.4 (9)	19.2, 54	27.2 (6.9)	14.3, 42.7
10-<20%	71.2 (8.1)	47.6, 85.5	43.8 (9.5)	24.7, 70.5	31.7 (7.7)	17.9, 58.2
20-<40%	77.1 (10.2)	56.5, 92.2	53.4 (15)	29.5, 82.2	33.9 (10.2)	18.5, 51.5
≥40%	87 (6.7)	66.4, 92.9	71.3 (6.7)	56.1, 83.1	42.5 (7.6)	32.1, 57.5
% mothers smoking at delivery						
<10%	85.6 (5.8)	72.3, 92.9	66.7 (9.2)	50.1, 83.1	42.4 (6.7)	31.6, 58.2
10-<15%	73.4 (5.6)	55, 80.9	45.3 (7)	29.9, 61.9	31.8 (5.6)	20.2, 43.8
15-<20%	67.3 (6.7)	52.2, 79.7	37.9 (7)	23.1, 56.1	27.7 (5.7)	17.2, 42.7
>20%	59.6 (9.1)	39, 81.1	30.5 (7.3)	19.2, 44.6	23.4 (5)	14.3, 31

Table S2. Observed and predicted breastfeeding: data for all primary care trusts

PRIMARY CARE TRUST	BREASTFEEDING INITIATION			ANY BREASTFEEDING AT 6-8 WKS			EXCL. BREASTFEEDING AT 6-8 WEEKS		
	O	P	SR	O	P	SR	O	P	SR
NORTH EAST									
County Durham	56	59.9	-0.86	26.9	28.7	-0.49	20.5	22.5	-0.63
Darlington	60.2	66.1	-0.67	33.7	33.3	0	25.1	25.4	-0.11
Gateshead	67.5	62.9	0.7	37.9	31.9	0.94	31.4	24.6	1.16
Hartlepool	45.8	49.3	-0.35	19.5	21	-0.23	16.6	17.2	-0.14
Middlesbrough	47.6	53.6	-0.81	24.7	25.7	-0.2	21.8	19.3	0.41
Newcastle	62.4	68.6	-1.13	42.1	40.5	0.27	32.3	28.8	0.67
North Tees	57.7	65.1	-1.09	25.2	32.5	-1.25	20.3	24.6	-0.83
North Tyneside	60	69	-1.4	34	36.6	-0.44	28.3	27.9	0.01
Northumberland	62.5	69	-1.13	35.8	36.5	-0.16	30.8	28.7	0.36
Redcar and Cleveland	52.7	56.3	-0.41	20.1	25.6	-0.83	16.8	20.2	-0.58
South Tyneside	52.9	57.9	-0.61	24.8	27.5	-0.44	19.1	21	-0.36
Sunderland Teaching	53.1	59.8	-1.09	24.5	29	-0.9	20.1	22.4	-0.54
NORTH WEST									
Ashton, Leigh and Wigan	56	61.7	-1.04	23.1	30.3	-1.57	17.2	23.8	-1.59
Blackburn with Darwen	72.6	63.7	1.27	32.9	38.5	-0.91	24.2	25.4	-0.28
Blackpool	56.8	52.7	0.48	24.7	24.1	0.05	19.4	18.9	0.02
Bolton	67	64.4	0.49	33.7	35.6	-0.44	27.8	25.3	0.51
Bury	69.2	70.7	-0.24	40.2	40.1	-0.02	30.5	29.1	0.2
Central and Eastern Cheshire	67.7	74	-1.44	38.8	44.6	-1.37	28.8	33.7	-1.24
Central Lancashire	66.9	69.5	-0.61	33.9	37.9	-0.98	23.9	28.2	-1.17
Cumbria	67.7	67.1	0.13	28.6	33.9	-1.13	21.4	26.4	-1.17
East Lancashire	68.3	63.9	0.91	35.7	34.5	0.22	27.1	25	0.47
Halton and St Helens	48.6	59.3	-1.9	19.2	28	-1.89	14.3	22.2	-1.89
Heywood, Middleton and Rochdale	60.6	58.8	0.29	39.2	31.4	1.39	24.7	22.3	0.45
Knowsley	39	52.8	-1.76	19.2	23.5	-0.74	15.9	19.1	-0.62
Liverpool	53.4	61.3	-1.55	26.7	32.8	-1.59	18.3	24.3	-1.74
Manchester	68.3	67.4	0.24	42.1	43.9	-0.52	25.7	28.2	-0.83
North Lancashire	68.6	69.3	-0.12	37.6	37.8	-0.07	30.5	28.7	0.3
Oldham	66.2	63.9	0.38	34.1	36.2	-0.44	20.3	24.6	-0.98
Salford	64.2	58.8	0.94	34.3	30.5	0.72	29.9	22.5	1.58
Sefton	**55.8**	**68.9**	**-2.17**	27.1	36.1	-1.58	23	27.9	-0.97
Stockport	73.2	74.2	-0.2	46.9	44.7	0.36	35.9	33.5	0.41
Tameside and Glossop	61.2	64	-0.47	35.6	33.9	0.22	25	25.3	-0.1
Trafford	76.6	80.2	-0.7	50.1	55.4	-0.95	37.1	40.7	-0.69
Warrington	60.8	71.8	-1.77	34.2	40.4	-1.03	24.6	31.2	-1.2
Western Cheshire	69.5	74.9	-0.92	35.2	44.4	-1.09	24.9	34.6	-1.23
Wirral	55	65.5	-1.7	29.9	34.3	-0.93	20.2	26.8	-1.52
YORKSHIRE AND THE HUMBER									
Barnsley	62.5	58.6	0.63	30.8	27.5	0.51	24.8	21.7	0.5
Bradford and Airedale	69.7	64.6	1.42	39.7	40.4	-0.25	26.3	25.9	0.07
Calderdale	78.4	71.5	1.14	40.5	41.1	-0.14	31.6	29.9	0.24
Doncaster	63.9	58.9	0.91	29.6	28.1	0.27	21.1	21.7	-0.22
East Riding Of Yorkshire	70.4	72.1	-0.3	42.2	42.1	-0.02	33.2	31.6	0.22
Hull	57.2	51.1	1.09	30.6	23.5	1.58	23.1	17.8	1.29
Kirklees	73.8	70.2	0.85	40.7	41.4	-0.19	26.9	28.1	-0.37
Leeds	72.2	68.9	1.05	**48.8**	**41.1**	**2.51**	**37.3**	**29**	**2.95**
North East Lincolnshire	55.5	54.9	0.08	22.2	24.7	-0.45	17.6	19.2	-0.37
North Lincolnshire	58.6	60.4	-0.22	33.2	28	0.74	26.5	21.2	0.83
North Yorkshire and York	73.6	73.5	0.05	-	-	-	-	-	-
Rotherham	60.1	58.9	0.19	29.3	28.3	0.15	22.6	21.7	0.12

PRIMARY CARE TRUST	BREASTFEEDING INITIATION			ANY BREASTFEEDING AT 6-8 WKS			EXCL. BREASTFEEDING AT 6-8 WEEKS		
	O	P	SR	O	P	SR	O	P	SR
Sheffield	**77.6**	**69.5**	**2.06**	**51.4**	**41.7**	**2.44**	**37.7**	**29.6**	**2.22**
Wakefield District	60.6	59.4	0.22	34.5	28.7	1.28	28.3	22.1	1.48
EAST MIDLANDS									
Bassetlaw	68.9	66.8	0.2	36.1	33.8	0.23	28.4	26.1	0.23
Derby City	71.8	70	0.34	38.3	41.1	-0.59	27.9	28	-0.06
Derbyshire County	72.8	70.4	0.66	42.4	38.5	1.04	35.7	29.9	1.7
Leicester City	73.6	70.4	0.74	50.9	50.4	0.08	31.9	30.3	0.35
Leicestershire County and Rutland	72.8	74.7	-0.52	43.1	46.9	-1.05	32.9	34.1	-0.38
Lincolnshire	72.1	66.8	1.45	38.9	34.8	1.17	29.6	26.5	0.93
Northamptonshire	75.9	72.6	1.03	44.3	43.3	0.25	33.4	31.5	0.57
Nottingham City	68.9	64.5	0.91	45.9	39.2	1.42	32.8	26	1.6
Nottinghamshire County	71.8	71.5	0.08	37.7	40.5	-0.81	28.8	30.8	-0.68
WEST MIDLANDS									
Birmingham East and North	65.2	66.5	-0.32	41.8	42.1	-0.14	26.7	27.6	-0.31
Coventry Teaching	75	69.8	1.11	38.1	44.7	-1.49	24.6	29.3	-1.19
Dudley	**52.2**	**66.9**	**-2.74**	28.7	35.4	-1.38	18.2	25.8	-1.73
Heart Of Birmingham Teaching	72.3	79.5	-1.91	-	-	-	-	-	-
Herefordshire	-	-	-	-	-	-	-	-	-
North Staffordshire	67.2	67.9	-0.1	39.9	35.7	0.48	31.4	27.6	0.47
Sandwell	56.5	62.9	-1.31	29.5	37.8	-1.89	18.5	24.7	-1.65
Shropshire County	74	73.4	0.11	42.2	42.2	-0.04	33.2	33	-0.02
Solihull Care Trust	69.2	76.1	-1.19	41.3	48.3	-0.97	31.2	35.5	-0.66
South Birmingham	68.9	67.7	0.26	44.1	42.3	0.35	28.6	28.9	-0.13
South Staffordshire	65.8	70.1	-1.1	33.3	38.5	-1.41	23.7	29.4	-1.67
Stoke On Trent	60.8	53.9	1.09	32.3	25.5	1.45	22.8	19.5	0.75
Telford and Wrekin	65.1	66.3	-0.17	33.2	34.4	-0.23	23.5	25.4	-0.38
Walsall Teaching	54.8	58.8	-0.7	30.6	31.8	-0.29	17.9	22.2	-1.05
Warwickshire	71.4	74.3	-0.77	41.9	46.4	-1.14	29.4	33.7	-1.18
Wolverhampton City	65.2	64	0.22	36	39.3	-0.67	23.1	25.5	-0.57
Worcestershire	73.9	73.7	0.07	41.5	43.3	-0.49	31.9	33.1	-0.38
EAST OF ENGLAND									
Bedfordshire	75.4	76.1	-0.16	45.2	50.3	-1.21	32.9	35.4	-0.64
Cambridgeshire	80.9	77	1.14	57.1	51	1.34	43.8	36.7	1.64
Great Yarmouth and Waveney	63.7	64.8	-0.17	37.1	32.4	0.7	29.1	24.3	0.79
Hertfordshire	-	-	-	-	-	-	-	-	-
Luton	66.4	75.4	-1.79	56.1	56.3	-0.07	32.7	34	-0.32
Mid Essex	71.6	75.3	-0.82	43.7	47.5	-0.74	32.2	34.9	-0.6
Norfolk	75.6	71.8	1.06	43.8	41.2	0.7	32.6	31.1	0.39
North East Essex	72.9	69.8	0.58	42.9	39.7	0.58	31.6	28.9	0.52
Peterborough	65.1	69.4	-0.65	43.8	40.6	0.44	29.3	27.4	0.26
South East Essex	73.3	74	-0.16	37.3	44.6	-1.38	25.5	33.3	-1.6
South West Essex	67.7	73	-1.28	-	-	-	-	-	-
Suffolk	71.8	72.5	-0.18	46.3	44	0.55	36.4	31.7	1.24
West Essex	-	-	-	-	-	-	-	-	-
LONDON									
Barking and Dagenham	70.7	75.9	-1.34	48.6	52.8	-0.61	20.5	27.6	-1.16
Barnet	91.2	87.9	1.54	72.8	69.6	0.87	42.9	42.3	0.09
Bexley Care Trust	73.4	74	-0.08	50.1	46.5	0.7	35.6	30.1	1.04
Brent Teaching	85.5	89.5	-1.84	**71.4**	**78.9**	**-2.39**	41.1	41.8	-0.2
Bromley	83	83.4	-0.07	52.8	58	-1.21	34.7	41.9	-1.65
Camden	90.4	91.1	-0.21	74.2	77	-0.63	48.4	47.7	0.1
City and Hackney Teaching	92.1	88.8	1.44	80.1	73.8	1.81	**50**	**40**	**2.37**
Croydon	85.9	81.9	1.57	67.3	64.3	0.87	37.1	35	0.54

PRIMARY CARE TRUST	BREASTFEEDING INITIATION			ANY BREASTFEEDING AT 6-8 WKS			EXCL. BREASTFEEDING AT 6-8 WEEKS		
	O	P	SR	O	P	SR	O	P	SR
Ealing	-	-	-	-	-	-	-	-	-
Enfield	90.3	86.7	1.56	64.6	66.8	-0.48	34.6	38.6	-0.86
Greenwich Teaching	79.8	82.3	-0.76	61.9	59.5	0.6	37.4	32.8	1.07
Hammersmith and Fulham	91.9	92.4	-0.11	82.2	74.7	1.66	51.5	49.5	0.32
Haringey Teaching	92.3	90.4	0.91	72.3	76.3	-0.94	44	42.6	0.22
Harrow	84.9	84	0.32	69.2	72.1	-0.52	45.1	40.4	0.73
Havering	67.7	70.3	-0.53	38.1	41.2	-0.52	23.3	27.7	-0.83
Hillingdon	77.3	78.7	-0.36	55.9	57.9	-0.45	31.6	32.7	-0.27
Hounslow	85.6	83	0.96	64.1	65.6	-0.3	42.2	35.3	1.36
Islington	88.7	89.2	-0.12	73.2	74.8	-0.33	48.9	42.3	1.19
Kensington and Chelsea	-	-	-	-	-	-	-	-	-
Kingston	91.5	87	1.38	72.1	66.7	1.09	49.9	46.2	0.6
Lambeth	92.9	92.4	0.25	-	-	-	-	-	-
Lewisham	88.4	90	-0.62	74.6	71.1	0.98	47	41.7	1.21
Newham	84.3	87.4	-1.38	-	-	-	-	-	-
Redbridge	83.1	84.8	-0.45	67	68.1	-0.25	32.3	37.5	-1.17
Richmond and Twickenham	91.3	92.5	-0.43	71.3	78	-1.55	49.6	57.4	-1.46
Southwark	90.5	89.8	0.37	75.3	72.6	0.8	42.8	43.6	-0.21
Sutton and Merton	79.9	84.5	-1.87	61	61.6	-0.16	39.1	41.9	-0.79
Tower Hamlets	88.9	88.2	0.35	71.7	67.6	1	32.1	36.8	-1.09
Waltham Forest	89.3	87.6	0.71	66.5	68.8	-0.53	35.2	37.5	-0.53
Wandsworth	92.2	92.1	0.1	72	73.8	-0.44	46	49.9	-0.88
Westminster	89.2	92.8	-1.29	83.1	79.2	0.94	52.4	50.8	0.25
SOUTH EAST COAST									
Brighton and Hove City	85.5	83.3	0.49	70.5	62.2	1.47	58.2	47.1	1.95
E Sussex Downs and Weald	80.9	75.8	1.01	49.3	46.6	0.45	36.5	35.4	0.17
Eastern and Coastal Kent	70.7	68.4	0.67	-	-	-	-	-	-
Hastings and Rother	76.3	68	1.14	43.2	38.3	0.66	30.9	28.6	0.3
Medway	67.9	66.3	0.29	37.9	35.1	0.52	25.5	25.2	0.01
Surrey	81.2	83.7	-1.15	56.8	62.6	-1.59	39.9	46.6	-1.82
West Kent	71.9	75.4	-1.07	-	-	-	-	-	-
West Sussex	-	-	-	-	-	-	-	-	-
SOUTH CENTRAL									
Berkshire East	81.2	80	0.33	54.8	59.2	-0.98	37.2	39.8	-0.63
Berkshire West	77.9	80.5	-0.77	55.1	57.4	-0.55	38.4	41.3	-0.73
Buckinghamshire	80.2	83	-0.85	56.3	61.4	-1.36	40	45.3	-1.42
Hampshire	**79.9**	**74.5**	**2.15**	45.5	45.9	-0.19	31.8	34.2	-1
Isle Of Wight NHS	81.1	68	1.45	44.6	35.7	0.96	31	26.9	0.45
Milton Keynes	75.4	74.1	0.27	55.9	48.3	1.46	34.6	32.9	0.31
Oxfordshire	78.3	80.4	-0.69	59.8	56.4	0.92	45	41.2	1.05
Portsmouth City Teaching	75.4	69.3	1	43.6	39.1	0.7	32.8	27.6	0.91
Southampton City	74.6	69.9	0.89	44.6	40.7	0.59	30.1	28	0.33
SOUTH WEST									
Bath and NE Somerset	-	-	-	-	-	-	-	-	-
Bournemouth and Poole	76.2	72.4	0.67	50.7	42.4	1.63	35	31.6	0.68
Bristol	79.3	76.9	0.67	54.3	50.2	0.99	37.5	35.3	0.53
Cornwall and Isles Of Scilly	78.8	71	1.85	44.4	38.8	1.29	33.8	29.8	0.97
Devon	75.9	73.4	0.7	**51.1**	**42.6**	**2.22**	**41.3**	**32.9**	**2.33**
Dorset	76.4	73.7	0.51	54	44.3	1.75	42.7	33.4	1.79
Gloucestershire	75.8	73.7	0.56	49	45	0.99	37.2	33.2	1.05
North Somerset	78	74.2	0.58	48.7	45.2	0.49	35.3	33.9	0.16
Plymouth Teaching	68.8	68.8	-0.01	35	36.9	-0.4	25.5	27.6	-0.5
Somerset	**79.7**	**71.1**	**2.07**	48	39.6	1.98	38.4	30.5	1.97

PRIMARY CARE TRUST	BREASTFEEDING INITIATION			ANY BREASTFEEDING AT 6-8 WKS			EXCL. BREASTFEEDING AT 6-8 WEEKS		
	O	P	SR	O	P	SR	O	P	SR
South Gloucestershire	77	72.5	0.79	43.5	43.2	0.01	31.1	32	-0.23
Swindon	75.9	72.7	0.56	40.3	43.7	-0.45	27.9	31.6	-0.55
Torbay Care Trust	68.6	64.1	0.52	35.9	33.3	0.25	25.3	25.5	-0.09
Wiltshire	80.3	74.2	1.47	49.9	45.1	0.96	37.1	33.8	0.68

O = observed percentage (%), P = predicted percentage (%), SR = standardised residuals (number of)

N.B. Observed figures presented in this table may differ slightly from DH annual outturn percentages, as we used quarterly actual data in our calculations.

Factors associated with breastfeeding: an area-based analysis (FAB)
Project protocol

A. Project summary

To measure the effects of breastfeeding interventions and socio-demographic factors on area-based breastfeeding rates.

The specific objectives are to:

1. Collate area-based data on breastfeeding prevalence at 6-8 weeks, socio-demographic factors and breastfeeding interventions
2. Use these data to identify predictors of variation between areas in breastfeeding prevalence at 6-8 weeks
3. Use individual level data to measure the demand for breastfeeding services
4. Monitor changes over time in breastfeeding prevalence and interventions, and evaluate the implementation of any subsequent changes in service.

Methods

Babies who are not breastfed have poorer health in infancy and childhood. Breastfeeding is recognised as a key indicator of the success of public health policies according to the new public health outcomes framework. Area-based data on breastfeeding rates at 6-8 weeks and socio-demographic factors (e.g. maternal age, ethnicity, deprivation) are routinely available; currently these are PCT-based but it is envisaged that these will become available for local authority areas. Data on breastfeeding interventions (e.g. Baby Friendly accreditation, number of breastfeeding counsellors, weekly opening hours of clinics/cafes) will be obtained from the relevant organisations. Data on local area-based breastfeeding initiatives will be obtained from the appropriate bodies. Data on other relevant interventions will be obtained e.g. Family Nurse Partnership sites. An Advisory Group with representatives from the NHS and breastfeeding organisations will ensure that all key data on breastfeeding support are collected. Area-level data will be summarised using descriptive statistics, graphs, and if appropriate using an atlas. Predictors of variation by area will be identified using regression models. The demand for breastfeeding services will be assessed using data from the Infant Feeding Surveys (2005, 2010) and the National Maternity Survey 2010.

B. Co-investigators

The co-investigators are: Maria Quigley, Laura Oakley, Jenny Kurinczuk (NPEU, Oxford), Mary Renfrew (MIRU, York). In addition, an Advisory Group will be formed.

C. Data collection including downloading data

Much of the data required for the project is available in the public domain. However it is envisaged that some primary data collection will be necessary.

