Factors associated with relapse of smoking in postpartum women:

An epidemiological analysis of East Sussex child health system data

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Summary

Aim: To examine factors associated with relapse of smoking around six weeks postpartum in women who had quit smoking during pregnancy in East Sussex.

Methods: Descriptive epidemiological analysis of data from the PCTs child health system using smoking status of women during pregnancy and at the six week health visitor review.

Results: Among the 512 women who had quit smoking during pregnancy, about half (46.5%) had relapsed by the six week health visitor review. Factors independently associated with increasing likelihood of smoking relapse were being around other smokers (odds ratio 5.6, 95% confidence interval 3.5 to 8.8) and high parity (third or later child relative to first time mothers: odds ratio 3.8, 2.3 to 6.5). Breastfeeding at six weeks was found to be independently associated with being a protective factor (odds ratio 0.6, 04 to 0.9).

Conclusion: The high rate of smoking relapse so early in the postpartum period is a public health concern. Supporting mothers to sustain smoking abstinence in the postpartum period must involve addressing the smoking behaviours of partners and other household smokers. Women should be encouraged to breastfeed as part of smoking relapse prevention and additional support may be needed for women of higher parity.

This report is a summary of a dissertation submitted in part fulfilment of the authors MSc Public Health, University of Brighton.

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Abbreviations

CHS	Child Health System
CI	confidence interval
DH	Department of Health
IMD	Index of Multiple Deprivation
NHS	National Health Service
NICE	National Institute for Health and Clinical Excellence
OR	odds ratio
PCT	Primary Care Trust
PSA	Public Service Agreement
RCT	Randomized Controlled Trial
ROC	Receiver Operating Characteristic
SUDI	Sudden Unexpected Death in Infancy

Chapter 1: Introduction and background

1.1 Smoking rates during pregnancy

Pregnancy-related smoking behaviours are captured in the Infant Feeding Survey which has been conducted every five years in the UK since 1975. In 1990 in Great Britain 28% of mothers smoked during pregnancy, in 1995 in England and Wales 23%, in England in 2000, 19%, and in 2005 17% of mothers smoked throughout pregnancy.[1,2] In 2005 in England just under half (48%) of mothers who smoked either during pregnancy or in the year pre-conception had given up by time of delivery, around two-thirds of which gave up on the confirmation of their pregnancy.[1]

1.2 Maternal and infant outcomes of smoking during pregnancy

Smoking during pregnancy is associated with risk to the health of the mother and infant and is one of the few modifiable risk factors in pregnancy that can reduce adverse pregnancy outcomes.[3] The Board of Science and Education of the British Medical Association produced a report that gave an evidence-based overview of the effect of smoking on sexual, reproductive and child health in the UK.[4] There is evidence of an increased risk of a number of adverse pregnancy outcomes from smoking during pregnancy: ectopic pregnancy, miscarriage, reduced foetal growth and low birth-weight, still births, infant death within the first four weeks, placental complications, premature birth, sudden unexpected death in infancy (SUDI) and certain foetal malformations. Infants may also have poorer lung function. There is also evidence that second-hand smoke exposure during pregnancy increases the risk of giving birth prematurely and having a low birth-weight baby. Stopping smoking before and during pregnancy reduces the risk of adverse outcomes and is a time when women are highly motivated to quit, with women more likely to stop smoking during pregnancy than at any other time of their life.[5] Evidence of the health effects of reducing smoking levels during pregnancy as opposed to quitting is limited and has been identified as an area where further research in the UK context is needed.[6]

1.3 Children and second-hand smoke exposure

There is a large body of evidence around the adverse health outcomes of children's exposure to second-hand smoke including SUDI, lower respiratory infections, middle ear diseases, asthma, reduced lung function and meningitis.[7-9] There is limited evidence that there may be an association between passive smoking in children and some childhood cancers[8] and some developmental and behavioural effects.[7] Children in homes of smokers may also be at greater risk of becoming victims of house fires.[8] The Royal College of Physicians has quantified the effects of passive smoking on children in the UK and estimates that each year it causes over 165,000 new episodes of disease, 300,000 contacts in primary care, 9,500 hospital admissions, 200 cases of bacterial meningitis and around 40 cases of SUDI.[7] The impact of parental smoking on children goes beyond the infant years, with children who have a parent smoking almost three times more likely to become a smoker themselves.[10] It has been estimated that in England and Wales around 23,000 children a year start smoking by the age of 16 as a result of exposure to family members smoking.[7] There is no risk-free level of second-hand smoke exposure[9] and the health implications of children's exposure are all avoidable.