For objective (2) (to identify predictors of variation between areas in breastfeeding prevalence at 6-8 weeks), the key data items are:

- **Outcome** i.e. breastfeeding prevalence at 6-8 weeks. Our primary outcome is the prevalence of any BF at 6-8 weeks but we will also look at exclusive (total) breastfeeding at 6-8 weeks and BF initiation.
- **Exposure** i.e. breastfeeding support. There are many possible services to consider (e.g. Baby Friendly accreditation, number of breastfeeding counsellors, weekly opening hours of clinics/cafes) and we need to decide which ones to focus on and how to "measure" the service (e.g. number of FTE staff or number of hours/days a service is available). Some things to consider are:
  - Which services are likely to have the strongest effect on BF rates.
  - Is it possible to focus on a few "key" services or do we need to be as inclusive as possible.
  - Changing services over time, particularly with the new government.
  - Retrospective versus current data.
  - NHS services versus voluntary organizations.
  - How easy is it to access the data e.g. some data is available on Chi-mat.

- **Socio-demographic factors** e.g. mother's age, ethnicity, area-based deprivation measures, etc.

- **Other potential confounders** e.g. number of births (in the PCT), rates of caesarean section, LBW, etc.

- **Health outcomes** – we could look at the association between BF at 6-8 weeks and health outcomes, and the association between BF support and health outcomes.

Table 1 shows the potential data items for the project which are already available in the public domain. Note that most of these variables are available at the PCT level (n=152 PCTs); some are also available at other levels e.g. local authority. The data items in Table 1 are probably sufficient for our outcomes (breastfeeding and also the health outcomes, if we decide to include these) and our confounders (socio-demographic and other factors). However, there are only limited data items on breastfeeding support. It should be noted that for 2009, detailed data on breastfeeding support is available for the 31 London PCTs; this was collected as part of the London mapping project which Mary Renfrew led.

We may want to do some preliminary analysis to help us decide how much additional primary data collection is necessary. For example, preliminary analysis of the Chi-mat data for all 152 PCTs and for the 31 London PCTs may help us identify what (if any) additional

data items need to be collected. We may also be able to add additional data easily (e.g. NCT, Baby Cafes?). If this analysis shows that (some of) the data items on BF services looks like they might be associated with BF rates then it would be worth doing primary data collection for these variables e.g. write to all PCTs.

For objective (3) (use individual level data to measure the "demand" for breastfeeding services), the Infant Feeding Surveys (2005, 2010) and the National Maternity Survey 2010 will be used e.g. IFS 2005, did anyone show you how to put baby to the breast and how useful was this or would you have liked help on this; while you were in hospital did you get enough help or advice with feeding problems.

Objective (4) (monitor changes over time and evaluate changes in service) will be planned once Objective 2 is finalised.

D. Proposed timeline (subject to decisions about preliminary analysis/primary data collection)

1. Planning and scoping phase (April – August 2011)

- Draft the study protocol
- Identify the key sources of routine data

2. Exploring existing data (September 2011 – February 2012)

- Start exploring existing data (what's there, what's missing, mapping; download relevant data):
    - DH BF rates
    - Chimat/similar
    - BFI
    - NCT and Baby cafes
    - Other sources e.g. Sure Start, FNP, Child Centres, Little Angels, BF Network
    - DH PCT data and progress reports
    - National Maternity Survey and Infant Feeding Surveys
- Identify and write to Advisory Group
- To conduct analysis using retrospective data – useful as a pilot, to check data quality, to look at effectiveness of previous interventions and trends over time)

3. Data collection (March – July 2012)

- 1st Advisory Group meeting (early 2012) – to discuss what data are available and data quality, and to agree whether further data needs to be collected and how
- Finalise list of data sources (much data will already exist and be accessible; some primary data collection is likely e.g. writing to local authorities/BF co-ordinators for localised BF initiatives)
- Download any relevant datasets

- Produce sampling frame and contact details for primary data collection
- Design simple data collection form to collect information on BF interventions
- Send out data collection forms (with reminders etc)
- Enter data collection forms

4. Data analysis (March - Dec 2012; note that some of this can be started before the data collection is complete)

- 2nd Advisory Group meeting (autumn 2012) – to describe what data has been collected e.g. completeness, quality, response rates
- Data management and cleaning - merge all relevant datasets, check and clean data.
- Descriptive data analysis – data quality, completeness, crude BF rates, crude data (and mapping) for BF interventions and confounders. Use maps and atlas as appropriate
- Regression models

5. Writing up and dissemination (end 2012 – early 2013)

- 3rd Advisory Group meeting (end 2012) – to present key findings and get relevant input on interpretation and dissemination
- Conference/other appropriate forum
- Liaise with local authorities/other relevant groups regarding appropriately targeted dissemination
- Journal article (s)

Table 1 Potential PCT-level data items available

Data item	Source of data
Breastfeeding	
% BF initiation	DH (Local delivery plan return)
% BF (exclusive or partial) at 6-8 weeks	DH (Local delivery plan return)
% "totally" BF (i.e. EBF) at 6-8 weeks	DH (Local delivery plan return)
% partially BF at 6-8 weeks	DH (Local delivery plan return)
Socio-demographic and clinical confounders	
IMD	Dept for communities & local gov
No. births	ONS
% CS	HES
% mothers aged 35+	HES
% mothers aged <20	HES
% smoking at time of delivery	Local delivery return plan
% LBW	ONS
% population BME (census-derived)	ONS
Maternal ethnicity	HES (applied for)
Health outcomes	
Infant mortality rate	ONS
Hospital adm rate for gastroenteritis, under 1 yr	HES
Hospital adm rate for RTI, under 1 yr	HES
Breastfeeding support/services	
BFI accreditation	UNICEF
No. FTE health visitors	Annual NHS workforce census
Breastfeeding support/services	
Available in 2009 for 31 London PCTs only:	
Infant Feeding lead WTE per 3000 births	
Staff dedicated to provision of BF services WTE	
No. BF services	
No. BF services in antenatal period	
No. BF services to hospital discharge	
No. BF services in community (postnatal)	
No. BF services with trained peer support	
No. services targeted to priority pop groups	
No. services planned/under evaluation	

FAB data analysis plan (objective 2)

Agreed by co-investigators June 2012

Note added 06.02.13
This data analysis plan is attached as a supplementary file for the paper submitted to the BMJ "Factors associated with breastfeeding in England: an analysis by primary care trust". The submitted paper covers the analysis of objective 2a as described in this analysis plan. Anything in this analysis plan which specifically relates to objective 2b should be ignored.

1. Aims and objectives

The overall objectives of the FAB project as described in the project protocol are to:

1. Collate area-based data on breastfeeding prevalence at 6-8 weeks, socio-demographic factors and breastfeeding interventions
2. Use these data to identify predictors of variation between areas in breastfeeding prevalence at 6-8 weeks
3. Use individual level data to measure the demand for breastfeeding services
4. Monitor changes over time in breastfeeding prevalence and interventions, and evaluate the implementation of any subsequent changes in service.

This data plan covers the analyses planned to address objective 2 (to use data to identify predictors of variation between areas in breastfeeding prevalence). We will address the following specific objectives as part of objective 2:

a. To identify socio-demographic predictors of variation between areas in breastfeeding rates
b. To measure the effect of a specific breastfeeding intervention (the Baby Friendly Initiative) on area-based breastfeeding rates
c. To measure the effect of other indicators of breastfeeding support on area-based breastfeeding rates

The first two objectives (objectives 2a and 2b) are covered in this analysis plan. The inclusion of other indicators of breastfeeding support (objective 2c) will be agreed after primary data collection has been planned.

2. Design

This is an ecological (area-based study) study making use of routine aggregate data. A subsequent phase may involve primary data collection and will address the third objective (objective 2c) of this study.

3. Variables

3.2 Definition of outcomes

The primary outcome is breastfeeding prevalence ('any breastfeeding') at 6-8 weeks. Secondary outcomes are the prevalence of exclusive ('total') breastfeeding at 6-8 weeks and initiation of breastfeeding

Information on breastfeeding status at 6-8 weeks (breastfeeding prevalence) is collected by the GP or HV conducting the routine 6-8 week infant check and reported by PCTs to the Department of Health (DH) as part of the of the Vital Signs Monitoring Return programme (VSMR). Infants exclusively breastfed are those who are receiving breast milk and "NOT receiving formula milk, any other liquids or food". The proportion 'any breastfeeding' comprises those infants

who are totally breastfed or who are receiving some breast milk in addition to other milk, liquids or food. The denominator for this outcome is the number of infants due a 6-8 week check.

Data on breastfeeding initiation is typically collected by midwives in acute trusts and again forms part of the VSMR. In this case, breastfeeding initiation is defined as the "mother…having initiated breastfeeding if, within the first 48 hours of birth, either she puts the baby to the breast or the baby is given any of the mothers breast milk". The denominator for this outcome is the number of maternities.

A third secondary outcome – drop off in breastfeeding between initiation and 6-8 weeks – may also be included.

Data on breastfeeding prevalence at 6-8 weeks and breastfeeding initiation are reported quarterly by PCTs. All outcome data used in this analysis will relate to the time period April 2010-March 2011 (2010-11 quarters 1-4).
The DH releases PCT level figures where the data pass validation checks and meets a minimum level of data coverage. Coverage is defined as the percentage of infants due a 6-8 week check for whom a breastfeeding status was recorded (breastfeeding prevalence), or as the percentage of maternities for which an initiation status was recorded (breastfeeding initiation). DH requires coverage to be a minimum of ≥90% (breastfeeding prevalence quarters 1-3) or ≥95% coverage (breastfeeding initiation, breastfeeding prevalence quarter 4 only). PCTs will therefore only be included in the analysis if they meet these criteria.

3.3 Definition of socio-demographic factors (objective 2a)

The following potential socio-demographic factors have been identified and will be included in the analysis as appropriate: area-based deprivation, ethnicity, maternal age and maternal smoking. All are available at the PCT level.

Deprivation

The area-based deprivation indicator to be used is the Index of Multiple Deprivation (IMD) 2010. This index measures a broad concept of deprivation and is derived from census variables and other more recent data sources. A total of 38 different indicators are aggregated into seven domains: income; employment; health and disability; education, skills and training; barriers to housing and services; living environment; and crime. These indicators are weighted and combined to calculate a final IMD 'raw' score. A high score indicates greater deprivation. The IMD is calculated at Lower Super Output Area (LSOA), of which there are 32,482 in England. This analysis makes use of a dataset which reports IMD 2010 score at the PCT level.

Ethnicity

Two different ethnicity variables have been identified for use, both reflecting the proportion from a Black and Minority ethnic (BME) background, defined in this case as non-White British. The first measure estimates the percentage of the *overall* PCT population from BME backgrounds (PEEG - Population Estimates by Ethnic Group). The estimate is derived from the 2001 Census and is calculated by the Office for National Statistics (ONS) using a cohort component methodology taking into account births, deaths, and migration to and from the area. Estimates for 2009 are the most recently available figures and are used in this analysis. The second measure summarises the proportion of women from a BME background who delivered in the given time period (2010-11). These figures are taken from HES data. Although the latter variable is most pertinent as it relates to the maternity population, there is some concern about the level of missing data. For this reason we will include both variables in descriptive analysis, and will adjust for the one which changes the effect measures the most, provided the level of missing data or accuracy of data is not an issue.

Maternal age

We will include two indicators of births by maternal age as covariables: the percentage of mothers aged <20 and the percentage of mothers aged ≥35. These data are drawn from HES delivery episode data and are available from ChiMat at PCT level for the year 2009-10.

Smoking

Smoking status is collected at the time of delivery and is reported as the percentage of women giving birth who are current smokers at the time of delivery. This is another data item included in the VSMR and the data for 2010-11 are used in this analysis.

3.3 Definition of the Baby Friendly Initiative (objective 2b)

The explanatory factors for objective 2b are Baby Friendly Initiative (BFI) status in the hospital (acute trust) and BFI status in the community.

BFI status comprises of multiple categories. As hospitals or community organisations move through the pathway to full accreditation they pass through the following milestones and awards: register of intent, certificate of commitment, stage 1, stage 2, before finally achieving full accreditation (stage 3).

BFI status will be measured at April 2010 to reflect status at the beginning of the period of outcome measurement. In the vast majority of cases, community BFI status relates directly to the same geographical area (PCT) used in the collection of breastfeeding data, reflecting the same unit of analysis. Occasionally, BFI accreditation relates to a specific provider arm rather than general services.

Hospital BFI status will need to be mapped to PCT level outcome data to enable us to measure the effect of hospital accreditation on breastfeeding rates. To facilitate this, data on the provider of maternity care by PCT of responsibility has been sought from HES. Where multiple acute trusts deliver maternity care to a single PCT population, an algorithm has been developed to take into account the proportion of deliveries attributable to each provider within a PCT. Using this it is possible to estimate the number of deliveries in each PCT taking place in a unit with each level of BFI award.

4. Data management

4.1 Breastfeeding outcomes

Data on breastfeeding outcomes are reported by quarter. Annual figures for 2010-11 will be calculated by summing the relevant quarterly figures and calculating the mean across the period. These figures will only be calculated for PCTs contributing data of an acceptable quality (i.e. meeting DH validation checks) for at least two of the four quarters in 2010-11.

3.2 Socio-demographic variables

All of the socio-demographic variables in this analysis are continuous variables. In addition to presenting summary data (means, ranges etc.), data may be grouped for the purpose of analysis. Continuous variables will be transformed into ordered categorical variables using quintiles or quartiles, or well-defined cut-offs if their association with the outcome of interest is not linear.

3.3 BFI status

BFI will be included in descriptive analysis as an ordered categorical variable with six groups. For regression analysis, BFI status will be collapsed into two or three groups as detailed in Tables 2 and 3. These groupings were agreed following advice from BFI staff and Advisory Group members. Time since award will be considered for the longer established hospital award but not for community BFI status as this is a more recent award.

5. Analysis plan

5.1 Descriptive analysis (objectives 2a and 2b)

Descriptive analysis will involve an examination of data quality and completeness, Crude breastfeeding rates will be reported and summarised. PCTS will be described with respect to each of the variables included in the analysis. This will involve the presentation of summary tables, scattergrams and other visual displays. Prevalence estimates for the primary and secondary outcomes will be presented alongside confidence intervals. All the potential socio-demographic indicators being considered are continuous variables, and as such, means and standard deviations will be presented where distributions are approximately normal. For variables with a non-normal distribution or those with extreme values, the median and interquartile range will be presented. Frequencies and percentages will be reported for the explanatory variables and for grouped continuous variables.

5.2 Multivariable analysis (objectives 2a and 2b

All statistical analyses will be conducted using Stata version 11. All tests will be two tailed and a 5% significance level will be used unless specified otherwise.

Statistical methods

Logistic regression will be used to estimate the effect of socio-demographic variables and breastfeeding support on breastfeeding outcomes. Aggregated data will be modelled as individual data and random effects models will be used to take into account the clustered hierarchical nature of the data.

Variables will only be retained in models where there is evidence of an independent association. This will be assessed by entering all potential explanatory variables in a regression model, dropping the least significant variable one by one, and examining the model as each variable is dropped until all variables remaining in the model are associated ($p<0.05$) with the outcome. This strategy will be repeated for each relationship under study.

For objective 2a, an adjusted odds ratio (OR) will only be presented where the socio-demographic variable is associated with the outcome in crude analysis at $p<0.10$ (i.e. looks to be a 'predictor' of breastfeeding outcomes).

Where adjusted odds ratios are reported, a minimum of three sets of odds ratios (OR) will be presented for each specific analysis: i) an unadjusted OR for all PCTs with valid outcome data, ii) an unadjusted OR for all PCTs with valid outcome data and no missing data for any explanatory factor, iii) an adjusted OR for all PCTs with valid outcome data and no missing data for any explanatory factor. For analyses undertaken for objective 2b, a fourth OR will be presented. This will be adjusted for socio-demographic variables, BFI status of hospital/community (whichever is not the main exposure), and (only where the outcome is breastfeeding at 6-8 weeks) breastfeeding initiation.

For objective 2a (identifying socio-demographic predictors), collinearity will be checked using summary tables showing the association between pairs of variables and by looking at the stability of coefficients and standard errors in models which include 'correlated' variables. Where extreme collinearity is present, only the strongest variable (as assessed using p values) will remain in the model.

For objective 2a, area-based deprivation and ethnicity will be considered as potential effect modifiers, and their role will be examined using Forest plots and tests for heterogeneity.

Planned analyses

Objective 2a

For this objective, we will examine the relationships detailed in Table 1.

Table 1. Analyses planned for objective 2a (socio-demographic predictors of breastfeeding rates)

Exposure	**Outcome**
Deprivation	Breastfeeding **initiation**
	Any breastfeeding at 6-8 weeks
	Exclusive breastfeeding at 6-8 weeks
Ethnicity	Breastfeeding **initiation**
	Any breastfeeding at 6-8 weeks
	Exclusive breastfeeding at 6-8 weeks
Young maternal age	Breastfeeding **initiation**
	Any breastfeeding at 6-8 weeks
	Exclusive breastfeeding at 6-8 weeks
Older maternal age	Breastfeeding **initiation**
	Any breastfeeding at 6-8 weeks
	Exclusive breastfeeding at 6-8 weeks
Maternal smoking	Breastfeeding **initiation**
	Any breastfeeding at 6-8 weeks
	Exclusive breastfeeding at 6-8 weeks

Objective 2b

Table 2 lists the planned analyses for the investigation of hospital BFI status. For the analysis looking at the effect of hospital BFI status on breastfeeding, the analysis is complicated by the fact that BFI status is not a simple categorical variable. There may be more than one provider of maternity services for each PCT, so instead of having single hospital BFI status for each PCT, we will instead model the percentage of births at a facility with each level of BFI award. BFI status is represented as 6 non-independent values where the 6th value is determined by the other 5 (since the sum of all values = 100). For example, assume a record for a single PCT ("PCT 1") is as follows:

	% of births at					
	No info	Register of intent	Certificate of commitment	Stage 1	Stage 2	Stage 3 (full)
PCT 1	25	5	10	35	15	10

For analysis A, we will include in the model a variable indicating the % of births in a stage 2/3 hospital, and a variable indicating the % of births in a hospital with no information/intent. Using the example above, the figures for this PCT would be 25% (15+10) and 30% (25+5) respectively. This is similar to our approach looking at maternal age, where we also plan to include in the model only the % of births in the 1st and 3rd age groups (three age groups in total). For analysis E, we would include only one variable, indicating the % of births at a facility with a status other than full accreditation. Using the example above, this value would be 90% (25+5+10+35+15).

Table 2. Analyses planned for the effect of hospital baby friendly status on breastfeeding rates (objective 2b)

Exposure		Categorisation	Outcome
Hospital BFI status	A	1. No info/register of intent 2. Certificate of commitment/stage 1 3. Stage 2/full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	B	1. No info/register of intent 2. Certificate of commitment/stage 1/stage 2 3. Full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	C	1. No info/register of intent 2. Certificate of commitment/stage 1/stage 2/full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	D	1. No info/register of intent/certificate of commitment/stage 1 2. Stage 2/full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	E	1. No info/register of intent/certificate of commitment/stage 1/stage 2 2. Full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks

Table 3 lists the planned analyses looking at the effect of community baby friendly status. This analysis is straightforward as there is a single community BFI status for each PCT.

Table 3. Analyses planned for the effect of community baby friendly status on breastfeeding rates (objective 2b)

Exposure		Categorisation	Outcome
Community BFI status	A	1. No info/register of intent 2. Certificate of commitment/stage 1 3. Stage 2/full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	B	1. No info/register of intent 2. Certificate of commitment/stage 1/stage 2 3. Full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	C	1. No info/register of intent 2. Certificate of commitment/stage 1/stage 2/full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	D	1. No info/register of intent/certificate of commitment/stage 1 2. Stage 2/full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	E	1. No info/register of intent/certificate of commitment/stage 1/stage 2 2. Full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks

Treatment of missing data

The percentage of missing data for the outcome variables will not exceed 10%. There should be minimal, if any, missing data for BFI status. If the level of missing data for covariates exceeds ≥10% we will explore strategies to address missing data e.g. multiple imputation.

BMJ open

Factors associated with breastfeeding in England: an analysis by primary care trust

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2013-002765.R1
Article Type:	Research
Date Submitted by the Author:	17-Apr-2013
Complete List of Authors:	Oakley, Laura; University of Oxford, National Perinatal Epidemiology Unit Renfrew, Mary; University of Dundee, School of Nursing and Midwifery Kurinczuk, Jenny ; University of Oxford, National Perinatal Epidemiology Unit Quigley, Maria; Oxford University, National Perinatal Epidemiology Unit
Primary Subject Heading:	Public health
Secondary Subject Heading:	Nutrition and metabolism, Paediatrics
Keywords:	Breastfeeding, PUBLIC HEALTH, NUTRITION & DIETETICS

Factors associated with breastfeeding in England: an analysis by primary care trust

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ABSTRACT

Objectives: To identify the socio-demographic factors associated with variation in area-based breastfeeding in England; to calculate predicted breastfeeding rates adjusted for socio-demographic variations.

Design: Ecological analysis of routine data using random effects logistic regression.

Setting: All 151 primary care trusts (PCTs) in England 2010-11.

Outcome measures: PCT level data on breastfeeding: initiation, any and exclusive breastfeeding at 6-8 weeks.

Results: There was considerable variation in breastfeeding across the PCTs (breastfeeding initiation mean 72%, range 39-93%; any breastfeeding at 6-8 weeks mean 45%, range 19-83%; exclusive breastfeeding at 6-8 weeks mean 32%, range 14-58%), with London PCTs reporting markedly higher rates. Maternal age was strongly associated with area-based breastfeeding, with a 4-6% increase in odds of breastfeeding associated with a unit increase in the percentage of older mothers. Outside London, the proportion of the local population from a Black and Minority Ethnic (BME) background, compared to those from a White British background, was associated with higher breastfeeding (1-3% increase in odds per unit increase in the proportion from a BME background). Area-based deprivation was associated with reduced odds of breastfeeding (21-32% reduced odds comparing most deprived quintile to least deprived). Weaker associations were observed between socio-demographic factors and breastfeeding in London PCTs. Very few PCTs reported breastfeeding figures substantially above or below the national average having adjusted for variations in socio-demographic factors.

Conclusions: Our results show striking associations between socio-demographic factors and breastfeeding at the area level, with much of the variation in breastfeeding rates explained by socio-demographic profile. The socio-demographic context of breastfeeding is clearly important at the area level as well as the individual level. Our findings can be used to inform decision making relating to local priorities and service provision.

ARTICLE SUMMARY

Article focus

- The primary aim of the reported study was to identify the socio-demographic factors independently associated with variation in area-based breastfeeding in England (breastfeeding initiation, any and exclusive breastfeeding rates at 6-8 weeks).
- The secondary aim was to calculate predicted area-based breastfeeding rates adjusted for socio-demographic variations using multivariable modelling.

Key messages

- Striking associations between socio-demographic factors and breastfeeding at the area level explain much of the variation in breastfeeding rates between areas. These associations were strongest in PCTs outside London; for London PCTs the associations were less consistent.
- After adjustment for socio-demographic factors most PCTs have breastfeeding rates in line with those expected given overall trends, however, breastfeeding rates are still comparatively low, especially for exclusive breastfeeding.
- The findings of this study confirm the importance of socio-demographic context and support the view that breastfeeding interventions need to be tailored to the needs of a particular setting. Our results can be used to compare breastfeeding across areas with similar socio-demographic characteristics and to inform service commissioning.

Strengths and limitations

- To our knowledge this is the first UK study investigating the relationship between socio-demographic factors and breastfeeding at an area-based level. We used routine data to look at breastfeeding prevalence and socio-demographic factors, and our analysis covers all English PCTs.
- This is an ecological study and as such our results are subject to the usual limitation that causality cannot be inferred. It is possible that variations in breastfeeding rates may be partially explained by area-level factors not measured in this study.
- The small sample number of PCTs in London may affect our confidence in the results from our analysis of London PCTs.

INTRODUCTION

Breastfeeding confers multiple benefits on both infants and mothers, with evidence linking breastfeeding to a lower risk of many adverse outcomes[1 2] including gastroenteritis[3 4], respiratory disease[4 5], necrotising enterocolitis[6] and otitis media[1 5] in infants, and a lower risk of breast cancer in mothers[1 2 7]. Breastfeeding has also been linked to other health, social and cognitive outcomes including childhood obesity and cognitive development[8 9].

Current UK guidance recommends that infants are exclusively breastfed to six months of age[10]. In England, just over four out of five (83%) mothers now start breastfeeding[11] but the recent improvements in initiation have not been reflected to the same extent in duration and exclusivity; by six weeks the proportion breastfeeding has dropped to 57%. Only 36% of mothers are still breastfeeding at 6 months. Twenty-four percent of mothers are breastfeeding exclusively at 6 weeks, and just 13% at 4 months[11]. Percentages are lower still in the other constituent countries of the United Kingdom, and in international comparisons, UK breastfeeding rates compare poorly with those of other European countries[12].

A recent report estimated that a moderate increase in breastfeeding rates in the UK could save over £17 million a year as a result of reduced costs for treating four acute infant diseases, with further savings accrued from the resulting reduction in breast cancer cases[2]. In the UK breastfeeding is a major factor in inequalities in health; not being breastfed is both a cause and a consequence of social inequalities[2]. Improving breastfeeding rates in the UK has been a key focus of successive governments over the last decade[13 14]; with the recent public health outcomes framework for England identifying breastfeeding as a key indicator for health improvement[15].

Previous studies have identified a variety of socio-demographic and behavioural factors including area of residence, maternal age, socio-economic background, maternal education, ethnicity, smoking behaviour and maternal obesity, as being associated with breastfeeding in both the UK and other high income countries[11 16-28]. However, these are based on the analysis of individual women and little is known about the factors that are associated with breastfeeding at the area level. In England, breastfeeding data have formed part of the Department of Health Vital Signs Monitoring Return (VSMR) since 2004 and are routinely reported at a number of different aggregate levels. Studies based on area-level data are well placed to make use of routinely collected data such as this, and can help to inform commissioning of services as well as providing a framework with which to evaluate relevant interventions. A recent study by Freemantle and colleagues used an approach similar to the one described here to look at factors associated with PCT level perinatal and infant mortality[29].

The aim of this study was to identify the socio-demographic factors associated with variation in area-based breastfeeding rates in England.

METHODS

We conducted an area-based analysis making use of data routinely collected at the primary care trust (PCT) level. Until their abolition in April 2013, PCTs were the administrative bodies responsible for commissioning all primary, community and secondary health services in a defined geographical area in England. For the time period under study, PCTs ranged in population size and annual number of births from 1,134 to 14,972 births (mean 4,550, sd 2,429; median 3,823, IQR 2,952-5,591) (2010 data). All one hundred and fifty one PCTs in England (boundaries as of 2010) were eligible for inclusion. Ethical approval was not required as the dataset comprised of publically available routine data at the aggregate level.

Outcome measures

In England, breastfeeding status at birth and at 6-8 weeks is routinely collected shortly after birth and at the 6-8 week infant review. We focused on three breastfeeding outcomes: breastfeeding initiation at birth, any breastfeeding at 6-8 weeks, and total (exclusive) breastfeeding at 6-8 weeks[30].

Breastfeeding is recorded as being initiated if infants receive any breast milk in the first 24 hours after birth. At 6-8 weeks, infants are classified into one of three categories according to feeding method in the preceding 24 hours: not breastfed; partially breastfed; or totally breastfed (hereafter referred to as "exclusively" breastfed). The last two groups are combined to give the outcome "any breastfeeding". Data on breastfeeding outcomes at these two time points (birth and 6-8 weeks) are released quarterly by the Department of Health (DH). For this analysis, overall figures for 2010-11 were calculated by summing raw quarterly actual data. PCTs were included where reported data for at least two of the four quarters of 2010-11 met DH data coverage standards (≥95% data coverage for initiation; for 6-8 week data, ≥90% and ≥95% data coverage for quarters 1-3 and quarter 4 respectively) and passed validation checks (relating to consistency in the reporting of number of maternities/infants due a 6-8 week check). According to usual DH practice, infants for whom a breastfeeding status (initiation or at 6-8 weeks) was not recorded were considered to be not breastfed, as long as the proportion of infants falling into this category within an individual PCT was small (<5% or <10% depending on the threshold for the quarter).

Explanatory variables

The following area-based socio-demographic indicators were included in our analysis: area-based deprivation, the proportion of births to older (aged >35 years) and younger (aged <20 years) mothers, and the proportion of the PCT population deriving from Black and Minority Ethnic (BME) backgrounds. We included the prevalence of maternal smoking as an additional explanatory factor.

We used the 2010 Index of Multiple Deprivation (IMD) as our indicator of material deprivation[31]. Data on thirty-eight domains contribute to this index and are combined to reflect a broad concept of deprivation. IMD is calculated at the level of "lower super output area" (LSOA), of which there are 32,482 in England. The score for each PCT is the average of the constituent LSOAs.

The estimated proportion of each PCT population from a Black and Minority Ethnic (BME) background was derived from the Office for National Statistics (ONS) Population Estimates by Ethnic Group (PEEG) for 2009[32]. PEEG is calculated using a cohort component methodology using data from the 2001 Census and more recent data on births, deaths and migration. BME was defined as non-White British.

The percentage of women smoking at delivery by PCT is reported quarterly by PCTs in England. In this analysis we used the figures for 2010-11 published by the Department of Health for England[30]. As with breastfeeding data, the DH imposes quality checks on these data (minimum of ≥95% data coverage, reported numbers of maternities and women smoking/not smoking must satisfy consistency checks).

Information on the percentage of births at PCT level occurring to older mothers (women aged older than 35) and younger mothers (women aged less than 20) in 2010-11 were derived from Hospital Episode Statistics (HES) data reported by the Child and Maternal Health Observatory (CHIMAT)[33].

Data on other factors strongly associated with breastfeeding, for example maternal education, are not collected routinely at the PCT level. We were therefore unable to include other factors of interest in the analysis.

Statistical analysis

The association between socio-demographic variables and all three breastfeeding outcomes was investigated using separate logistic regression models. Random effects logistic regression models were used to take into account the clustered hierarchical nature of the data.

Most explanatory variables were analysed as continuous variables, for example the proportion of births in a PCT to mothers aged less than 20, thus we estimated the effect of a one percentage point increase in each variable on the breastfeeding proportion in the PCT. IMD scores were divided into quintiles for ease of analysis.

Preliminary analyses of the data revealed a striking difference in the socio-demographic profile of London PCTs when compared to PCTs outside London. There was also evidence that the effect of area-based deprivation differed according to whether PCTs were in London or not. For this reason, all analysis was stratified by region (London vs. non-London).

Variables (or any resulting odds ratios for that variable) which were associated ($p < 0.10$ using Wald test for at least one relevant OR) with breastfeeding in univariable analysis were included in multivariable random effects logistic regression models. The final model included all variables which were associated ($p < 0.05$ using Wald test for at least one relevant OR) with the outcome

after adjusting for other factors in the model. This strategy was repeated for each relationship under study.

The final multivariable models were used to generate predicted proportions of all breastfeeding outcomes for PCTs in England, assuming fixed effects for the explanatory variables shown in the tables. Differences between observed and predicted proportions were examined by calculating standardized residuals for all PCTS; those with observed proportions that were two or more standardized residuals above or below predicted proportions were highlighted as possible outliers. These figures can be used to provide a more suitable comparison of local performance, as they take into account the distribution of socio-demographic factors that we know to affect breastfeeding.
All statistical analyses were conducted using STATA version 11 (StataCorp, College Station, TX); all tests were two tailed and a 5% significance level was used unless specified otherwise.

RESULTS

All 151 PCTs in England in 2010 were included for the analysis of breastfeeding initiation, but 10 PCTs failed to report 6-8 week data that met DH quality controls for two or more quarters. Therefore, information on breastfeeding initiation was available for 151 PCTs, and for breastfeeding status at 6-8 weeks, data were available for 141 PCTs.

Breastfeeding initiation varied across the PCTs from 39% to 93%, with a mean of 72% (Table 1). For breastfeeding status at 6-8 weeks, the mean percentage of any breastfeeding was 45% (range 19-83%) and for exclusive breastfeeding, 32% (range 14-58%). On average, one in five (19%) births in each PCT were to women aged over 35 (range 9-42%) and 6% were to women aged under 20 (range 1-12%). The mean proportion of mothers who were smoking at the time of delivery was 15% (range 3-33%). The proportion of the PCT population from a BME background averaged 19% across all PCTs (range 4-67%).

The profile of London PCTs differed markedly from PCTs in the rest of England. Breastfeeding tended to be more common in London PCTs, with average breastfeeding initiation at 86%, compared to 69% for PCTs outside London. Equivalent figures for any and exclusive breastfeeding at 6-8 weeks in London were 68% and 43%, and outside London, 40% and 29%. London PCTs also had a higher proportion of births to older mothers (25% vs. 18%), a higher proportion of residents from a BME background (40% vs. 13%), a lower proportion of births to teenage mothers (3% vs. 7%) and a lower prevalence of maternal smoking at delivery (7% vs. 17%). The deprivation profile was similar when comparing London and non-London PCTs. All further results are shown separately for PCTs outside (n=120) and inside (n=31) London.

PCTs outside London

The relationship between any breastfeeding at 6-8 weeks and each of the five socio-demographic variables under study is presented in a series of scatter plots in Figure 1, with data points for non-

London PCTs highlighted with solid markers. There are striking associations between breastfeeding and most of the socio-demographic variables: at the PCT level, the percentage of mothers breastfeeding tends to decrease as deprivation increases, and as the proportion of both younger mothers and maternal smoking increases. In general, breastfeeding rises in line with increases in the proportion of older mothers and the proportion of the population from BME background. Scatter plots for breastfeeding initiation and exclusive breastfeeding at 6-8 weeks showed similar patterns (see Table S1 – supplementary table).

Odds ratios for the association between these socio-demographic factors and each of the three breastfeeding outcomes are shown in Table 2. In univariable analysis, breastfeeding (all outcomes) was significantly higher in those PCTs with a higher proportion of older mothers and a higher BME population. Lower breastfeeding at birth and 6-8 weeks was observed in PCTs with increased deprivation and those areas with a higher prevalence of maternal smoking or teenage mothers.

In multivariable analysis of non-London PCTs with complete data (n=115 for initiation, n=110 for 6-8 weeks), the following variables were independently associated with breastfeeding (all outcomes): lower area-based deprivation, more births to older women, and higher BME population (Table 2). The proportion of teenage mothers and maternal smoking were no longer significant after adjustment for other variables (p values for teenage mothers in last included model: 0.67, 0.49 and 0.39 for initiation, any and exclusive; p values for maternal smoking in last included model: 0.73, 0.98 and 0.63 for initiation, any and exclusive). The effect of deprivation was somewhat attenuated by adjustment for other factors, although when compared to the least deprived quintile, a significant decrease in odds was still observed in quintiles 4 and 5 for exclusive breastfeeding at 6-8 weeks, and quintile 5 for breastfeeding initiation and any breastfeeding at 6-8 weeks. For breastfeeding initiation, the most deprived quintile (quintile 5) was associated with a reduction in the odds of 32% (adjusted OR 0.68) when compared with the least deprived. Areas with higher proportions of older mothers, and increased BME population all had higher odds of breastfeeding at birth and 6-8 weeks. Of these two factors, the strongest association was with older maternal age, where a unit increase in the percentage of mothers aged 35 or over was associated with a six percent increase in the odds of any breastfeeding at 6-8 weeks (adjusted OR 1.06) and a five percent increase in the odds of breastfeeding initiation or exclusive breastfeeding at 6-8 weeks (adjusted OR 1.05).

London PCTs

The same striking associations between breastfeeding and the socio-demographic variables are evident in the London PCTs (Figure 1, highlighted with hollow markers). The only exception was area deprivation which was not strongly associated with breastfeeding. These figures also provide strong evidence of the difference in both the socio-demographic and the breastfeeding profile of London PCTs compared to non-London PCTs.

Univariable analysis of the London PCTs showed significant associations between all breastfeeding outcomes and the maternal age profile of PCTs, the proportion of a PCT population from a BME background, and maternal smoking (Table 3). Area-based deprivation showed no or little significant association with breastfeeding in London.

In the multivariable analysis, factors independently associated with breastfeeding initiation were area deprivation, older maternal age and maternal smoking (Table 3). The proportion of teenage mothers and BME population were not retained in the final model as they were no longer significant after adjustment (p values for last model including these variables: 0.73 for teenage mothers, 0.94 for BME). Increased maternal smoking at delivery was associated with lower breastfeeding initiation, and in line with the results for PCTs outside London, increased prevalence of older mothers was associated with higher breastfeeding initiation. However, contrary to the results observed outside London, increased deprivation appeared to be independently associated with *higher* breastfeeding initiation. Quintiles 3-5 had a significantly increased odds ratio compared to the least deprived quintile 1; for quintile 5 (most deprived PCTs) the adjusted odds ratio was 1.71.

After adjustment for other factors, deprivation was not independently associated with breastfeeding at 6-8 weeks in London PCTs (not taken forward to multivariable modelling in analysis of any breastfeeding; p values for last model including this variable in analysis of exclusive breastfeeding ranged from 0.21-0.74). Older maternal age was associated with breastfeeding at 6-8 weeks, with an odds ratio of 1.06 for both any and exclusive breastfeeding. This is equivalent to a 6% increase in the odds of breastfeeding for every one percent increase in the proportion of older mothers. The proportion of teenage mothers was not associated with either any breastfeeding or exclusive breastfeeding at 6-8 weeks after adjustment for other factors (p values for last models including this variable: 0.28 for any breastfeeding, 0.74 for exclusive breastfeeding). BME population was independently associated with any breastfeeding at 6-8 weeks (OR 1.03 per unit change), and maternal smoking associated with increased exclusive breastfeeding. In the final multivariable model for any breastfeeding at 6-8 weeks, maternal smoking did not retain significance (p value for last model including this variable 0.58).

Observed and predicted proportions

Figure 2 shows the breastfeeding proportions observed in each PCT plotted against the breastfeeding proportion that would be predicted based on the multivariable models shown in Tables 2 and 3. The vast majority of PCTs reported proportions consistent (within two standardized residuals) with the proportions predicted by the models. Three PCTs (all non-London) reported breastfeeding initiation as considerably higher than predicted, and two PCTs (both non-London) reported figures lower than predicted (outliers are highlighted in Figure 2). Three PCTs (all non-London) and four PCTs (three non-London, one London) reported proportions of any and exclusive breastfeeding higher than predicted. One London PCT reported the proportion of any breastfeeding

at 6-8 weeks as lower than expected. Table S2 shows the observed and predicted breastfeeding proportions for each PCT.

DISCUSSION

This is the first UK study to our knowledge designed to investigate the relationship between socio-demographic factors and breastfeeding at the area level, an analysis which is important given that services are commissioned and delivered at this level. There was enormous variation in area-based rates of breastfeeding. However, after adjusting for socio-demographic factors, most areas have breastfeeding rates within the expected range of the national average, albeit a relatively low national average (e.g. 45% any breastfeeding at 6-8 weeks). The area-based analysis revealed some striking associations between socio-demographic factors and breastfeeding; these persisted after adjustment for other factors. For example, an increase in the proportion of mothers aged 35 or older from 15% to 20% is associated with a 34% increase in the odds for area-level any breastfeeding at 6-8 weeks.

Limitations

This study used aggregate data and as such is subject to the usual limitation that causality cannot be inferred. Although the use of routine data has many benefits, for example wide geographical coverage, there are also inherent disadvantages such as the difficulty in assessing data quality. It is also possible that higher levels of breastfeeding can be partially explained by area-level factors not measured in this study, for example a greater number of accessible breastfeeding services. We included all socio-economic indicators routinely available at the PCT level. There may be other relevant factors that would have been useful to include, such as levels of maternal education.

The Department of Health for England does not make raw figures for annual outturn breastfeeding data routinely available. In order to model figures in our regression analysis, we relied on quarterly actual data. These data may differ very slightly from annual outturn data but there is no reason to suspect trends would be different. One advantage of our method (summing breastfeeding data across quarters) was that we were able to include PCTs with one or two data quarters missing, thus minimising data loss. However, a small number of PCTs were excluded as breastfeeding data did not meet our stipulated criteria (acceptable data quality for at least two quarters). In addition, the small number of PCTs in London (n=27-29 depending on analysis) may affect our confidence in the results from our analysis of London PCTs: it is unclear whether lack of association reflects a true lack of effort or is simply the consequence of an underpowered analysis. The observed breastfeeding proportions used in this analysis are likely to be an underestimate of the true number breastfeeding as we mirrored the denominators used by the DH which assumes that those for whom a breastfeeding status was not recorded are not breastfeeding.

Data on smoking at delivery was not available for all PCTs. Six PCTs were not eligible for inclusion as reported data did not meet DH quality checks. Despite this, smoking status was available for 99% of maternities in 2010-11 (range for individual PCTs included in this analysis 95.5-100%).

Our ethnicity indicator related to the general PCT population rather than the maternal population. Given the high level of missing data on maternal ethnicity from Hospital Episode Statistics (HES) (approximately eight percent in 2009-10[34]), using these data would have resulted in a reduction in our sample size. We compared the general ethnicity data with the HES maternal ethnicity data and noted that it correlated well, although the maternal HES ethnicity data reported higher proportions across all PCTs, probably due to the younger age profile of BME populations. We combined all non-White groups into a single BME indicator. This helped to minimise potential problems due to small numbers of certain ethnic groups in many PCTs. This decision was also supported by strong evidence that all non-White women are more likely to initiate and continue breastfeeding when compared to White women[11]. However, our approach left us unable to examine the separate contribution of individual ethnic groups or relevant factors such as migration history or acculturation status[35] to breastfeeding rates.