1.4 Policy context

In 1998 the Government published *Smoking Kills: A White Paper on Tobacco,* the first White Paper on smoking and a landmark strategy to improve the health and wellbeing of the country. Smoking during pregnancy was one of the key focus areas of the strategy with a target set to decrease the prevalence of smoking during pregnancy from 23% to 15% by 2010[11] (from the 1995 baseline, measured by the Infant Feeding Survey). There has been progress in reducing smoking among pregnant women and around 19,000 pregnant women a year in England set a quit date with National Health Service (NHS) Smoking Cessation Services. Around half of these successfully quit at four weeks.[12] Data suggest that the target on reducing the percentage of women smoking during pregnancy could be met, with 15% of mothers smoking at time of delivery in 2008/09[13] (of

mothers where smoking status at delivery known). Building on the success of *Smoking Kills*, in the early part of 2010 the DH published a new comprehensive tobacco control strategy for England, setting out an ambitious vision of a "smokefree future" and its goal to eradicate the health-harms from tobacco.[3] One of the overarching objectives of the strategy is to motivate and assist every smoker to quit, with pregnant women identified as a group where particular focus is needed. Under this objective, the strategy sets out an aspiration to halve smoking rates among pregnant women by 2020. The strategy commits to: improving the identification of women smoking while pregnant; developing care pathways for pregnant smokers and those with young children in the household; offering services that are acceptable and accessible; and developing the evidence base for interventions that are effective, both clinically and in terms of cost.

The National Institute for Health and Clinical Excellence (NICE) has recently released public health guidance on stopping smoking in pregnancy and following childbirth (NICE public health guidance 26), with recommendations around identifying women who smoke during pregnancy, how to refer women to NHS Stop Smoking Services, how these services can best support them, how to help women's partners who smoke, pharmacology support and training for professionals.[14] Although the scope of the guidance was to also include women who had recently given birth, due to the lack of evidence around interventions for this particular group of women, no specific recommendations were made for smoking behaviours during the postpartum period.

1.5 Health inequalities

Smoking levels in the general population have an impact on health inequalities and historically as higher socio-economic groups has responded faster to the evidence of tobacco-related health harm, this has contributed substantially to an increase in the inequalities gap.[3] Tackling health inequalities has become an increasing priority for the Government and in 2001 a national Public Service

Agreement (PSA) target was set to reduce inequalities in health outcomes by 10%, measured by life expectancy and infant mortality (PSA 10). In 2004 the targets were updated and in the case of infant mortality, the target is to reduce by 10% the gap between routine and manual groups and the population as a whole by 2010.[15] This was reaffirmed in 2007 and became part of PSA 18 – *promote better health and wellbeing for all*. Smoking during and after pregnancy increases the risk of infant mortality with the highest smoking rates seen in women of routine and manual occupations.[1] Interventions to reduce smoking during pregnancy can have a demonstrable impact on infant mortality rates and could help close the inequality gap.[16]

As the current PSA inequalities targets relate to the period until 2010, the Government commissioned an independent review to inform the development of an evidence-based strategy to reduce health inequalities in England beyond 2010. *Fair Society, Healthy lives: The Marmot Review* made a number of recommendations and suggested indicators to assess performance improvement. The review emphasised the importance of health and well-being from the early years of life, with one of the six policy objectives set as "give every child the best start in life" as this is "crucial to reducing health inequalities across the life course."[17] Under this objective, it is recommended to prioritise interventions pre- and post-pregnancy to reduce adverse pregnancy and infancy outcomes, with monitoring smoking rates during pregnancy and breastfeeding rates as potential output indicators.