Interpretation of results

There was compelling evidence of a strong area effect of older maternal age on breastfeeding, with a one percent increase in the percentage of older mothers in a PCT associated with a 4-6% increase in the odds of breastfeeding. This trend was consistent across all outcomes and in both London and non-London PCTs, and is in line with evidence from individual level studies that older mothers are more likely to initiate and continue breastfeeding[11 24].

Outside London, the proportion of the PCT population from a BME background was associated with breastfeeding, with a unit increase in BME population resulting in a 1-3% increase in the odds of breastfeeding. Non-white ethnicity has consistently been linked to increased breastfeeding in individual level studies[16 17 20 22 26], although there is some variation between individual ethnic groups and by acculturation status[35]. Existing literature suggests that the strongest overall effect of ethnicity is on initiation and continuation, with minimal differences by ethnicity in the number of women who breastfeed exclusively[36 37]. Although BME background was associated with all breastfeeding outcomes outside London, it was only independently associated with breastfeeding at 6-8 weeks in London. The fact that we did not identify an independent effect of BME population on initiation in London may be partly due to the high rate of BME in the London PCTs (mean value 40%) making it difficult to detect an independent effect of ethnicity. In addition, it may be that high rates of breastfeeding in ethnically diverse areas supports the concept of "community ethnicity"[20], whereby some groups of White women appear to be more likely to breastfeed if they reside in an area with a high BME population. Differences in the composition of BME populations in London compared to outside London may also help to explain inconsistency in the observed effect of BME on breastfeeding.

PCTs in the most deprived quintile had a 21-32% reduced odds of breastfeeding compared to PCTs in the least deprived quintile. In London PCTs, results were less consistent after adjustment, with area deprivation only associated with breastfeeding initiation, and this association being in the opposite direction to that observed outside London (increased deprivation associated with increased odds of initiation). This perhaps highlights the complex relationships between ethnicity, socio-economic status and breastfeeding behaviour. BME populations tend to cluster in more deprived neighbourhoods. Women from non-White backgrounds are more likely to breastfeed. In general, mothers from lower socio-economic backgrounds are less likely to breastfeed. There is evidence that this latter trend cannot be generalised to mothers from non-White backgrounds[17]. Several studies have found that the effect of deprivation[17], socio-economic status[19], and income[22], is negligible when looking at breastfeeding among certain minority ethnic groups. Outside London, both deprivation and area level ethnicity remained independent predictors of breastfeeding even after adjusting for the other. Within London, the effect of one appeared to be attenuated by the other, except when looking at exclusive breastfeeding which was not independently associated with either.

Our analysis was designed to explain the variation in breastfeeding between PCTs. Only a handful of PCTs reported breastfeeding figures substantially above or below the proportions predicted by our models. The majority of outliers were PCTs with observed proportions higher than expected based on the national average having adjusted for socio-demographic factors; though two PCTs did report breastfeeding initiation as lower than predicted and one PCT had a lower than expected proportion of any breastfeeding at 6-8 weeks.

Implications

Our results demonstrate that while area-based rates of breastfeeding vary enormously, much of this variation is explained by the socio-demographic profile of the area. Currently, breastfeeding data provided at the PCT level for comparative purposes is unadjusted[38] and may result in misleading assessment of local performance. Adjusted breastfeeding figures as reported in this study may be used to identify areas with higher or lower than expected rates of breastfeeding. For those performing above expected levels, there may be lessons to be learned from examining local service provision.

The socio-demographic context within which a breastfeeding service is implemented or evaluated is clearly important[39]. A 'one size fits all' approach to breastfeeding support is unlikely to demonstrate a strong effect at the population level over and above the 'background noise' of such strong socio-demographic effects. Interventions which are tailored to the needs of a particular setting are more likely to be effective[40], particularly those that follow local needs assessment. Our findings can be used to help inform the primary focus of an intervention, for example whether the emphasis should be on breastfeeding initiation, duration or exclusivity, or a combination of these outcomes[40]. The size of effects observed in our study may also inform estimates of the likely effect of breastfeeding interventions, in a trial or other setting. In situations where the required trial size is too large to be

feasible, other forms of evaluation, such as case studies of high performing PCTs, are likely to be a more suitable approach.

In the new (post-April 2013) NHS structure in England, it is uncertain which organisations will be responsible for commissioning breastfeeding services. However, our results will be relevant to whichever local structures take over this function, particularly given that many of the geographical areas presented here will be recognisable in the new structure. Although most PCTs are performing at the level expected given current trends, overall breastfeeding rates are still low and fall short of UK recommendations for mothers to breastfeed exclusively for the first six months of life.

Conclusion

Our results confirm the importance of socio-demographic indicators of breastfeeding, and provide evidence that these indicators explain much of the heterogeneity between PCTs in terms of the proportion of mothers breastfeeding. However, there is little room for complacency; while some areas in England now have high rates of breastfeeding initiation; almost all have low rates of duration, particularly of exclusive breastfeeding. In order to maximise the likelihood of success, interventions designed to increase breastfeeding at the area level will need to be tailored to the socio-demographic context, and monitoring and assessment of area-based rates will need to take these factors into account.

Contributors
MQ and JK conceived the study and all authors contributed to the design of the study. MQ and LO designed and conducted the analysis. All authors were involved in the interpretation of the data. LO and MQ wrote the initial draft of the manuscript, and all authors contributed to revising consecutive drafts. All authors approved the final version of the manuscript. All authors had full access to all of the data in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. MQ and LO are the guarantors for the study.

Funding
This paper reports on an independent study which is funded by the Policy Research Programme in the Department of Health. The views expressed are not necessarily those of the Department. The funder had no role in: the design and conduct of the study; the analysis and interpretation of the data; and the drafting of the paper and decision to submit the paper for publication.

Competing interests
None.

Data sharing
Observed and predicted breastfeeding rates by PCT are provided as Supplementary Data. For further information please contact the corresponding author.

Ethics approval
Not needed.

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Table 1. Distribution of breastfeeding outcomes and socio-demographic variables by PCT

	ALL PCTS (n=151)			NON-LONDON PCTS (n=120)			LONDON PCTS (n=31)		
	mean (sd)	median (IQR)	min, max	mean (sd)	median (IQR)	min, max	mean (sd)	median (IQR)	min, max
Breastfeeding									
% initiating breastfeeding	72.3 (11.2)	72.8 (65.2-79.9)	39.0, 92.9	68.7 (9.1)	69.6 (62.5-75.7)	39.0, 85.5	86.3 (6.6)	88.9 (83.1-91.3)	67.7, 92.9
% any breastfeeding at 6-8 weeks[1]	45.3 (15)	42.3 (34.5-54.0)	19.2, 83.1	39.7 (10.0)	39.9 (33.7-45.5)	19.2, 70.5	67.5 (10.6)	71.3 (63.0-73.7)	38.1, 83.1
% exclusive breastfeeding at 6-8 weeks[1]	31.6 (9.1)	31.4 (24.9-37.1)	14.2, 58.2	29.2 (7.4)	29.3 (24.2-33.2)	14.3, 58.2	41.2 (8.8)	42.5 (35.0-48.6)	20.5, 57.5
Socio-demographic									
IMD (raw score)[2]	23.6 (8.4)	23.3 (16.6-29.5)	8.8, 45.3	23.1 (8.3)	22.8 (16.4-28.5)	8.8, 45.3	25.6 (8.8)	25.0 (16.7-31.9)	10.1, 41.8
% mothers aged 35+	19.3 (5.7)	18.4 (15.1-22.0)	9.4, 41.8	17.8 (4.4)	17.6 (14.5-21.2)	9.4, 32.3	25.2 (6.4)	24.5 (20.1-30.4)	15.4, 41.8
% mothers aged <20	5.9 (2.3)	5.8 (4.1-7.4)	1.3, 11.8	6.6 (1.9)	6.3 (5.3, 7.9)	2.8, 11.8	3.1 (1.1)	2.8 (2.2-3.8)	1.3, 5.6
% population BME	18.7 (14.3)	13.0 (7.8-25.9)	4.3, 67.0	13.1 (8.7)	10.9 (7.3-16.9)	4.3, 67.0	40.4 (10.9)	42.9 (33.9-47.5)	16.4, 61.9
% mothers smoking at delivery[3]	14.7 (6.1)	15.0 (10.7-18.8)	3.0, 33.2	16.7 (4.8)	16.5 (13.7,-19.9)	6.1, 33.2	6.6 (2.9)	5.9 (4.4-7.5)	3.0, 13.6

sd: standard deviation, IQR: interquartile range, IMD: Index of Multiple Deprivation, BME: Black and Minority Ethnic
[1]Restricted to 141 PCTs with data on breastfeeding at 6-8 weeks
[2]A high score is indicative of greater deprivation
[3]Restricted to 146 PCTs with data on smoking at delivery

Information on maternal smoking at delivery was unavailable for a number of PCTs, leaving 144 and 137 PCTs included in the complete case analysis for breastfeeding initiation and breastfeeding at 6-8 weeks (115 non-London PCTs and 29 London PCTs; 110 non-London PCTs and 27 London PCTs).

Figure legends:

Figure 1. Scatterplots for any breastfeeding at 6-8 weeks by socio-demographic factors (London vs. non-London)

Figure 2. Observed vs. predicted proportions of any breastfeeding at 6-8weeks

Table 2. Socio-demographic factors associated with PCT level breastfeeding: univariable and multivariable models for non-London PCTs

NON-LONDON PCTS	% INITIATING BREASTFEEDING (n=115)				% ANY BREASTFEEDING AT 6-8 WEEKS (n=110)				% EXCLUSIVE BREASTFEEDING AT 6-8 WEEKS (n=110)			
	UNADJUSTED		ADJUSTED[1]		UNADJUSTED		ADJUSTED[2]		UNADJUSTED		ADJUSTED[3]	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Index of Multiple Deprivation												
Quintile 1 (least deprived)	1.00		1.00		1.00		1.00		1.00		1.00	
Quintile 2	0.82	(0.68-1.00)	1.03	(0.88-1.20)	0.74*	(0.60-0.91)	0.98	(0.85-1.12)	0.83*	(0.70-0.98)	1.02	(0.89-1.17)
Quintile 3	0.68***	(0.56-0.83)	0.97	(0.82-1.15)	0.61***	(0.49-0.75)	0.89	(0.77-1.04)	0.67***	(0.56-0.79)	0.94	(0.80-1.10)
Quintile 4	0.56***	(0.46-0.68)	0.84	(0.70-1.01)	0.54***	(0.44-0.67)	0.83*	(0.71-0.98)	0.61***	(0.51-0.72)	0.90	(0.76-1.06)
Quintile 5 (most deprived)	0.50**	(0.41-0.61)	0.68**	(0.54-0.86)	0.51***	(0.41-0.64)	0.69***	(0.57-0.85)	0.54***	(0.45-0.65)	0.79*	(0.64-0.97)
% mothers aged 35+	1.07***	(1.06-1.09)	1.05***	(1.04-1.07)	1.08***	(1.06-1.09)	1.06**	(1.04-0.85)	1.07***	(1.05-1.08)	1.05***	(1.04-1.07)
% mothers aged <20	0.86***	(0.83-0.88)			0.84***	(0.82-0.87)			0.88***	(0.86-0.90)		
% population BME	1.01*	(1.00-1.02)	1.02***	(1.01-1.02)	1.02***	(1.01-1.03)	1.03***	(1.02-1.04)	1.01*	(1.00-1.02)	1.01***	(1.01-1.02)
% mothers smoking at delivery	0.94***	(0.93-0.95)			0.93***	(0.92-0.94)			0.95***	(0.94-0.96)		

*p <0.05 **p <0.01 ***p <0.001

OR: Odds ratio, BME: Black and Minority Ethnic

[1]Variables in model: IMD, % births to older mothers, % of population BME

[2]Variables in model: IMD, % births to older mothers, % of population BME

[3]Variables in model: IMD, % births to older mothers, % of population BME

Table 3. Socio-demographic factors associated with PCT level breastfeeding: univariable and multivariable models for London PCTs

LONDON PCTS	% INITIATING BREASTFEEDING (n=29)				% ANY BREASTFEEDING AT 6-8 WEEKS (n=27)				% EXCLUSIVE BREASTFEEDING AT 6-8 WEEKS (n=27)			
	UNADJUSTED		ADJUSTED[1]		UNADJUSTED		ADJUSTED[2]		UNADJUSTED		ADJUSTED[3]	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Index of Multiple Deprivation												
Quintile 1 (least deprived)	1.00		1.00		1.00				1.00			
Quintile 2	0.61	(0.35-1.04)	1.31	(0.94-1.84)	0.70	(0.43-1.15)			0.63*	(0.35-0.93)		
Quintile 3	1.22	(0.71-2.10)	1.38*	(1.03-1.85)	1.39	(0.85-2.28)			1.07	(0.72-1.57)		
Quintile 4	1.34	(0.75-2.37)	1.46*	(1.06-2.00)	1.48	(0.88-2.50)			0.95	(0.62-1.43)		
Quintile 5 (most deprived)	1.10	(0.69-1.75)	1.71***	(1.30-2.25)	1.18	(0.76-1.84)			0.82	(0.58-1.17)		
% mothers aged 35+	1.05***	(1.03-1.08)	1.04***	(1.02-1.06)	1.04**	(1.02-11.07)	1.06***	(1.04-1.07)	1.05***	(1.03-1.06)	1.06***	(1.04-1.07)
% mothers aged <20	0.79**	(0.68-0.92)			0.79**	(0.69-0.91)			0.82***	(0.74-0.91)		
% population BME	1.02*	(1.00-1.03)			1.03***	(1.01-1.04)	1.03***	(1.03-1.04)	1.01	(1.00-1.02)		
% mothers smoking at delivery	0.88***	(0.84-0.91)	0.90***	(0.87-0.94)	0.88***	(0.84-0.91)			0.92***	(0.89-0.95)	0.95**	(0.92-0.98)

*p <0.05 **p <0.01 ***p <0.001

OR: Odds ratio, BME: Black and Minority Ethnic

[1]Variables in model: IMD, % births to older mothers, % smoking at delivery

[2]Variables in model: % of births to older mothers, % population BME

[3]Variables in model: % of births to older mothers, % smoking at delivery

Factors associated with breastfeeding in England: an analysis by primary care trust

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ABSTRACT

Objectives: To identify the socio-demographic factors associated with variation in area-based breastfeeding in England; to calculate predicted breastfeeding rates adjusted for socio-demographic variations.

Design: Ecological analysis of routine data using random effects logistic regression.

Setting: All 151 primary care trusts (PCTs) in England 2010-11.

Outcome measures: PCT level data on breastfeeding: initiation, any and exclusive breastfeeding at 6-8 weeks.

Results: There was considerable variation in breastfeeding across the PCTs (breastfeeding initiation mean 72%, range 39-93%; any breastfeeding at 6-8 weeks mean 45%, range 19-83%; exclusive breastfeeding at 6-8 weeks mean 32%, range 14-58%), with London PCTs reporting markedly higher rates. Maternal age was strongly associated with area-based breastfeeding, with a 4-6% increase in odds of breastfeeding associated with a unit increase in the percentage of older mothers. Outside London, the proportion of the local population from a Black and Minority Ethnic (BME) background, compared to those from a White British background, was associated with higher breastfeeding (1-3% increase in odds per unit increase in the proportion from a BME background). Area-based deprivation was associated with reduced odds of breastfeeding (21-32% reduced odds comparing most deprived quintile to least deprived). Weaker associations were observed between socio-demographic factors and breastfeeding in London PCTs. Very few PCTs reported breastfeeding figures substantially above or below the national average having adjusted for variations in socio-demographic factors.

Conclusions: Our results show striking associations between socio-demographic factors and breastfeeding at the area level, with much of the variation in breastfeeding rates explained by socio-demographic profile. The socio-demographic context of breastfeeding is clearly important at the area level as well as the individual level. Our findings can be used to inform decision making relating to local priorities and service provision.

Article focus

- The primary aim of the reported study was to identify the socio-demographic factors independently associated with variation in area-based breastfeeding in England (breastfeeding initiation, any and exclusive breastfeeding rates at 6-8 weeks).
- The secondary aim was to calculate predicted area-based breastfeeding rates adjusted for socio-demographic variations using multivariable modelling.

Key messages

- Striking associations between socio-demographic factors and breastfeeding at the area level explain much of the variation in breastfeeding rates between areas. These associations were strongest in PCTs outside London; for London PCTs the associations were less consistent.
- After adjustment for socio-demographic factors most PCTs have breastfeeding rates in line with those expected given overall trends, however, breastfeeding rates are still comparatively low, especially for exclusive breastfeeding.
- The findings of this study confirm the importance of socio-demographic context and support the view that breastfeeding interventions need to be tailored to the needs of a particular setting. Our results can be used to compare breastfeeding across areas with similar socio-demographic characteristics and to inform service commissioning.

Strengths and limitations

- To our knowledge this is the first UK study investigating the relationship between socio-demographic factors and breastfeeding at an area-based level. We used routine data to look at breastfeeding prevalence and socio-demographic factors, and our analysis covers all English PCTs.
- This is an ecological study and as such our results are subject to the usual limitation that causality cannot be inferred. It is possible that variations in breastfeeding rates may be partially explained by area-level factors not measured in this study.
- The small sample number of PCTs in London may affect our confidence in the results from our analysis of London PCTs.

INTRODUCTION

Breastfeeding confers multiple benefits on both infants and mothers, with evidence linking breastfeeding to a lower risk of many adverse outcomes[1 2] including gastroenteritis[3 4], respiratory disease[4 5], necrotising enterocolitis[6] and otitis media[1 5] in infants, and a lower risk of breast cancer in mothers[1 2 7]. Breastfeeding has also been linked to other health, social and cognitive outcomes including childhood obesity and cognitive development[8 9].

Current UK guidance recommends that infants are exclusively breastfed to six months of age[10]. In England, just over four out of five (83%) mothers now start breastfeeding[11] but the recent improvements in initiation have not been reflected to the same extent in duration and exclusivity; by six weeks the proportion breastfeeding has dropped to 57%. Only 36% of mothers are still breastfeeding at 6 months. Twenty-four percent of mothers are breastfeeding exclusively at 6 weeks, and just 13% at 4 months[11]. Percentages are lower still in the other constituent countries of the United Kingdom, and in international comparisons, UK breastfeeding rates compare poorly with those of other European countries[12].

A recent report estimated that a moderate increase in breastfeeding rates in the UK could save over £17 million a year as a result of reduced costs for treating four acute infant diseases, with further savings accrued from the resulting reduction in breast cancer cases[2]. In the UK breastfeeding is a major factor in inequalities in health; not being breastfed is both a cause and a consequence of social inequalities[2]. Improving breastfeeding rates in the UK has been a key focus of successive governments over the last decade[13 14]; with the recent public health outcomes framework for England identifying breastfeeding as a key indicator for health improvement[15].

Previous studies have identified a variety of socio-demographic and behavioural factors including area of residence, maternal age, socio-economic background, maternal education, ethnicity, smoking behaviour and maternal obesity, as being associated with breastfeeding in both the UK and other high income countries[11 16-28]. However, these are based on the analysis of individual women and little is known about the factors that are associated with breastfeeding at the area level. In England, breastfeeding data have formed part of the Department of Health Vital Signs Monitoring Return (VSMR) since 2004 and are routinely reported at a number of different aggregate levels. Studies based on area-level data are well placed to make use of routinely collected data such as this, and can help to inform commissioning of services as well as providing a framework with which to evaluate relevant interventions. A recent study by Freemantle and colleagues used an approach similar to the one described here to look at factors associated with PCT level perinatal and infant mortality[29].

The aim of this study was to identify the socio-demographic factors associated with variation in area-based breastfeeding rates in England.

METHODS

We conducted an area-based analysis making use of data routinely collected at the primary care trust (PCT) level. Until their abolition in April 2013, PCTs were the administrative bodies responsible for commissioning all primary, community and secondary health services in a defined geographical area in England. For the time period under study, PCTs ranged in population size and annual number of births from 1,134 to 14,972 births (mean 4,550, sd 2,429; median 3,823, IQR 2,952-5,591) (2010 data). All one hundred and fifty one PCTs in England (boundaries as of 2010) were eligible for inclusion. Ethical approval was not required as the dataset comprised of publically available routine data at the aggregate level.

Outcome measures

In England, breastfeeding status at birth and at 6-8 weeks is routinely collected shortly after birth and at the 6-8 week infant review. We focused on three breastfeeding outcomes: breastfeeding initiation at birth, any breastfeeding at 6-8 weeks, and total (exclusive) breastfeeding at 6-8 weeks[30].

Breastfeeding is recorded as being initiated if infants receive any breast milk in the first 24 hours after birth. At 6-8 weeks, infants are classified into one of three categories according to feeding method in the preceding 24 hours: not breastfed; partially breastfed; or totally breastfed (hereafter referred to as "exclusively" breastfed). The last two groups are combined to give the outcome "any breastfeeding". Data on breastfeeding outcomes at these two time points (birth and 6-8 weeks) are released quarterly by the Department of Health (DH). For this analysis, overall figures for 2010-11 were calculated by summing raw quarterly actual data. PCTs were included where reported data for at least two of the four quarters of 2010-11 met DH data coverage standards (≥95% data coverage for initiation; for 6-8 week data, ≥90% and ≥95% data coverage for quarters 1-3 and quarter 4 respectively) and passed validation checks (relating to consistency in the reporting of number of maternities/infants due a 6-8 week check). According to usual DH practice, infants for whom a breastfeeding status (initiation or at 6-8 weeks) was not recorded were considered to be not breastfed, as long as the proportion of infants falling into this category within an individual PCT was small (<5% or <10% depending on the threshold for the quarter).

Explanatory variables

The following area-based socio-demographic indicators were included in our analysis: area-based deprivation, the proportion of births to older (aged >35 years) and younger (aged <20 years) mothers, and the proportion of the PCT population deriving from Black and Minority Ethnic (BME) backgrounds. We included the prevalence of maternal smoking as an additional explanatory factor.

We used the 2010 Index of Multiple Deprivation (IMD) as our indicator of material deprivation[31]. Data on thirty-eight domains contribute to this index and are combined to reflect a broad concept of deprivation. IMD is calculated at the level of "lower super output area" (LSOA), of which there are 32,482 in England. The score for each PCT is the average of the constituent LSOAs.

The estimated proportion of each PCT population from a Black and Minority Ethnic (BME) background was derived from the Office for National Statistics (ONS) Population Estimates by Ethnic Group (PEEG) for 2009[32]. PEEG is calculated using a cohort component methodology using data from the 2001 Census and more recent data on births, deaths and migration. BME was defined as non-White British.

The percentage of women smoking at delivery by PCT is reported quarterly by PCTs in England. In this analysis we used the figures for 2010-11 published by the Department of Health for England[30]. As with breastfeeding data, the DH imposes quality checks on these data (minimum of ≥95% data coverage, reported numbers of maternities and women smoking/not smoking must satisfy consistency checks).

Information on the percentage of births at PCT level occurring to older mothers (women aged older than 35) and younger mothers (women aged less than 20) in 2010-11 were derived from Hospital Episode Statistics (HES) data reported by the Child and Maternal Health Observatory (CHIMAT)[33].

Data on other factors strongly associated with breastfeeding, for example maternal education, are not collected routinely at the PCT level. We were therefore unable to include other factors of interest in the analysis.

Statistical analysis

The association between socio-demographic variables and all three breastfeeding outcomes was investigated using separate logistic regression models. Random effects logistic regression models were used to take into account the clustered hierarchical nature of the data.

Most explanatory variables were analysed as continuous variables, for example the proportion of births in a PCT to mothers aged less than 20, thus we estimated the effect of a one percentage point increase in each variable on the breastfeeding proportion in the PCT. IMD scores were divided into quintiles for ease of analysis.

Preliminary analyses of the data revealed a striking difference in the socio-demographic profile of London PCTs when compared to PCTs outside London. There was also evidence that the effect of area-based deprivation differed according to whether PCTs were in London or not. For this reason, all analysis was stratified by region (London vs. non-London).

Variables (or any resulting odds ratios for that variable) which were associated ($p < 0.10$ using Wald test for at least one relevant OR) with breastfeeding in univariable analysis were included in multivariable random effects logistic regression models. The final model included all variables which were associated ($p < 0.05$ using Wald test for at least one relevant OR) with the outcome

after adjusting for other factors in the model. This strategy was repeated for each relationship under study.

The final multivariable models were used to generate predicted proportions of all breastfeeding outcomes for PCTs in England, assuming fixed effects for the explanatory variables shown in the tables. Differences between observed and predicted proportions were examined by calculating standardized residuals for all PCTS; those with observed proportions that were two or more standardized residuals above or below predicted proportions were highlighted as possible outliers. These figures can be used to provide a more suitable comparison of local performance, as they take into account the distribution of socio-demographic factors that we know to affect breastfeeding.
All statistical analyses were conducted using STATA version 11 (StataCorp, College Station, TX); all tests were two tailed and a 5% significance level was used unless specified otherwise.

RESULTS

All 151 PCTs in England in 2010 were included for the analysis of breastfeeding initiation, but 10 PCTs failed to report 6-8 week data that met DH quality controls for two or more quarters. Therefore, information on breastfeeding initiation was available for 151 PCTs, and for breastfeeding status at 6-8 weeks, data were available for 141 PCTs.

Breastfeeding initiation varied across the PCTs from 39% to 93%, with a mean of 72% (Table 1). For breastfeeding status at 6-8 weeks, the mean percentage of any breastfeeding was 45% (range 19-83%) and for exclusive breastfeeding, 32% (range 14-58%). On average, one in five (19%) births in each PCT were to women aged over 35 (range 9-42%) and 6% were to women aged under 20 (range 1-12%). The mean proportion of mothers who were smoking at the time of delivery was 15% (range 3-33%). The proportion of the PCT population from a BME background averaged 19% across all PCTs (range 4-67%).

The profile of London PCTs differed markedly from PCTs in the rest of England. Breastfeeding tended to be more common in London PCTs, with average breastfeeding initiation at 86%, compared to 69% for PCTs outside London. Equivalent figures for any and exclusive breastfeeding at 6-8 weeks in London were 68% and 43%, and outside London, 40% and 29%. London PCTs also had a higher proportion of births to older mothers (25% vs. 18%), a higher proportion of residents from a BME background (40% vs. 13%), a lower proportion of births to teenage mothers (3% vs. 7%) and a lower prevalence of maternal smoking at delivery (7% vs. 17%). The deprivation profile was similar when comparing London and non-London PCTs. All further results are shown separately for PCTs outside (n=120) and inside (n=31) London.

PCTs outside London

The relationship between any breastfeeding at 6-8 weeks and each of the five socio-demographic variables under study is presented in a series of scatter plots in Figure 1, with data points for non-

London PCTs highlighted with solid markers. There are striking associations between breastfeeding and most of the socio-demographic variables: at the PCT level, the percentage of mothers breastfeeding tends to decrease as deprivation increases, and as the proportion of both younger mothers and maternal smoking increases. In general, breastfeeding rises in line with increases in the proportion of older mothers and the proportion of the population from BME background. Scatter plots for breastfeeding initiation and exclusive breastfeeding at 6-8 weeks showed similar patterns (see Table S1 – supplementary table).

Odds ratios for the association between these socio-demographic factors and each of the three breastfeeding outcomes are shown in Table 2. In univariable analysis, breastfeeding (all outcomes) was significantly higher in those PCTs with a higher proportion of older mothers and a higher BME population. Lower breastfeeding at birth and 6-8 weeks was observed in PCTs with increased deprivation and those areas with a higher prevalence of maternal smoking or teenage mothers.

In multivariable analysis of non-London PCTs with complete data (n=115 for initiation, n=110 for 6-8 weeks), the following variables were independently associated with breastfeeding (all outcomes): lower area-based deprivation, more births to older women, and higher BME population (Table 2). The proportion of teenage mothers and maternal smoking were no longer significant after adjustment for other variables (p values for teenage mothers in last included model: 0.67, 0.49 and 0.39 for initiation, any and exclusive; p values for maternal smoking in last included model: 0.73, 0.98 and 0.63 for initiation, any and exclusive). The effect of deprivation was somewhat attenuated by adjustment for other factors, although when compared to the least deprived quintile, a significant decrease in odds was still observed in quintiles 4 and 5 for exclusive breastfeeding at 6-8 weeks, and quintile 5 for breastfeeding initiation and any breastfeeding at 6-8 weeks. For breastfeeding initiation, the most deprived quintile (quintile 5) was associated with a reduction in the odds of 32% (adjusted OR 0.68) when compared with the least deprived. Areas with higher proportions of older mothers, and increased BME population all had higher odds of breastfeeding at birth and 6-8 weeks. Of these two factors, the strongest association was with older maternal age, where a unit increase in the percentage of mothers aged 35 or over was associated with a six percent increase in the odds of any breastfeeding at 6-8 weeks (adjusted OR 1.06) and a five percent increase in the odds of breastfeeding initiation or exclusive breastfeeding at 6-8 weeks (adjusted OR 1.05).

London PCTs

The same striking associations between breastfeeding and the socio-demographic variables are evident in the London PCTs (Figure 1, highlighted with hollow markers). The only exception was area deprivation which was not strongly associated with breastfeeding. These figures also provide strong evidence of the difference in both the socio-demographic and the breastfeeding profile of London PCTs compared to non-London PCTs.

Univariable analysis of the London PCTs showed significant associations between all breastfeeding outcomes and the maternal age profile of PCTs, the proportion of a PCT population from a BME background, and maternal smoking (Table 3). Area-based deprivation showed no or little significant association with breastfeeding in London.

In the multivariable analysis, factors independently associated with breastfeeding initiation were area deprivation, older maternal age and maternal smoking (Table 3). The proportion of teenage mothers and BME population were not retained in the final model as they were no longer significant after adjustment (p values for last model including these variables: 0.73 for teenage mothers, 0.94 for BME). Increased maternal smoking at delivery was associated with lower breastfeeding initiation, and in line with the results for PCTs outside London, increased prevalence of older mothers was associated with higher breastfeeding initiation. However, contrary to the results observed outside London, increased deprivation appeared to be independently associated with *higher* breastfeeding initiation. Quintiles 3-5 had a significantly increased odds ratio compared to the least deprived quintile 1; for quintile 5 (most deprived PCTs) the adjusted odds ratio was 1.71.

After adjustment for other factors, deprivation was not independently associated with breastfeeding at 6-8 weeks in London PCTs (not taken forward to multivariable modelling in analysis of any breastfeeding; p values for last model including this variable in analysis of exclusive breastfeeding ranged from 0.21-0.74). Older maternal age was associated with breastfeeding at 6-8 weeks, with an odds ratio of 1.06 for both any and exclusive breastfeeding. This is equivalent to a 6% increase in the odds of breastfeeding for every one percent increase in the proportion of older mothers. The proportion of teenage mothers was not associated with either any breastfeeding or exclusive breastfeeding at 6-8 weeks after adjustment for other factors (p values for last models including this variable: 0.28 for any breastfeeding, 0.74 for exclusive breastfeeding). BME population was independently associated with any breastfeeding at 6-8 weeks (OR 1.03 per unit change), and maternal smoking associated with increased exclusive breastfeeding. In the final multivariable model for any breastfeeding at 6-8 weeks, maternal smoking did not retain significance (p value for last model including this variable 0.58).

Observed and predicted proportions

Figure 2 shows the breastfeeding proportions observed in each PCT plotted against the breastfeeding proportion that would be predicted based on the multivariable models shown in Tables 2 and 3. The vast majority of PCTs reported proportions consistent (within two standardized residuals) with the proportions predicted by the models. Three PCTs (all non-London) reported breastfeeding initiation as considerably higher than predicted, and two PCTs (both non-London) reported figures lower than predicted (outliers are highlighted in Figure 2). Three PCTs (all non-London) and four PCTs (three non-London, one London) reported proportions of any and exclusive breastfeeding higher than predicted. One London PCT reported the proportion of any breastfeeding

at 6-8 weeks as lower than expected. Table S2 shows the observed and predicted breastfeeding proportions for each PCT.

DISCUSSION

This is the first UK study to our knowledge designed to investigate the relationship between socio-demographic factors and breastfeeding at the area level, an analysis which is important given that services are commissioned and delivered at this level. There was enormous variation in area-based rates of breastfeeding. However, after adjusting for socio-demographic factors, most areas have breastfeeding rates within the expected range of the national average, albeit a relatively low national average (e.g. 45% any breastfeeding at 6-8 weeks). The area-based analysis revealed some striking associations between socio-demographic factors and breastfeeding; these persisted after adjustment for other factors. For example, an increase in the proportion of mothers aged 35 or older from 15% to 20% is associated with a 34% increase in the odds for area-level any breastfeeding at 6-8 weeks.

Limitations

This study used aggregate data and as such is subject to the usual limitation that causality cannot be inferred. Although the use of routine data has many benefits, for example wide geographical coverage, there are also inherent disadvantages such as the difficulty in assessing data quality. It is also possible that higher levels of breastfeeding can be partially explained by area-level factors not measured in this study, for example a greater number of accessible breastfeeding services. We included all socio-economic indicators routinely available at the PCT level. There may be other relevant factors that would have been useful to include, such as levels of maternal education.

The Department of Health for England does not make raw figures for annual outturn breastfeeding data routinely available. In order to model figures in our regression analysis, we relied on quarterly actual data. These data may differ very slightly from annual outturn data but there is no reason to suspect trends would be different. One advantage of our method (summing breastfeeding data across quarters) was that we were able to include PCTs with one or two data quarters missing, thus minimising data loss. However, a small number of PCTs were excluded as breastfeeding data did not meet our stipulated criteria (acceptable data quality for at least two quarters). In addition, the small number of PCTs in London (n=27-29 depending on analysis) may affect our confidence in the results from our analysis of London PCTs: it is unclear whether lack of association reflects a true lack of effort or is simply the consequence of an underpowered analysis. The observed breastfeeding proportions used in this analysis are likely to be an underestimate of the true number breastfeeding as we mirrored the denominators used by the DH which assumes that those for whom a breastfeeding status was not recorded are not breastfeeding.

Data on smoking at delivery was not available for all PCTs. Six PCTs were not eligible for inclusion as reported data did not meet DH quality checks. Despite this, smoking status was available for 99% of maternities in 2010-11 (range for individual PCTs included in this analysis 95.5-100%).

Our ethnicity indicator related to the general PCT population rather than the maternal population. Given the high level of missing data on maternal ethnicity from Hospital Episode Statistics (HES) (approximately eight percent in 2009-10[34]), using these data would have resulted in a reduction in our sample size. We compared the general ethnicity data with the HES maternal ethnicity data and noted that it correlated well, although the maternal HES ethnicity data reported higher proportions across all PCTs, probably due to the younger age profile of BME populations. We combined all non-White groups into a single BME indicator. This helped to minimise potential problems due to small numbers of certain ethnic groups in many PCTs. This decision was also supported by strong evidence that all non-White women are more likely to initiate and continue breastfeeding when compared to White women[11]. However, our approach left us unable to examine the separate contribution of individual ethnic groups or relevant factors such as migration history or acculturation status[35] to breastfeeding rates.

Interpretation of results

There was compelling evidence of a strong area effect of older maternal age on breastfeeding, with a one percent increase in the percentage of older mothers in a PCT associated with a 4-6% increase in the odds of breastfeeding. This trend was consistent across all outcomes and in both London and non-London PCTs, and is in line with evidence from individual level studies that older mothers are more likely to initiate and continue breastfeeding[11 24].

Outside London, the proportion of the PCT population from a BME background was associated with breastfeeding, with a unit increase in BME population resulting in a 1-3% increase in the odds of breastfeeding. Non-white ethnicity has consistently been linked to increased breastfeeding in individual level studies[16 17 20 22 26], although there is some variation between individual ethnic groups and by acculturation status[35]. Existing literature suggests that the strongest overall effect of ethnicity is on initiation and continuation, with minimal differences by ethnicity in the number of women who breastfeed exclusively[36 37]. Although BME background was associated with all breastfeeding outcomes outside London, it was only independently associated with breastfeeding at 6-8 weeks in London. The fact that we did not identify an independent effect of BME population on initiation in London may be partly due to the high rate of BME in the London PCTs (mean value 40%) making it difficult to detect an independent effect of ethnicity. In addition, it may be that high rates of breastfeeding in ethnically diverse areas supports the concept of "community ethnicity"[20], whereby some groups of White women appear to be more likely to breastfeed if they reside in an area with a high BME population. Differences in the composition of BME populations in London compared to outside London may also help to explain inconsistency in the observed effect of BME on breastfeeding.

PCTs in the most deprived quintile had a 21-32% reduced odds of breastfeeding compared to PCTs in the least deprived quintile. In London PCTs, results were less consistent after adjustment, with area deprivation only associated with breastfeeding initiation, and this association being in the opposite direction to that observed outside London (increased deprivation associated with increased odds of initiation). This perhaps highlights the complex relationships between ethnicity, socio-economic status and breastfeeding behaviour. BME populations tend to cluster in more deprived neighbourhoods. Women from non-White backgrounds are more likely to breastfeed. In general, mothers from lower socio-economic backgrounds are less likely to breastfeed. There is evidence that this latter trend cannot be generalised to mothers from non-White backgrounds[17]. Several studies have found that the effect of deprivation[17], socio-economic status[19], and income[22], is negligible when looking at breastfeeding among certain minority ethnic groups. Outside London, both deprivation and area level ethnicity remained independent predictors of breastfeeding even after adjusting for the other. Within London, the effect of one appeared to be attenuated by the other, except when looking at exclusive breastfeeding which was not independently associated with either.

Our analysis was designed to explain the variation in breastfeeding between PCTs. Only a handful of PCTs reported breastfeeding figures substantially above or below the proportions predicted by our models. The majority of outliers were PCTs with observed proportions higher than expected based on the national average having adjusted for socio-demographic factors; though two PCTs did report breastfeeding initiation as lower than predicted and one PCT had a lower than expected proportion of any breastfeeding at 6-8 weeks.

Implications

Our results demonstrate that while area-based rates of breastfeeding vary enormously, much of this variation is explained by the socio-demographic profile of the area. Currently, breastfeeding data provided at the PCT level for comparative purposes is unadjusted[38] and may result in misleading assessment of local performance. Adjusted breastfeeding figures as reported in this study may be used to identify areas with higher or lower than expected rates of breastfeeding. For those performing above expected levels, there may be lessons to be learned from examining local service provision.

The socio-demographic context within which a breastfeeding service is implemented or evaluated is clearly important[39]. A 'one size fits all' approach to breastfeeding support is unlikely to demonstrate a strong effect at the population level over and above the 'background noise' of such strong socio-demographic effects. Interventions which are tailored to the needs of a particular setting are more likely to be effective[40], particularly those that follow local needs assessment. Our findings can be used to help inform the primary focus of an intervention, for example whether the emphasis should be on breastfeeding initiation, duration or exclusivity, or a combination of these outcomes[40]. The size of effects observed in our study may also inform estimates of the likely effect of breastfeeding interventions, in a trial or other setting. In situations where the required trial size is too large to be

feasible, other forms of evaluation, such as case studies of high performing PCTs, are likely to be a more suitable approach.

In the new (post-April 2013) NHS structure in England, it is uncertain which organisations will be responsible for commissioning breastfeeding services. However, our results will be relevant to whichever local structures take over this function, particularly given that many of the geographical areas presented here will be recognisable in the new structure. Although most PCTs are performing at the level expected given current trends, overall breastfeeding rates are still low and fall short of UK recommendations for mothers to breastfeed exclusively for the first six months of life.

Conclusion

Our results confirm the importance of socio-demographic indicators of breastfeeding, and provide evidence that these indicators explain much of the heterogeneity between PCTs in terms of the proportion of mothers breastfeeding. However, there is little room for complacency; while some areas in England now have high rates of breastfeeding initiation; almost all have low rates of duration, particularly of exclusive breastfeeding. In order to maximise the likelihood of success, interventions designed to increase breastfeeding at the area level will need to be tailored to the socio-demographic context, and monitoring and assessment of area-based rates will need to take these factors into account.

Contributors
MQ and JK conceived the study and all authors contributed to the design of the study. MQ and LO designed and conducted the analysis. All authors were involved in the interpretation of the data. LO and MQ wrote the initial draft of the manuscript, and all authors contributed to revising consecutive drafts. All authors approved the final version of the manuscript. All authors had full access to all of the data in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. MQ and LO are the guarantors for the study.

Funding
This paper reports on an independent study which is funded by the Policy Research Programme in the Department of Health. The views expressed are not necessarily those of the Department. The funder had no role in: the design and conduct of the study; the analysis and interpretation of the data; and the drafting of the paper and decision to submit the paper for publication.

Competing interests
None.

Data sharing
Observed and predicted breastfeeding rates by PCT are provided as Supplementary Data. For further information please contact the corresponding author.

Ethics approval
Not needed.