1.6 Cost to the NHS

A review into the costs of a mother smoking during pregnancy, in terms of additional cost to the NHS during pregnancy and in the first year following birth, estimates that smoking-related maternal outcomes costs the NHS between £8 million and £64 million per year, with smoking-related infant outcomes (in the first year of life only) costing the NHS between £12 million and £23.5 million per year.[18] The cost of children's exposure to second-hand smoke is around £10

million per year for primary care contacts and around £13.6 million for hospital admissions in the UK.[7]

In summary, smoking during pregnancy carries significant health risks to both the mother and infant and reducing the number of women smoking during pregnancy has been a public health priority for some years, with the Government's commitment reflected in national targets. Smoking both in the general population and throughout pregnancy is related to health inequalities and has large financial costs for the NHS. Much progress in tobacco control has been made in England since *Smoking Kills,* with significant public health legislation causing a shift in the smoking culture in England. Although policies and targets in relation to maternal smoking focus only on the pregnancy itself, understanding the possible predictors of postpartum relapse is essential to help inform how women can best be supported to remain abstinent and have smokefree homes. Preventing women from returning to smoking is a key action in reducing health inequalities to give children the best start to life and reduce their chances of becoming smokers themselves; and reducing inequalities in women's health.

1.7 Study aim

The recently published NICE guidance on stopping smoking during pregnancy highlights the lack of evidence around how to prevent smoking relapse following childbirth and this local data could help inform that evidence base. The purpose of this study was to determine factors associated with a relapse of smoking around six weeks postpartum for women who had quit smoking during pregnancy in East Sussex.

Chapter 2: Literature review summary

A comprehensive literature review was undertaken, a brief summary only is provided here.

Women who give up smoking during pregnancy and relapse during the postpartum period are more likely to be younger, non-white, of lower socio-economic status, less educated, have a higher parity, have a partner who smokes, be heavier smokers pre-pregnancy and may suffer feelings of stress or depression. It is less clear the impact that marital status and concerns about weight may have on the likelihood of postpartum relapse. Breastfeeding, high self-efficacy levels and being a 'spontaneous quitter' may be protective factors. Although the number of studies that investigate each factor differ, the strongest evidence-based risk factor is having a partner or other household member who smokes (Table 1).

Table 1: Protective and risk factors for postpartum smoking relapse

Number of studies that identified the factor as significant (or a key theme in qualitative studies) in predicting relapse has been shown by the number of $^{+}$ (based on all analyses, so may not be controlled for confounding)

Protective factors	Risk Factors
Breastfeeding^{+++} High self-efficacy levels^{+} Spontaneous quitter^{+}	Younger maternal age^{++++} Non-white ethnic background^{++} Publically insured (USA)$^{+++}$ Lower education level^{++} Higher parity^{++} Feelings of depression^{+++} Stress^{+++++} Higher smoking levels pre-pregnancy^{++} Partner and other household smokers$^{++++++++}$

Many of the factors that predict smoking relapse in the postpartum period reflect the characteristics of women who continue to smoke during pregnancy. Similarly, these factors are also associated with women who are less likely to initiate breastfeeding. Even when controlling for such confounders, an association between smoking and a decreased initiation or duration of breastfeeding can be seen.

The growing body of evidence around the predictors or postpartum smoking relapse for women who gave up smoking during pregnancy mainly has come from the USA with no current evidence found from the UK. Due to the infrastructure of health service provision in the UK, differing population demographics and smoking legislation, it may not be possible to generalise to the UK and mothers receiving care within the NHS. Little research has been done in the early postpartum period and no studies have looked at the urban/rural classification for where mothers live. Only a couple of studies were identified that looked at breastfeeding and smoking relapse during the postpartum period, neither of which were based in the UK.