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Table 1. Distribution of breastfeeding outcomes and socio-demographic variables by PCT

	ALL PCTS (n=151)			NON-LONDON PCTS (n=120)			LONDON PCTS (n=31)		
	mean (sd)	median (IQR)	min, max	mean (sd)	median (IQR)	min, max	mean (sd)	median (IQR)	min, max
Breastfeeding									
% initiating breastfeeding	72.3 (11.2)	72.8 (65.2-79.9)	39.0, 92.9	68.7 (9.1)	69.6 (62.5-75.7)	39.0, 85.5	86.3 (6.6)	88.9 (83.1-91.3)	67.7, 92.9
% any breastfeeding at 6-8 weeks[1]	45.3 (15)	42.3 (34.5-54.0)	19.2, 83.1	39.7 (10.0)	39.9 (33.7-45.5)	19.2, 70.5	67.5 (10.6)	71.3 (63.0-73.7)	38.1, 83.1
% exclusive breastfeeding at 6-8 weeks[1]	31.6 (9.1)	31.4 (24.9-37.1)	14.2, 58.2	29.2 (7.4)	29.3 (24.2-33.2)	14.3, 58.2	41.2 (8.8)	42.5 (35.0-48.6)	20.5, 57.5
Socio-demographic									
IMD (raw score)[2]	23.6 (8.4)	23.3 (16.6-29.5)	8.8, 45.3	23.1 (8.3)	22.8 (16.4-28.5)	8.8, 45.3	25.6 (8.8)	25.0 (16.7-31.9)	10.1, 41.8
% mothers aged 35+	19.3 (5.7)	18.4 (15.1-22.0)	9.4, 41.8	17.8 (4.4)	17.6 (14.5-21.2)	9.4, 32.3	25.2 (6.4)	24.5 (20.1-30.4)	15.4, 41.8
% mothers aged <20	5.9 (2.3)	5.8 (4.1-7.4)	1.3, 11.8	6.6 (1.9)	6.3 (5.3, 7.9)	2.8, 11.8	3.1 (1.1)	2.8 (2.2-3.8)	1.3, 5.6
% population BME	18.7 (14.3)	13.0 (7.8-25.9)	4.3, 67.0	13.1 (8.7)	10.9 (7.3-16.9)	4.3, 67.0	40.4 (10.9)	42.9 (33.9-47.5)	16.4, 61.9
% mothers smoking at delivery[3]	14.7 (6.1)	15.0 (10.7-18.8)	3.0, 33.2	16.7 (4.8)	16.5 (13.7,-19.9)	6.1, 33.2	6.6 (2.9)	5.9 (4.4-7.5)	3.0, 13.6

sd: standard deviation, IQR: interquartile range, IMD: Index of Multiple Deprivation, BME: Black and Minority Ethnic

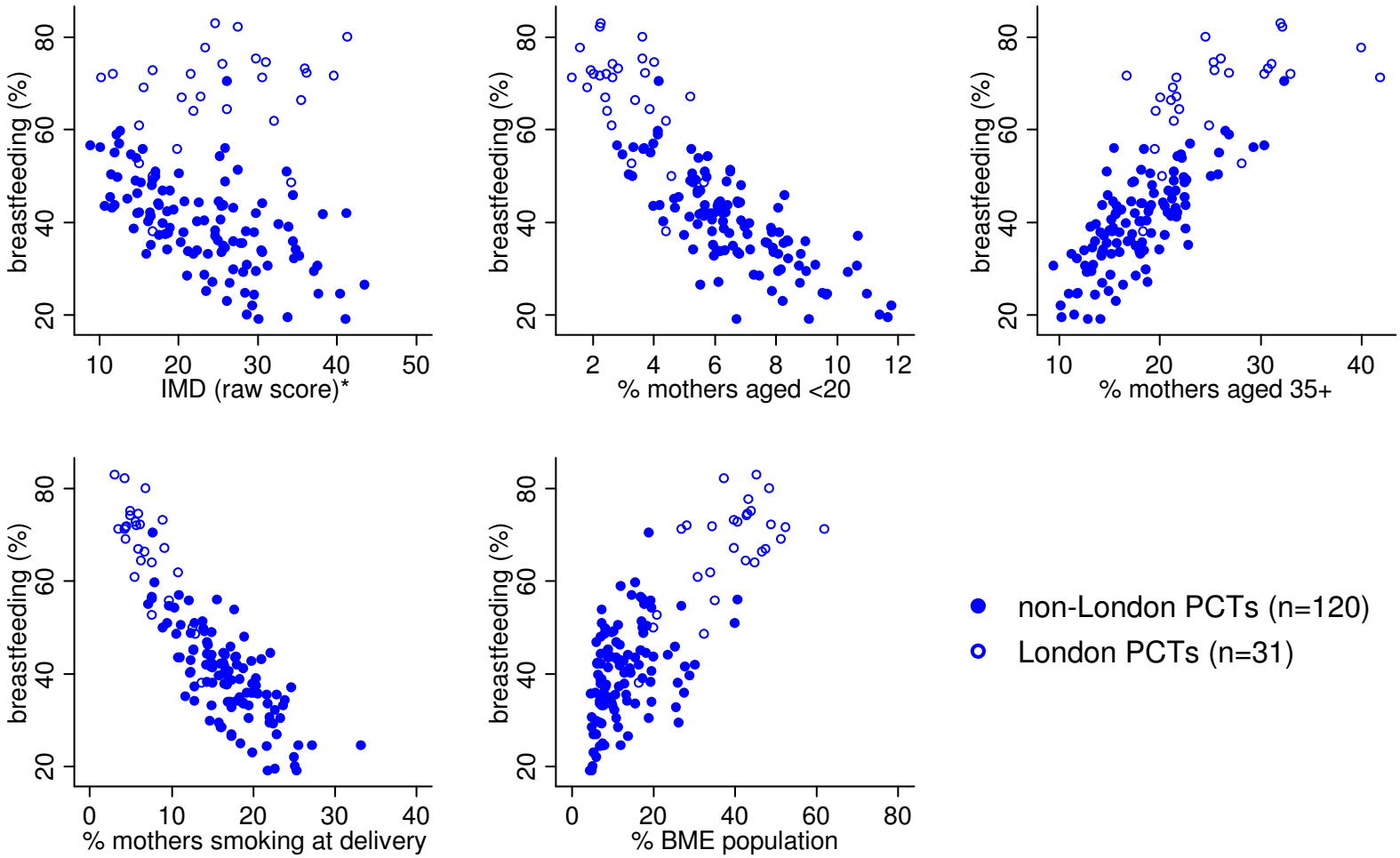
[1]Restricted to 141 PCTs with data on breastfeeding at 6-8 weeks

[2]A high score is indicative of greater deprivation

[3]Restricted to 146 PCTs with data on smoking at delivery

Information on maternal smoking at delivery was unavailable for a number of PCTs, leaving 144 and 137 PCTs included in the complete case analysis for breastfeeding initiation and breastfeeding at 6-8 weeks (115 non-London PCTs and 29 London PCTs; 110 non-London PCTs and 27 London PCTs).

Figure 1. Scatterplots for any breastfeeding at 6-8 weeks by socio-demographic factors (London vs. non-London)



*A high IMD score is indicative of greater deprivation

IMD: Index of Multiple Deprivation, BME: Black and Minority Ethnic

Table 2. Socio-demographic factors associated with PCT level breastfeeding: univariable and multivariable models for non-London PCTs

NON-LONDON PCTS	% INITIATING BREASTFEEDING (n=115)				% ANY BREASTFEEDING AT 6-8 WEEKS (n=110)				% EXCLUSIVE BREASTFEEDING AT 6-8 WEEKS (n=110)			
	UNADJUSTED		ADJUSTED[1]		UNADJUSTED		ADJUSTED[2]		UNADJUSTED		ADJUSTED[3]	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Index of Multiple Deprivation												
Quintile 1 (least deprived)	1.00		1.00		1.00		1.00		1.00		1.00	
Quintile 2	0.82	(0.68-1.00)	1.03	(0.88-1.20)	0.74*	(0.60-0.91)	0.98	(0.85-1.12)	0.83*	(0.70-0.98)	1.02	(0.89-1.17)
Quintile 3	0.68***	(0.56-0.83)	0.97	(0.82-1.15)	0.61***	(0.49-0.75)	0.89	(0.77-1.04)	0.67***	(0.56-0.79)	0.94	(0.80-1.10)
Quintile 4	0.56***	(0.46-0.68)	0.84	(0.70-1.01)	0.54***	(0.44-0.67)	0.83*	(0.71-0.98)	0.61***	(0.51-0.72)	0.90	(0.76-1.06)
Quintile 5 (most deprived)	0.50**	(0.41-0.61)	0.68**	(0.54-0.86)	0.51***	(0.41-0.64)	0.69***	(0.57-0.85)	0.54***	(0.45-0.65)	0.79*	(0.64-0.97)
% mothers aged 35+	1.07***	(1.06-1.09)	1.05***	(1.04-1.07)	1.08***	(1.06-1.09)	1.06**	(1.04-0.85)	1.07***	(1.05-1.08)	1.05***	(1.04-1.07)
% mothers aged <20	0.86***	(0.83-0.88)			0.84***	(0.82-0.87)			0.88***	(0.86-0.90)		
% population BME	1.01*	(1.00-1.02)	1.02***	(1.01-1.02)	1.02***	(1.01-1.03)	1.03***	(1.02-1.04)	1.01*	(1.00-1.02)	1.01***	(1.01-1.02)
% mothers smoking at delivery	0.94***	(0.93-0.95)			0.93***	(0.92-0.94)			0.95***	(0.94-0.96)		

*p <0.05 **p <0.01 ***p <0.001

OR: Odds ratio, BME: Black and Minority Ethnic

[1]Variables in model: IMD, % births to older mothers, % of population BME

[2]Variables in model: IMD, % births to older mothers, % of population BME

[3]Variables in model: IMD, % births to older mothers, % of population BME

Table 3. Socio-demographic factors associated with PCT level breastfeeding: univariable and multivariable models for London PCTs

LONDON PCTS	% INITIATING BREASTFEEDING (n=29)				% ANY BREASTFEEDING AT 6-8 WEEKS (n=27)				% EXCLUSIVE BREASTFEEDING AT 6-8 WEEKS (n=27)			
	UNADJUSTED		ADJUSTED[1]		UNADJUSTED		ADJUSTED[2]		UNADJUSTED		ADJUSTED[3]	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Index of Multiple Deprivation												
Quintile 1 (least deprived)	1.00		1.00		1.00				1.00			
Quintile 2	0.61	(0.35-1.04)	1.31	(0.94-1.84)	0.70	(0.43-1.15)			0.63*	(0.35-0.93)		
Quintile 3	1.22	(0.71-2.10)	1.38*	(1.03-1.85)	1.39	(0.85-2.28)			1.07	(0.72-1.57)		
Quintile 4	1.34	(0.75-2.37)	1.46*	(1.06-2.00)	1.48	(0.88-2.50)			0.95	(0.62-1.43)		
Quintile 5 (most deprived)	1.10	(0.69-1.75)	1.71***	(1.30-2.25)	1.18	(0.76-1.84)			0.82	(0.58-1.17)		
% mothers aged 35+	1.05***	(1.03-1.08)	1.04***	(1.02-1.06)	1.04**	(1.02-11.07)	1.06***	(1.04-1.07)	1.05***	(1.03-1.06)	1.06***	(1.04-1.07)
% mothers aged <20	0.79**	(0.68-0.92)			0.79**	(0.69-0.91)			0.82***	(0.74-0.91)		
% population BME	1.02*	(1.00-1.03)			1.03***	(1.01-1.04)	1.03***	(1.03-1.04)	1.01	(1.00-1.02)		
% mothers smoking at delivery	0.88***	(0.84-0.91)	0.90***	(0.87-0.94)	0.88***	(0.84-0.91)			0.92***	(0.89-0.95)	0.95**	(0.92-0.98)

*p <0.05 **p <0.01 ***p <0.001

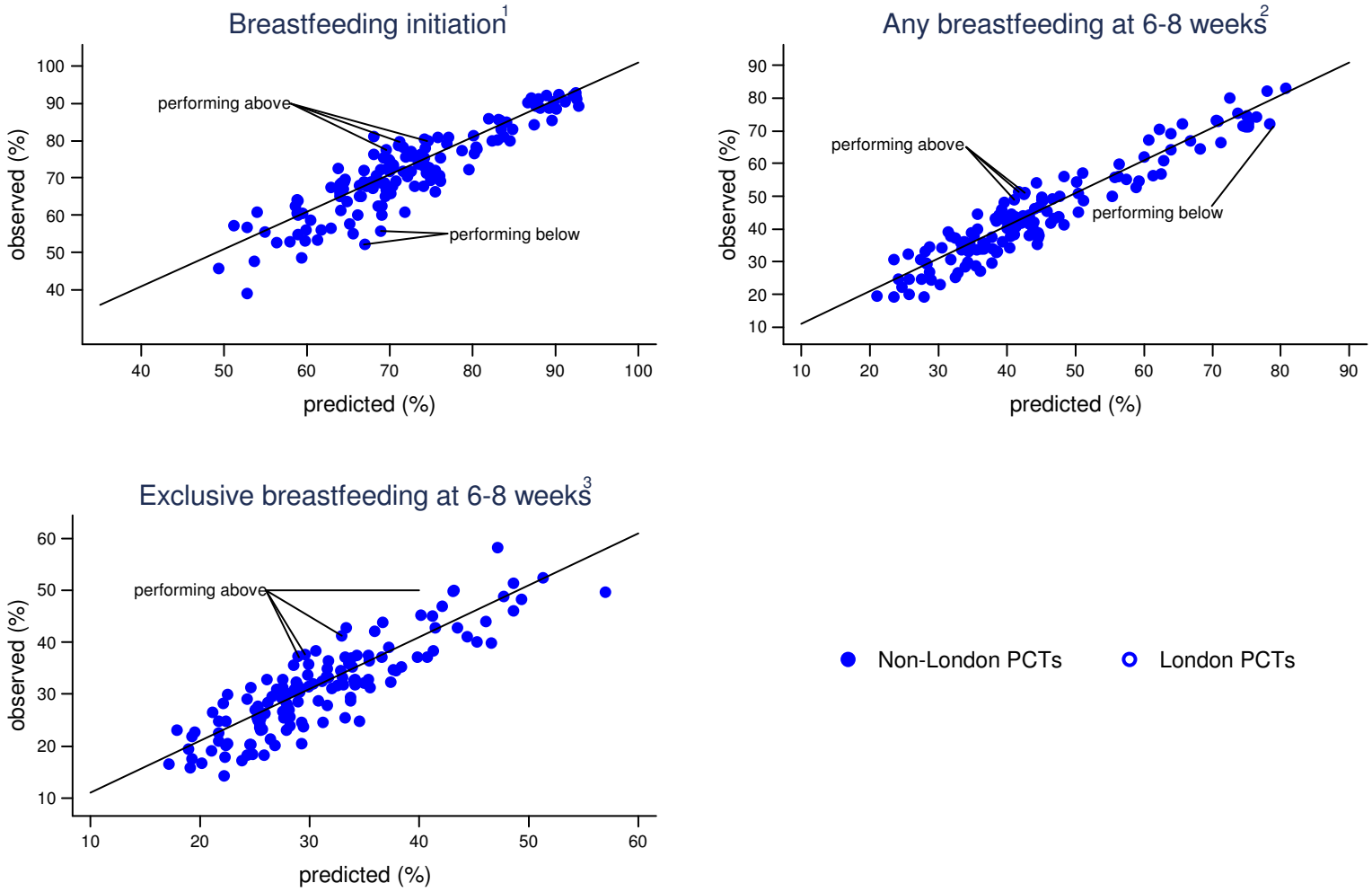
OR: Odds ratio, BME: Black and Minority Ethnic

[1]Variables in model: IMD, % births to older mothers, % smoking at delivery

[2]Variables in model: % of births to older mothers, % population BME

[3]Variables in model: % of births to older mothers, % smoking at delivery

Figure 2. Observed vs. predicted proportions of any breastfeeding at 6-8 weeks



N.B. In some cases PCTs classified as potential outliers reported similar breastfeeding figures to PCTs not identified as potential outliers: this discrepancy is due to differences in PCT size.

[1]Performing above: Hampshire, Sheffield, Somerset. Performing below: Dudley, Sefton.

[2]Performing above: Devon, Leeds, Sheffield. Performing below: Brent.

[3]Performing above: City and Hackney, Devon, Leeds, Sheffield

Supplementary tables

Table S1. Breastfeeding outcomes by socio-demographic variables

	% INITIATING BREASTFEEDING AT BIRTH		% ANY BREASTFEEDING AT 6-8 WEEKS		% EXCLUSIVE BREASTFEEDING AT 6-8 WEEKS	
	mean (sd)	min,max	mean (sd)	min,max	mean (sd)	min,max
Index of Multiple Deprivation						
Quintile 1 (least deprived)	77.8 (5.5)	67.7, 91.5	52.7 (9)	38.8, 72.1	37.8 (5.9)	28.8, 49.9
Quintile 2	73.5 (6.2)	60.8, 91.2	44.7 (9.1)	33.3, 72.8	32.2 (5)	23.3, 42.9
Quintile 3	72.8 (11.5)	52.2, 92.2	44.7 (16.2)	25.2, 83.1	31.5 (9.6)	18.2, 57.5
Quintile 4	67.2 (12.4)	48.6, 91.9	40.4 (17.6)	19.2, 82.2	28.4 (10.5)	14.3, 58.2
Quintile 5 (most deprived)	69.6 (15.1)	39, 92.9	44.2 (18.5)	19.2, 80.1	28.3 (9.9)	15.9, 50
% mothers aged 35+						
<15%	60.5 (8.2)	39, 73.6	31.5 (7.7)	19.2, 50.9	23.2 (4.8)	14.3, 32.8
15-<20%	69.8 (8)	52.2, 88.9	41 (9.3)	23.1, 71.7	28.8 (5.6)	17.2, 42.2
20-<25%	78.1 (6.2)	67.7, 92.1	51.6 (11)	35.2, 80.1	35.5 (5.2)	24.9, 50
≥25%	86.5 (5.9)	76, 92.9	67.2 (10.5)	50.1, 83.1	45.5 (6.6)	34.7, 58.2
% mothers aged <20						
<3%	87.7 (4.2)	79.9, 92.2	70.3 (7.8)	54.8, 83.1	44.5 (7.1)	32.1, 57.5
3-<6%	76.5 (7.7)	53.4, 92.9	50.3 (11.5)	26.7, 80.1	34.5 (7.5)	18.3, 58.2
6-<8%	68 (7.9)	39, 81.1	38.4 (6.9)	19.2, 51.4	28.7 (5.1)	15.9, 38.4
≥8%	59.3 (7.2)	45.8, 76.3	30.2 (6.8)	19.2, 45.9	22.3 (4.6)	14.3, 32.8
% population BME						
<10%	65.9 (9.8)	39, 81.1	35.4 (9)	19.2, 54	27.2 (6.9)	14.3, 42.7
10-<20%	71.2 (8.1)	47.6, 85.5	43.8 (9.5)	24.7, 70.5	31.7 (7.7)	17.9, 58.2
20-<40%	77.1 (10.2)	56.5, 92.2	53.4 (15)	29.5, 82.2	33.9 (10.2)	18.5, 51.5
≥40%	87 (6.7)	66.4, 92.9	71.3 (6.7)	56.1, 83.1	42.5 (7.6)	32.1, 57.5
% mothers smoking at delivery						
<10%	85.6 (5.8)	72.3, 92.9	66.7 (9.2)	50.1, 83.1	42.4 (6.7)	31.6, 58.2
10-<15%	73.4 (5.6)	55, 80.9	45.3 (7)	29.9, 61.9	31.8 (5.6)	20.2, 43.8
15-<20%	67.3 (6.7)	52.2, 79.7	37.9 (7)	23.1, 56.1	27.7 (5.7)	17.2, 42.7
>20%	59.6 (9.1)	39, 81.1	30.5 (7.3)	19.2, 44.6	23.4 (5)	14.3, 31