This study will add to the literature around predictors of smoking relapse during the early postpartum period for women who have given up smoking during pregnancy, by providing evidence from a UK setting, with a relatively large sample size that allow confounding factors to be controlled. Using variables identified from the literature, where possible, this study looked at whether socio-demographic factors, breastfeeding and being around family and friends who smoke predict a relapse of smoking by six weeks postpartum in East Sussex women who quit smoking during pregnancy.

Chapter 3: Methods

3.1 Study design

This is a descriptive epidemiological study using data from the PCTs Child Health System.

3.2 Data collection

The breastfeeding information collected by Health Visitors specifically relates to six weeks postpartum, however the smoking information refers to 'current' smoking status, which depending on when the six week review was done, may differ slightly from six weeks postpartum.

The process for maximising the data return rates for breastfeeding at six weeks means that for mothers who at the new birth visit are formula feeding and either smoking or have never smoked, the form is completed immediately and returned to the Child Health department, otherwise it is left for completion at the six week review. All forms are returned to the Child Health department and are added to the child's record in the child health system (CHS).

3.3 Study population

All mothers (n=11,727) who were under the responsibility of the PCT for their six week postpartum review during a 21 month period (01/04/2008 to 31/12/2009) were eligible for the study. Mothers were excluded if they had moved out the area prior to the infant being six weeks old, had moved into the area after this time, or if the baby had died before reaching the age of six weeks. It was not possible to exclude infants who were in a neonatal or special care baby unit after birth, where it would be impossible for mothers to initiate breastfeeding. Of 11,727 eligible women, smoking data were available for 6,437 (55%) women.

A comparison between mothers whose smoking status during pregnancy was recorded and those whose status was not, was undertaken to ascertain whether there was a selection bias by the health visitors (Table 2). There was no real difference in age, urban/rural classification or parity between those women whose smoking status was recorded and those whose were not. There was a slight bias towards health visitors not recording smoking status in the more deprived areas. The smoking status was not recorded for 18.9% of mothers in the most deprived areas compared to 15.3% of those where data had been captured ($p<0.01$, $\chi^2= 30.6$).

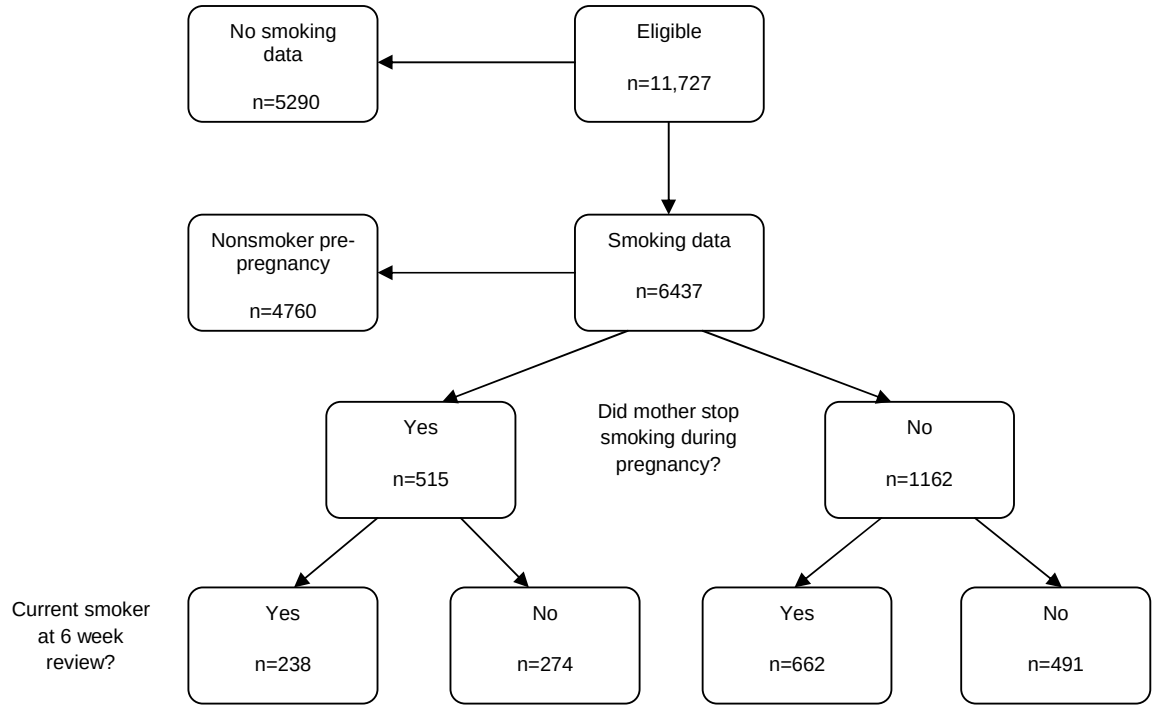
Table 2 – Characteristics of women according to availability of smoking status