Table S2. Observed and predicted breastfeeding: data for all primary care trusts

PRIMARY CARE TRUST	BREASTFEEDING INITIATION			ANY BREASTFEEDING AT 6-8 WKS			EXCL. BREASTFEEDING AT 6-8 WEEKS		
	O	P	SR	O	P	SR	O	P	SR
NORTH EAST									
County Durham	56	59.9	-0.86	26.9	28.7	-0.49	20.5	22.5	-0.63
Darlington	60.2	66.1	-0.67	33.7	33.3	0	25.1	25.4	-0.11
Gateshead	67.5	62.9	0.7	37.9	31.9	0.94	31.4	24.6	1.16
Hartlepool	45.8	49.3	-0.35	19.5	21	-0.23	16.6	17.2	-0.14
Middlesbrough	47.6	53.6	-0.81	24.7	25.7	-0.2	21.8	19.3	0.41
Newcastle	62.4	68.6	-1.13	42.1	40.5	0.27	32.3	28.8	0.67
North Tees	57.7	65.1	-1.09	25.2	32.5	-1.25	20.3	24.6	-0.83
North Tyneside	60	69	-1.4	34	36.6	-0.44	28.3	27.9	0.01
Northumberland	62.5	69	-1.13	35.8	36.5	-0.16	30.8	28.7	0.36
Redcar and Cleveland	52.7	56.3	-0.41	20.1	25.6	-0.83	16.8	20.2	-0.58
South Tyneside	52.9	57.9	-0.61	24.8	27.5	-0.44	19.1	21	-0.36
Sunderland Teaching	53.1	59.8	-1.09	24.5	29	-0.9	20.1	22.4	-0.54
NORTH WEST									
Ashton, Leigh and Wigan	56	61.7	-1.04	23.1	30.3	-1.57	17.2	23.8	-1.59
Blackburn with Darwen	72.6	63.7	1.27	32.9	38.5	-0.91	24.2	25.4	-0.28
Blackpool	56.8	52.7	0.48	24.7	24.1	0.05	19.4	18.9	0.02
Bolton	67	64.4	0.49	33.7	35.6	-0.44	27.8	25.3	0.51
Bury	69.2	70.7	-0.24	40.2	40.1	-0.02	30.5	29.1	0.2
Central and Eastern Cheshire	67.7	74	-1.44	38.8	44.6	-1.37	28.8	33.7	-1.24
Central Lancashire	66.9	69.5	-0.61	33.9	37.9	-0.98	23.9	28.2	-1.17
Cumbria	67.7	67.1	0.13	28.6	33.9	-1.13	21.4	26.4	-1.17
East Lancashire	68.3	63.9	0.91	35.7	34.5	0.22	27.1	25	0.47
Halton and St Helens	48.6	59.3	-1.9	19.2	28	-1.89	14.3	22.2	-1.89
Heywood, Middleton and Rochdale	60.6	58.8	0.29	39.2	31.4	1.39	24.7	22.3	0.45
Knowsley	39	52.8	-1.76	19.2	23.5	-0.74	15.9	19.1	-0.62
Liverpool	53.4	61.3	-1.55	26.7	32.8	-1.59	18.3	24.3	-1.74
Manchester	68.3	67.4	0.24	42.1	43.9	-0.52	25.7	28.2	-0.83
North Lancashire	68.6	69.3	-0.12	37.6	37.8	-0.07	30.5	28.7	0.3
Oldham	66.2	63.9	0.38	34.1	36.2	-0.44	20.3	24.6	-0.98
Salford	64.2	58.8	0.94	34.3	30.5	0.72	29.9	22.5	1.58
Sefton	**55.8**	**68.9**	**-2.17**	27.1	36.1	-1.58	23	27.9	-0.97
Stockport	73.2	74.2	-0.2	46.9	44.7	0.36	35.9	33.5	0.41
Tameside and Glossop	61.2	64	-0.47	35.6	33.9	0.22	25	25.3	-0.1
Trafford	76.6	80.2	-0.7	50.1	55.4	-0.95	37.1	40.7	-0.69
Warrington	60.8	71.8	-1.77	34.2	40.4	-1.03	24.6	31.2	-1.2
Western Cheshire	69.5	74.9	-0.92	35.2	44.4	-1.09	24.9	34.6	-1.23
Wirral	55	65.5	-1.7	29.9	34.3	-0.93	20.2	26.8	-1.52
YORKSHIRE AND THE HUMBER									
Barnsley	62.5	58.6	0.63	30.8	27.5	0.51	24.8	21.7	0.5
Bradford and Airedale	69.7	64.6	1.42	39.7	40.4	-0.25	26.3	25.9	0.07
Calderdale	78.4	71.5	1.14	40.5	41.1	-0.14	31.6	29.9	0.24
Doncaster	63.9	58.9	0.91	29.6	28.1	0.27	21.1	21.7	-0.22
East Riding Of Yorkshire	70.4	72.1	-0.3	42.2	42.1	-0.02	33.2	31.6	0.22
Hull	57.2	51.1	1.09	30.6	23.5	1.58	23.1	17.8	1.29
Kirklees	73.8	70.2	0.85	40.7	41.4	-0.19	26.9	28.1	-0.37
Leeds	72.2	68.9	1.05	**48.8**	**41.1**	**2.51**	**37.3**	**29**	**2.95**
North East Lincolnshire	55.5	54.9	0.08	22.2	24.7	-0.45	17.6	19.2	-0.37
North Lincolnshire	58.6	60.4	-0.22	33.2	28	0.74	26.5	21.2	0.83
North Yorkshire and York	73.6	73.5	0.05	-	-	-	-	-	-
Rotherham	60.1	58.9	0.19	29.3	28.3	0.15	22.6	21.7	0.12

PRIMARY CARE TRUST	BREASTFEEDING INITIATION			ANY BREASTFEEDING AT 6-8 WKS			EXCL. BREASTFEEDING AT 6-8 WEEKS		
	O	P	SR	O	P	SR	O	P	SR
Sheffield	**77.6**	**69.5**	**2.06**	**51.4**	**41.7**	**2.44**	**37.7**	**29.6**	**2.22**
Wakefield District	60.6	59.4	0.22	34.5	28.7	1.28	28.3	22.1	1.48
EAST MIDLANDS									
Bassetlaw	68.9	66.8	0.2	36.1	33.8	0.23	28.4	26.1	0.23
Derby City	71.8	70	0.34	38.3	41.1	-0.59	27.9	28	-0.06
Derbyshire County	72.8	70.4	0.66	42.4	38.5	1.04	35.7	29.9	1.7
Leicester City	73.6	70.4	0.74	50.9	50.4	0.08	31.9	30.3	0.35
Leicestershire County and Rutland	72.8	74.7	-0.52	43.1	46.9	-1.05	32.9	34.1	-0.38
Lincolnshire	72.1	66.8	1.45	38.9	34.8	1.17	29.6	26.5	0.93
Northamptonshire	75.9	72.6	1.03	44.3	43.3	0.25	33.4	31.5	0.57
Nottingham City	68.9	64.5	0.91	45.9	39.2	1.42	32.8	26	1.6
Nottinghamshire County	71.8	71.5	0.08	37.7	40.5	-0.81	28.8	30.8	-0.68
WEST MIDLANDS									
Birmingham East and North	65.2	66.5	-0.32	41.8	42.1	-0.14	26.7	27.6	-0.31
Coventry Teaching	75	69.8	1.11	38.1	44.7	-1.49	24.6	29.3	-1.19
Dudley	**52.2**	**66.9**	**-2.74**	28.7	35.4	-1.38	18.2	25.8	-1.73
Heart Of Birmingham Teaching	72.3	79.5	-1.91	-	-	-	-	-	-
Herefordshire	-	-	-	-	-	-	-	-	-
North Staffordshire	67.2	67.9	-0.1	39.9	35.7	0.48	31.4	27.6	0.47
Sandwell	56.5	62.9	-1.31	29.5	37.8	-1.89	18.5	24.7	-1.65
Shropshire County	74	73.4	0.11	42.2	42.2	-0.04	33.2	33	-0.02
Solihull Care Trust	69.2	76.1	-1.19	41.3	48.3	-0.97	31.2	35.5	-0.66
South Birmingham	68.9	67.7	0.26	44.1	42.3	0.35	28.6	28.9	-0.13
South Staffordshire	65.8	70.1	-1.1	33.3	38.5	-1.41	23.7	29.4	-1.67
Stoke On Trent	60.8	53.9	1.09	32.3	25.5	1.45	22.8	19.5	0.75
Telford and Wrekin	65.1	66.3	-0.17	33.2	34.4	-0.23	23.5	25.4	-0.38
Walsall Teaching	54.8	58.8	-0.7	30.6	31.8	-0.29	17.9	22.2	-1.05
Warwickshire	71.4	74.3	-0.77	41.9	46.4	-1.14	29.4	33.7	-1.18
Wolverhampton City	65.2	64	0.22	36	39.3	-0.67	23.1	25.5	-0.57
Worcestershire	73.9	73.7	0.07	41.5	43.3	-0.49	31.9	33.1	-0.38
EAST OF ENGLAND									
Bedfordshire	75.4	76.1	-0.16	45.2	50.3	-1.21	32.9	35.4	-0.64
Cambridgeshire	80.9	77	1.14	57.1	51	1.34	43.8	36.7	1.64
Great Yarmouth and Waveney	63.7	64.8	-0.17	37.1	32.4	0.7	29.1	24.3	0.79
Hertfordshire	-	-	-	-	-	-	-	-	-
Luton	66.4	75.4	-1.79	56.1	56.3	-0.07	32.7	34	-0.32
Mid Essex	71.6	75.3	-0.82	43.7	47.5	-0.74	32.2	34.9	-0.6
Norfolk	75.6	71.8	1.06	43.8	41.2	0.7	32.6	31.1	0.39
North East Essex	72.9	69.8	0.58	42.9	39.7	0.58	31.6	28.9	0.52
Peterborough	65.1	69.4	-0.65	43.8	40.6	0.44	29.3	27.4	0.26
South East Essex	73.3	74	-0.16	37.3	44.6	-1.38	25.5	33.3	-1.6
South West Essex	67.7	73	-1.28	-	-	-	-	-	-
Suffolk	71.8	72.5	-0.18	46.3	44	0.55	36.4	31.7	1.24
West Essex	-	-	-	-	-	-	-	-	-
LONDON									
Barking and Dagenham	70.7	75.9	-1.34	48.6	52.8	-0.61	20.5	27.6	-1.16
Barnet	91.2	87.9	1.54	72.8	69.6	0.87	42.9	42.3	0.09
Bexley Care Trust	73.4	74	-0.08	50.1	46.5	0.7	35.6	30.1	1.04
Brent Teaching	85.5	89.5	-1.84	**71.4**	**78.9**	**-2.39**	41.1	41.8	-0.2
Bromley	83	83.4	-0.07	52.8	58	-1.21	34.7	41.9	-1.65
Camden	90.4	91.1	-0.21	74.2	77	-0.63	48.4	47.7	0.1
City and Hackney Teaching	92.1	88.8	1.44	80.1	73.8	1.81	**50**	**40**	**2.37**
Croydon	85.9	81.9	1.57	67.3	64.3	0.87	37.1	35	0.54

PRIMARY CARE TRUST	BREASTFEEDING INITIATION			ANY BREASTFEEDING AT 6-8 WKS			EXCL. BREASTFEEDING AT 6-8 WEEKS		
	O	P	SR	O	P	SR	O	P	SR
Ealing	-	-	-	-	-	-	-	-	-
Enfield	90.3	86.7	1.56	64.6	66.8	-0.48	34.6	38.6	-0.86
Greenwich Teaching	79.8	82.3	-0.76	61.9	59.5	0.6	37.4	32.8	1.07
Hammersmith and Fulham	91.9	92.4	-0.11	82.2	74.7	1.66	51.5	49.5	0.32
Haringey Teaching	92.3	90.4	0.91	72.3	76.3	-0.94	44	42.6	0.22
Harrow	84.9	84	0.32	69.2	72.1	-0.52	45.1	40.4	0.73
Havering	67.7	70.3	-0.53	38.1	41.2	-0.52	23.3	27.7	-0.83
Hillingdon	77.3	78.7	-0.36	55.9	57.9	-0.45	31.6	32.7	-0.27
Hounslow	85.6	83	0.96	64.1	65.6	-0.3	42.2	35.3	1.36
Islington	88.7	89.2	-0.12	73.2	74.8	-0.33	48.9	42.3	1.19
Kensington and Chelsea	-	-	-	-	-	-	-	-	-
Kingston	91.5	87	1.38	72.1	66.7	1.09	49.9	46.2	0.6
Lambeth	92.9	92.4	0.25	-	-	-	-	-	-
Lewisham	88.4	90	-0.62	74.6	71.1	0.98	47	41.7	1.21
Newham	84.3	87.4	-1.38	-	-	-	-	-	-
Redbridge	83.1	84.8	-0.45	67	68.1	-0.25	32.3	37.5	-1.17
Richmond and Twickenham	91.3	92.5	-0.43	71.3	78	-1.55	49.6	57.4	-1.46
Southwark	90.5	89.8	0.37	75.3	72.6	0.8	42.8	43.6	-0.21
Sutton and Merton	79.9	84.5	-1.87	61	61.6	-0.16	39.1	41.9	-0.79
Tower Hamlets	88.9	88.2	0.35	71.7	67.6	1	32.1	36.8	-1.09
Waltham Forest	89.3	87.6	0.71	66.5	68.8	-0.53	35.2	37.5	-0.53
Wandsworth	92.2	92.1	0.1	72	73.8	-0.44	46	49.9	-0.88
Westminster	89.2	92.8	-1.29	83.1	79.2	0.94	52.4	50.8	0.25
SOUTH EAST COAST									
Brighton and Hove City	85.5	83.3	0.49	70.5	62.2	1.47	58.2	47.1	1.95
E Sussex Downs and Weald	80.9	75.8	1.01	49.3	46.6	0.45	36.5	35.4	0.17
Eastern and Coastal Kent	70.7	68.4	0.67	-	-	-	-	-	-
Hastings and Rother	76.3	68	1.14	43.2	38.3	0.66	30.9	28.6	0.3
Medway	67.9	66.3	0.29	37.9	35.1	0.52	25.5	25.2	0.01
Surrey	81.2	83.7	-1.15	56.8	62.6	-1.59	39.9	46.6	-1.82
West Kent	71.9	75.4	-1.07	-	-	-	-	-	-
West Sussex	-	-	-	-	-	-	-	-	-
SOUTH CENTRAL									
Berkshire East	81.2	80	0.33	54.8	59.2	-0.98	37.2	39.8	-0.63
Berkshire West	77.9	80.5	-0.77	55.1	57.4	-0.55	38.4	41.3	-0.73
Buckinghamshire	80.2	83	-0.85	56.3	61.4	-1.36	40	45.3	-1.42
Hampshire	**79.9**	**74.5**	**2.15**	45.5	45.9	-0.19	31.8	34.2	-1
Isle Of Wight NHS	81.1	68	1.45	44.6	35.7	0.96	31	26.9	0.45
Milton Keynes	75.4	74.1	0.27	55.9	48.3	1.46	34.6	32.9	0.31
Oxfordshire	78.3	80.4	-0.69	59.8	56.4	0.92	45	41.2	1.05
Portsmouth City Teaching	75.4	69.3	1	43.6	39.1	0.7	32.8	27.6	0.91
Southampton City	74.6	69.9	0.89	44.6	40.7	0.59	30.1	28	0.33
SOUTH WEST									
Bath and NE Somerset	-	-	-	-	-	-	-	-	-
Bournemouth and Poole	76.2	72.4	0.67	50.7	42.4	1.63	35	31.6	0.68
Bristol	79.3	76.9	0.67	54.3	50.2	0.99	37.5	35.3	0.53
Cornwall and Isles Of Scilly	78.8	71	1.85	44.4	38.8	1.29	33.8	29.8	0.97
Devon	75.9	73.4	0.7	**51.1**	**42.6**	**2.22**	**41.3**	**32.9**	**2.33**
Dorset	76.4	73.7	0.51	54	44.3	1.75	42.7	33.4	1.79
Gloucestershire	75.8	73.7	0.56	49	45	0.99	37.2	33.2	1.05
North Somerset	78	74.2	0.58	48.7	45.2	0.49	35.3	33.9	0.16
Plymouth Teaching	68.8	68.8	-0.01	35	36.9	-0.4	25.5	27.6	-0.5
Somerset	**79.7**	**71.1**	**2.07**	48	39.6	1.98	38.4	30.5	1.97

PRIMARY CARE TRUST	BREASTFEEDING INITIATION			ANY BREASTFEEDING AT 6-8 WKS			EXCL. BREASTFEEDING AT 6-8 WEEKS		
	O	P	SR	O	P	SR	O	P	SR
South Gloucestershire	77	72.5	0.79	43.5	43.2	0.01	31.1	32	-0.23
Swindon	75.9	72.7	0.56	40.3	43.7	-0.45	27.9	31.6	-0.55
Torbay Care Trust	68.6	64.1	0.52	35.9	33.3	0.25	25.3	25.5	-0.09
Wiltshire	80.3	74.2	1.47	49.9	45.1	0.96	37.1	33.8	0.68

O = observed percentage (%), P = predicted percentage (%), SR = standardised residuals (number of)

N.B. Observed figures presented in this table may differ slightly from DH annual outturn percentages, as we used quarterly actual data in our calculations.

Factors associated with breastfeeding: an area-based analysis (FAB) Project protocol

A. Project summary

To measure the effects of breastfeeding interventions and socio-demographic factors on area-based breastfeeding rates.

The specific objectives are to:

1. Collate area-based data on breastfeeding prevalence at 6-8 weeks, socio-demographic factors and breastfeeding interventions
2. Use these data to identify predictors of variation between areas in breastfeeding prevalence at 6-8 weeks
3. Use individual level data to measure the demand for breastfeeding services
4. Monitor changes over time in breastfeeding prevalence and interventions, and evaluate the implementation of any subsequent changes in service.

Methods

Babies who are not breastfed have poorer health in infancy and childhood. Breastfeeding is recognised as a key indicator of the success of public health policies according to the new public health outcomes framework. Area-based data on breastfeeding rates at 6-8 weeks and socio-demographic factors (e.g. maternal age, ethnicity, deprivation) are routinely available; currently these are PCT-based but it is envisaged that these will become available for local authority areas. Data on breastfeeding interventions (e.g. Baby Friendly accreditation, number of breastfeeding counsellors, weekly opening hours of clinics/cafes) will be obtained from the relevant organisations. Data on local area-based breastfeeding initiatives will be obtained from the appropriate bodies. Data on other relevant interventions will be obtained e.g. Family Nurse Partnership sites. An Advisory Group with representatives from the NHS and breastfeeding organisations will ensure that all key data on breastfeeding support are collected. Area-level data will be summarised using descriptive statistics, graphs, and if appropriate using an atlas. Predictors of variation by area will be identified using regression models. The demand for breastfeeding services will be assessed using data from the Infant Feeding Surveys (2005, 2010) and the National Maternity Survey 2010.

B. Co-investigators

The co-investigators are: Maria Quigley, Laura Oakley, Jenny Kurinczuk (NPEU, Oxford), Mary Renfrew (MIRU, York). In addition, an Advisory Group will be formed.

C. Data collection including downloading data

Much of the data required for the project is available in the public domain. However it is envisaged that some primary data collection will be necessary.

For objective (2) (to identify predictors of variation between areas in breastfeeding prevalence at 6-8 weeks), the key data items are:

- **Outcome** i.e. breastfeeding prevalence at 6-8 weeks. Our primary outcome is the prevalence of any BF at 6-8 weeks but we will also look at exclusive (total) breastfeeding at 6-8 weeks and BF initiation.
- **Exposure** i.e. breastfeeding support. There are many possible services to consider (e.g. Baby Friendly accreditation, number of breastfeeding counsellors, weekly opening hours of clinics/cafes) and we need to decide which ones to focus on and how to "measure" the service (e.g. number of FTE staff or number of hours/days a service is available). Some things to consider are:
  - Which services are likely to have the strongest effect on BF rates.
  - Is it possible to focus on a few "key" services or do we need to be as inclusive as possible.
  - Changing services over time, particularly with the new government.
  - Retrospective versus current data.
  - NHS services versus voluntary organizations.
  - How easy is it to access the data e.g. some data is available on Chi-mat.

- **Socio-demographic factors** e.g. mother's age, ethnicity, area-based deprivation measures, etc.

- **Other potential confounders** e.g. number of births (in the PCT), rates of caesarean section, LBW, etc.

- **Health outcomes** – we could look at the association between BF at 6-8 weeks and health outcomes, and the association between BF support and health outcomes.

Table 1 shows the potential data items for the project which are already available in the public domain. Note that most of these variables are available at the PCT level (n=152 PCTs); some are also available at other levels e.g. local authority. The data items in Table 1 are probably sufficient for our outcomes (breastfeeding and also the health outcomes, if we decide to include these) and our confounders (socio-demographic and other factors). However, there are only limited data items on breastfeeding support. It should be noted that for 2009, detailed data on breastfeeding support is available for the 31 London PCTs; this was collected as part of the London mapping project which Mary Renfrew led.

We may want to do some preliminary analysis to help us decide how much additional primary data collection is necessary. For example, preliminary analysis of the Chi-mat data for all 152 PCTs and for the 31 London PCTs may help us identify what (if any) additional

data items need to be collected. We may also be able to add additional data easily (e.g. NCT, Baby Cafes?). If this analysis shows that (some of) the data items on BF services looks like they might be associated with BF rates then it would be worth doing primary data collection for these variables e.g. write to all PCTs.

For objective (3) (use individual level data to measure the "demand" for breastfeeding services), the Infant Feeding Surveys (2005, 2010) and the National Maternity Survey 2010 will be used e.g. IFS 2005, did anyone show you how to put baby to the breast and how useful was this or would you have liked help on this; while you were in hospital did you get enough help or advice with feeding problems.

Objective (4) (monitor changes over time and evaluate changes in service) will be planned once Objective 2 is finalised.