Characteristic	Smoking data available (n=6437) Number (%)	Smoking data not available (n=5290) Number (%)
Age [mean (standard deviation)]	29.2 (6.3)	29.0 (6.3)
Ethnicity		
White British	5219 (84.2)	4108 (84.9)
Non-white British	967 (15.8)	733 (15.1)
Deprivation – national IMD quintile[a]		
1 - most deprived	983 (15.3)	995 (18.9)
2 - second most deprived	1920 (29.8)	1494 (28.4)
3 - third most deprived	1258 (19.5)	1019 (19.4)
4 - second least deprived	1394 (21.7)	1111 (21.1)
5 - least deprived	880 (13.7)	637 (12.1)
Urban/rural classification		
Urban	5152 (80.1)	4207 (80.0)
Town and fringe	441 (6.9)	329 (6.3)
Village, hamlet, isolated dwellings	842 (13.1)	720 (13.7)
Parity		
First child	2864 (45.0)	2308 (44.8)
Second child	2140 (33.6)	1695 (32.9)
Third or later child	1361 (21.4)	1146 (22.3)

[a] p<0.01 Chi-squared test Numbers may not sum to the total due to missing data

Of the 6,437 women whose smoking status during pregnancy was recorded, 4,760 (74%) were non-smokers pre-pregnancy, 1,162 (18%) continued to smoke during pregnancy, and 515 (8%) had quit smoking during their pregnancy (Figure 1). Of those who quit while pregnant, 512 had a postpartum smoking status recorded and three did not. Women identified as having given up smoking during pregnancy were split into two groups, those who had relapsed by the six week review, and those who had not.

Figure 1 – Flow chart showing smoking status of eligible women



No postpartum data for 3 women who quit smoking whilst pregnant

No postpartum data for 9 women who did not stop smoking during pregnancy

3.4 Measures

3.4.1 Dependent variable

For mothers who gave up smoking during pregnancy, current smoking status at the six week review *(yes/no)* has been used to identify those who are abstinent and those who have relapsed at six weeks postpartum.

3.4.2 Independent variables

A review of the literature identified predictors of postpartum relapse as younger maternal age, non-white ethnicity, low socio-economic status, low educational attainment, higher parity, having a partner who smokes, higher smoking intensity pre-pregnancy, feelings of stress or depression and not breastfeeding. The PCT's CHS did not contain information on socio-economic status or educational attainment of the mother, smoking intensity pre-pregnancy or whether mothers were experiencing feelings of stress or depression.

3.4.2.1 Socio-demographic characteristics

Maternal age was calculated from the baby's date of birth and the mother's date of birth. For calculating odds ratios for the likelihood of smoking relapse, maternal age was split into under and over twenty years of age to align with the *Every Child Matters* agenda which focuses on the well-being of children to age 19 and has teenage pregnancy as a key area of work.[19]

Ethnicity of the baby is collected on the birth notification form. Mother's ethnicity is not captured, however, by classifying into white and non-white categories; the ethnicity of the baby usually reflects whether the mother was white or non-white.