D. Proposed timeline (subject to decisions about preliminary analysis/primary data collection)

1. Planning and scoping phase (April – August 2011)

- Draft the study protocol
- Identify the key sources of routine data

2. Exploring existing data (September 2011 – February 2012)

- Start exploring existing data (what's there, what's missing, mapping; download relevant data):
    - DH BF rates
    - Chimat/similar
    - BFI
    - NCT and Baby cafes
    - Other sources e.g. Sure Start, FNP, Child Centres, Little Angels, BF Network
    - DH PCT data and progress reports
    - National Maternity Survey and Infant Feeding Surveys
- Identify and write to Advisory Group
- To conduct analysis using retrospective data – useful as a pilot, to check data quality, to look at effectiveness of previous interventions and trends over time)

3. Data collection (March – July 2012)

- 1st Advisory Group meeting (early 2012) – to discuss what data are available and data quality, and to agree whether further data needs to be collected and how
- Finalise list of data sources (much data will already exist and be accessible; some primary data collection is likely e.g. writing to local authorities/BF co-ordinators for localised BF initiatives)
- Download any relevant datasets

- Produce sampling frame and contact details for primary data collection
- Design simple data collection form to collect information on BF interventions
- Send out data collection forms (with reminders etc)
- Enter data collection forms

4. Data analysis (March - Dec 2012; note that some of this can be started before the data collection is complete)

- 2nd Advisory Group meeting (autumn 2012) – to describe what data has been collected e.g. completeness, quality, response rates
- Data management and cleaning - merge all relevant datasets, check and clean data.
- Descriptive data analysis – data quality, completeness, crude BF rates, crude data (and mapping) for BF interventions and confounders. Use maps and atlas as appropriate
- Regression models

5. Writing up and dissemination (end 2012 – early 2013)

- 3rd Advisory Group meeting (end 2012) – to present key findings and get relevant input on interpretation and dissemination
- Conference/other appropriate forum
- Liaise with local authorities/other relevant groups regarding appropriately targeted dissemination
- Journal article (s)

Table 1 Potential PCT-level data items available

Data item	Source of data
Breastfeeding	
% BF initiation	DH (Local delivery plan return)
% BF (exclusive or partial) at 6-8 weeks	DH (Local delivery plan return)
% "totally" BF (i.e. EBF) at 6-8 weeks	DH (Local delivery plan return)
% partially BF at 6-8 weeks	DH (Local delivery plan return)
Socio-demographic and clinical confounders	
IMD	Dept for communities & local gov
No. births	ONS
% CS	HES
% mothers aged 35+	HES
% mothers aged <20	HES
% smoking at time of delivery	Local delivery return plan
% LBW	ONS
% population BME (census-derived)	ONS
Maternal ethnicity	HES (applied for)
Health outcomes	
Infant mortality rate	ONS
Hospital adm rate for gastroenteritis, under 1 yr	HES
Hospital adm rate for RTI, under 1 yr	HES
Breastfeeding support/services	
BFI accreditation	UNICEF
No. FTE health visitors	Annual NHS workforce census
Breastfeeding support/services	
Available in 2009 for 31 London PCTs only:	
Infant Feeding lead WTE per 3000 births	
Staff dedicated to provision of BF services WTE	
No. BF services	
No. BF services in antenatal period	
No. BF services to hospital discharge	
No. BF services in community (postnatal)	
No. BF services with trained peer support	
No. services targeted to priority pop groups	
No. services planned/under evaluation	

FAB data analysis plan (objective 2)

Agreed by co-investigators June 2012

Note added 06.02.13
This data analysis plan is attached as a supplementary file for the paper submitted to the BMJ "Factors associated with breastfeeding in England: an analysis by primary care trust". The submitted paper covers the analysis of objective 2a as described in this analysis plan. Anything in this analysis plan which specifically relates to objective 2b should be ignored.

1. Aims and objectives

The overall objectives of the FAB project as described in the project protocol are to:

1. Collate area-based data on breastfeeding prevalence at 6-8 weeks, socio-demographic factors and breastfeeding interventions
2. Use these data to identify predictors of variation between areas in breastfeeding prevalence at 6-8 weeks
3. Use individual level data to measure the demand for breastfeeding services
4. Monitor changes over time in breastfeeding prevalence and interventions, and evaluate the implementation of any subsequent changes in service.

This data plan covers the analyses planned to address objective 2 (to use data to identify predictors of variation between areas in breastfeeding prevalence). We will address the following specific objectives as part of objective 2:

a. To identify socio-demographic predictors of variation between areas in breastfeeding rates
b. To measure the effect of a specific breastfeeding intervention (the Baby Friendly Initiative) on area-based breastfeeding rates
c. To measure the effect of other indicators of breastfeeding support on area-based breastfeeding rates

The first two objectives (objectives 2a and 2b) are covered in this analysis plan. The inclusion of other indicators of breastfeeding support (objective 2c) will be agreed after primary data collection has been planned.

2. Design

This is an ecological (area-based study) study making use of routine aggregate data. A subsequent phase may involve primary data collection and will address the third objective (objective 2c) of this study.

3. Variables

3.2 Definition of outcomes

The primary outcome is breastfeeding prevalence ('any breastfeeding') at 6-8 weeks. Secondary outcomes are the prevalence of exclusive ('total') breastfeeding at 6-8 weeks and initiation of breastfeeding

Information on breastfeeding status at 6-8 weeks (breastfeeding prevalence) is collected by the GP or HV conducting the routine 6-8 week infant check and reported by PCTs to the Department of Health (DH) as part of the of the Vital Signs Monitoring Return programme (VSMR). Infants exclusively breastfed are those who are receiving breast milk and "NOT receiving formula milk, any other liquids or food". The proportion 'any breastfeeding' comprises those infants

who are totally breastfed or who are receiving some breast milk in addition to other milk, liquids or food. The denominator for this outcome is the number of infants due a 6-8 week check.

Data on breastfeeding initiation is typically collected by midwives in acute trusts and again forms part of the VSMR. In this case, breastfeeding initiation is defined as the "mother…having initiated breastfeeding if, within the first 48 hours of birth, either she puts the baby to the breast or the baby is given any of the mothers breast milk". The denominator for this outcome is the number of maternities.

A third secondary outcome – drop off in breastfeeding between initiation and 6-8 weeks – may also be included.

Data on breastfeeding prevalence at 6-8 weeks and breastfeeding initiation are reported quarterly by PCTs. All outcome data used in this analysis will relate to the time period April 2010-March 2011 (2010-11 quarters 1-4).
The DH releases PCT level figures where the data pass validation checks and meets a minimum level of data coverage. Coverage is defined as the percentage of infants due a 6-8 week check for whom a breastfeeding status was recorded (breastfeeding prevalence), or as the percentage of maternities for which an initiation status was recorded (breastfeeding initiation). DH requires coverage to be a minimum of ≥90% (breastfeeding prevalence quarters 1-3) or ≥95% coverage (breastfeeding initiation, breastfeeding prevalence quarter 4 only). PCTs will therefore only be included in the analysis if they meet these criteria.

3.3 Definition of socio-demographic factors (objective 2a)

The following potential socio-demographic factors have been identified and will be included in the analysis as appropriate: area-based deprivation, ethnicity, maternal age and maternal smoking. All are available at the PCT level.

Deprivation

The area-based deprivation indicator to be used is the Index of Multiple Deprivation (IMD) 2010. This index measures a broad concept of deprivation and is derived from census variables and other more recent data sources. A total of 38 different indicators are aggregated into seven domains: income; employment; health and disability; education, skills and training; barriers to housing and services; living environment; and crime. These indicators are weighted and combined to calculate a final IMD 'raw' score. A high score indicates greater deprivation. The IMD is calculated at Lower Super Output Area (LSOA), of which there are 32,482 in England. This analysis makes use of a dataset which reports IMD 2010 score at the PCT level.

Ethnicity

Two different ethnicity variables have been identified for use, both reflecting the proportion from a Black and Minority ethnic (BME) background, defined in this case as non-White British. The first measure estimates the percentage of the *overall* PCT population from BME backgrounds (PEEG - Population Estimates by Ethnic Group). The estimate is derived from the 2001 Census and is calculated by the Office for National Statistics (ONS) using a cohort component methodology taking into account births, deaths, and migration to and from the area. Estimates for 2009 are the most recently available figures and are used in this analysis. The second measure summarises the proportion of women from a BME background who delivered in the given time period (2010-11). These figures are taken from HES data. Although the latter variable is most pertinent as it relates to the maternity population, there is some concern about the level of missing data. For this reason we will include both variables in descriptive analysis, and will adjust for the one which changes the effect measures the most, provided the level of missing data or accuracy of data is not an issue.

Maternal age

We will include two indicators of births by maternal age as covariables: the percentage of mothers aged <20 and the percentage of mothers aged ≥35. These data are drawn from HES delivery episode data and are available from ChiMat at PCT level for the year 2009-10.

Smoking

Smoking status is collected at the time of delivery and is reported as the percentage of women giving birth who are current smokers at the time of delivery. This is another data item included in the VSMR and the data for 2010-11 are used in this analysis.

3.3 Definition of the Baby Friendly Initiative (objective 2b)

The explanatory factors for objective 2b are Baby Friendly Initiative (BFI) status in the hospital (acute trust) and BFI status in the community.

BFI status comprises of multiple categories. As hospitals or community organisations move through the pathway to full accreditation they pass through the following milestones and awards: register of intent, certificate of commitment, stage 1, stage 2, before finally achieving full accreditation (stage 3).

BFI status will be measured at April 2010 to reflect status at the beginning of the period of outcome measurement. In the vast majority of cases, community BFI status relates directly to the same geographical area (PCT) used in the collection of breastfeeding data, reflecting the same unit of analysis. Occasionally, BFI accreditation relates to a specific provider arm rather than general services.

Hospital BFI status will need to be mapped to PCT level outcome data to enable us to measure the effect of hospital accreditation on breastfeeding rates. To facilitate this, data on the provider of maternity care by PCT of responsibility has been sought from HES. Where multiple acute trusts deliver maternity care to a single PCT population, an algorithm has been developed to take into account the proportion of deliveries attributable to each provider within a PCT. Using this it is possible to estimate the number of deliveries in each PCT taking place in a unit with each level of BFI award.

4. Data management

4.1 Breastfeeding outcomes

Data on breastfeeding outcomes are reported by quarter. Annual figures for 2010-11 will be calculated by summing the relevant quarterly figures and calculating the mean across the period. These figures will only be calculated for PCTs contributing data of an acceptable quality (i.e. meeting DH validation checks) for at least two of the four quarters in 2010-11.

3.2 Socio-demographic variables

All of the socio-demographic variables in this analysis are continuous variables. In addition to presenting summary data (means, ranges etc.), data may be grouped for the purpose of analysis. Continuous variables will be transformed into ordered categorical variables using quintiles or quartiles, or well-defined cut-offs if their association with the outcome of interest is not linear.

3.3 BFI status

BFI will be included in descriptive analysis as an ordered categorical variable with six groups. For regression analysis, BFI status will be collapsed into two or three groups as detailed in Tables 2 and 3. These groupings were agreed following advice from BFI staff and Advisory Group members. Time since award will be considered for the longer established hospital award but not for community BFI status as this is a more recent award.

5. Analysis plan

5.1 Descriptive analysis (objectives 2a and 2b)

Descriptive analysis will involve an examination of data quality and completeness, Crude breastfeeding rates will be reported and summarised. PCTS will be described with respect to each of the variables included in the analysis. This will involve the presentation of summary tables, scattergrams and other visual displays. Prevalence estimates for the primary and secondary outcomes will be presented alongside confidence intervals. All the potential socio-demographic indicators being considered are continuous variables, and as such, means and standard deviations will be presented where distributions are approximately normal. For variables with a non-normal distribution or those with extreme values, the median and interquartile range will be presented. Frequencies and percentages will be reported for the explanatory variables and for grouped continuous variables.

5.2 Multivariable analysis (objectives 2a and 2b

All statistical analyses will be conducted using Stata version 11. All tests will be two tailed and a 5% significance level will be used unless specified otherwise.

Statistical methods

Logistic regression will be used to estimate the effect of socio-demographic variables and breastfeeding support on breastfeeding outcomes. Aggregated data will be modelled as individual data and random effects models will be used to take into account the clustered hierarchical nature of the data.

Variables will only be retained in models where there is evidence of an independent association. This will be assessed by entering all potential explanatory variables in a regression model, dropping the least significant variable one by one, and examining the model as each variable is dropped until all variables remaining in the model are associated ($p<0.05$) with the outcome. This strategy will be repeated for each relationship under study.

For objective 2a, an adjusted odds ratio (OR) will only be presented where the socio-demographic variable is associated with the outcome in crude analysis at $p<0.10$ (i.e. looks to be a 'predictor' of breastfeeding outcomes).

Where adjusted odds ratios are reported, a minimum of three sets of odds ratios (OR) will be presented for each specific analysis: i) an unadjusted OR for all PCTs with valid outcome data, ii) an unadjusted OR for all PCTs with valid outcome data and no missing data for any explanatory factor, iii) an adjusted OR for all PCTs with valid outcome data and no missing data for any explanatory factor. For analyses undertaken for objective 2b, a fourth OR will be presented. This will be adjusted for socio-demographic variables, BFI status of hospital/community (whichever is not the main exposure), and (only where the outcome is breastfeeding at 6-8 weeks) breastfeeding initiation.

For objective 2a (identifying socio-demographic predictors), collinearity will be checked using summary tables showing the association between pairs of variables and by looking at the stability of coefficients and standard errors in models which include 'correlated' variables. Where extreme collinearity is present, only the strongest variable (as assessed using p values) will remain in the model.

For objective 2a, area-based deprivation and ethnicity will be considered as potential effect modifiers, and their role will be examined using Forest plots and tests for heterogeneity.

Planned analyses

Objective 2a

For this objective, we will examine the relationships detailed in Table 1.

Table 1. Analyses planned for objective 2a (socio-demographic predictors of breastfeeding rates)

Exposure	**Outcome**
Deprivation	Breastfeeding **initiation**
	Any breastfeeding at 6-8 weeks
	Exclusive breastfeeding at 6-8 weeks
Ethnicity	Breastfeeding **initiation**
	Any breastfeeding at 6-8 weeks
	Exclusive breastfeeding at 6-8 weeks
Young maternal age	Breastfeeding **initiation**
	Any breastfeeding at 6-8 weeks
	Exclusive breastfeeding at 6-8 weeks
Older maternal age	Breastfeeding **initiation**
	Any breastfeeding at 6-8 weeks
	Exclusive breastfeeding at 6-8 weeks
Maternal smoking	Breastfeeding **initiation**
	Any breastfeeding at 6-8 weeks
	Exclusive breastfeeding at 6-8 weeks

Objective 2b

Table 2 lists the planned analyses for the investigation of hospital BFI status. For the analysis looking at the effect of hospital BFI status on breastfeeding, the analysis is complicated by the fact that BFI status is not a simple categorical variable. There may be more than one provider of maternity services for each PCT, so instead of having single hospital BFI status for each PCT, we will instead model the percentage of births at a facility with each level of BFI award. BFI status is represented as 6 non-independent values where the 6th value is determined by the other 5 (since the sum of all values = 100). For example, assume a record for a single PCT ("PCT 1") is as follows:

	% of births at					
	No info	Register of intent	Certificate of commitment	Stage 1	Stage 2	Stage 3 (full)
PCT 1	25	5	10	35	15	10

For analysis A, we will include in the model a variable indicating the % of births in a stage 2/3 hospital, and a variable indicating the % of births in a hospital with no information/intent. Using the example above, the figures for this PCT would be 25% (15+10) and 30% (25+5) respectively. This is similar to our approach looking at maternal age, where we also plan to include in the model only the % of births in the 1st and 3rd age groups (three age groups in total). For analysis E, we would include only one variable, indicating the % of births at a facility with a status other than full accreditation. Using the example above, this value would be 90% (25+5+10+35+15).

Table 2. Analyses planned for the effect of hospital baby friendly status on breastfeeding rates (objective 2b)

Exposure		Categorisation	Outcome
Hospital BFI status	A	1. No info/register of intent 2. Certificate of commitment/stage 1 3. Stage 2/full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	B	1. No info/register of intent 2. Certificate of commitment/stage 1/stage 2 3. Full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	C	1. No info/register of intent 2. Certificate of commitment/stage 1/stage 2/full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	D	1. No info/register of intent/certificate of commitment/stage 1 2. Stage 2/full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	E	1. No info/register of intent/certificate of commitment/stage 1/stage 2 2. Full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks

Table 3 lists the planned analyses looking at the effect of community baby friendly status. This analysis is straightforward as there is a single community BFI status for each PCT.

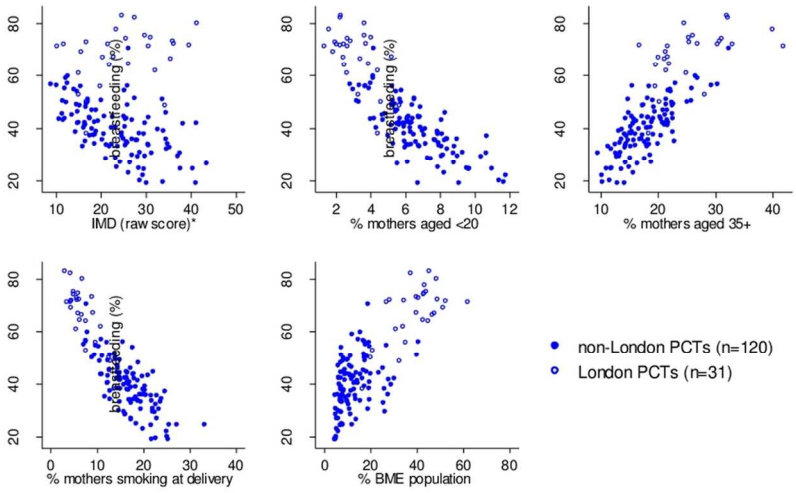
Table 3. Analyses planned for the effect of community baby friendly status on breastfeeding rates (objective 2b)

Exposure		Categorisation	Outcome
Community BFI status	A	1. No info/register of intent 2. Certificate of commitment/stage 1 3. Stage 2/full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	B	1. No info/register of intent 2. Certificate of commitment/stage 1/stage 2 3. Full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	C	1. No info/register of intent 2. Certificate of commitment/stage 1/stage 2/full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	D	1. No info/register of intent/certificate of commitment/stage 1 2. Stage 2/full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks
	E	1. No info/register of intent/certificate of commitment/stage 1/stage 2 2. Full	Breastfeeding **initiation**
			Any breastfeeding at 6-8 weeks
			Exclusive breastfeeding at 6-8 weeks

Treatment of missing data

The percentage of missing data for the outcome variables will not exceed 10%. There should be minimal, if any, missing data for BFI status. If the level of missing data for covariates exceeds ≥10% we will explore strategies to address missing data e.g. multiple imputation.

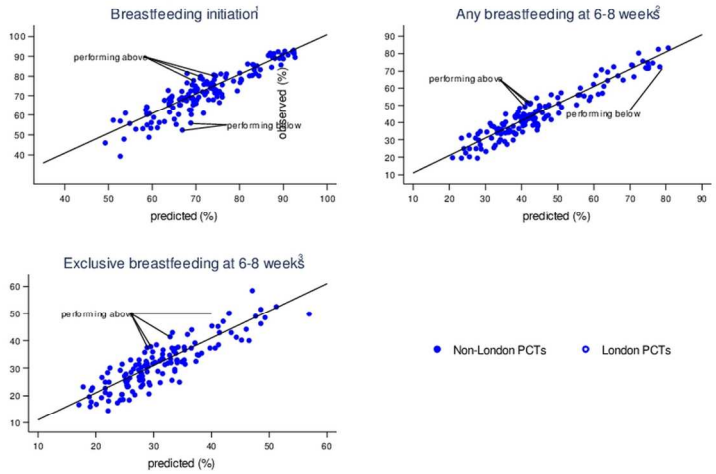
Figure 1. Scatterplots for any breastfeeding at 6-8 weeks by socio-demographic factors (London vs. non-London)



*A high IMD score is indicative of greater deprivation
IMD: Index of Multiple Deprivation, BME: Black and Minority Ethnic

116x90mm (300 x 300 DPI)

Figure 2. Observed vs. predicted proportions of any breastfeeding at 6-8 weeks



N.B. In some cases PCTs classified as potential outliers reported similar breastfeeding figures to PCTs not identified as potential outliers: this discrepancy is due to differences in PCT size.
[1]Performing above: Hampshire, Sheffield, Somerset. Performing below: Dudley, Sefton.
[2]Performing above: Devon, Leeds, Sheffield. Performing below: Brent.
[3]Performing above: City and Hackney, Devon, Leeds, Sheffield

127x90mm (300 x 300 DPI)