Deprivation is based on the postcode at time of delivery (linked to lower super output area using the NHS Postcode Directory[20]). The English Index of Multiple Deprivation 2007[21] (IMD 2007) at a lower super output area were used to classify into national deprivation quintiles. The IMD recognises that individuals can experience deprivation in a variety of ways and is made up of seven different weighted domains (income, employment, health and disability, education, barriers to housing and services, living environment and crime).

Urban/rural classifications were based on the postcode at time of delivery and linked to the urban/rural classification using the NHS Postcode Directory.[20] The indicator used is the *Rural and Urban Area Classification 2004,* which uses a consistent approach to classify areas as urban or rural in England and Wales.[22] For the purposes of analysis, women from *hamlet and isolated dwellings* were grouped with women from the *village* classification to increase the numbers in each group and in line with guidance on aggregating the urban/rural classifications.[23]

3.4.2.2 Pregnancy/postnatal characteristics

Parity refers to the number of previous live births as collected on the birth notification form. For calculating odds ratios for the likelihood of postpartum smoking relapse, parity was grouped into first child, second child and third or later child.

Breastfeeding status at six weeks is collected by the health visitor at the six week review. Information is collected on whether the mother is breastfeeding partially, exclusively or not at all. Based on the World Health Organization recommendations, the DH recommends exclusive breastfeeding for the first six months of an infant's life.[24] However, the national indicator on breastfeeding at six to eight weeks counts both exclusive and partial breastfeeding.[25] In line with

the national indicator, for the purposes of calculating the likelihood of smoking relapse by breastfeeding status, mothers who were partially or totally breastfeeding at six weeks were counted as breastfeeding.

3.4.2.3 Smoking characteristics

Father/other household smoker data are collected by the health visitor at the six week review. They record a yes/no response to whether the father or any other household member is a current smoker. For calculating odds ratios for the likelihood of postpartum relapse, these have been combined to identify women who are consistently around other smokers, irrespective of whether they are the father or not.

3.5 Statistical analyses

All analyses were conducted using SPSS 16.0 for Windows and statistically significant differences are defined where $p<0.05$, as is statistical convention.[26] To indicate the magnitude of the characteristics of interest and provide a range in which the estimates would lie in the total population,[27] 95% confidence intervals have been presented.

Bivariate analyses were conducted to investigate characteristics associated with smoking relapse at the six week review and Chi-squared tests were performed to identify whether there was a significant association between smoking relapse and each of the possible predictors. Odds ratios were calculated to provide an estimate for the relationship between relapse and a particular characteristic, and to allow the effect of other characteristics on that relationship to be investigated using logistic regression,[28] which was used to control for confounding.[29] A backwards likelihood ratio stepwise method was used with the probability threshold for removal set at the SPSS default of 0.10.[30] The backwards likelihood ratio method starts with all predictors included in the

model and removes those that do not have a significant impact on how well the model fits the data, with the predictor that has the least impact being removed first. A backwards method was chosen as there is a lower risk of making a Type II error than with the forward method.[30]

3.6 Missing data

For some women who quit smoking while pregnant not all characteristic data were recorded. All analysis is based on where complete variable data is available only.

Chapter 4: Results

4.1 Characteristics of study population

Table 3 shows the characteristics of women who quit smoking during pregnancy. Women identified as quitters had a mean age of 26 years and the majority (89.8%) were White British. The highest percentage of quitters (37.9%) was in the second most deprived quintile, with 18.0% from the most deprived areas and most of the women were from urban areas (85.0%). Over half of quitters (56.0%) were first time mothers. A large percentage of women who quit smoking whilst pregnant were not breastfeeding at six weeks postpartum (70.6%), 11.6% were partially breastfeeding with 17.8% exclusively breastfeeding at six weeks. Almost two-thirds (62.2%) of women who quit smoking whilst pregnant were around other smokers (father or other household member). The median age of the baby at the time of the six week review was 6.1 weeks.

Table 3: Characteristics of women (n=512) who quit smoking while pregnant

Characteristic	**Number (%)**
Socio-demographic characteristics	
Age [mean (standard deviation)]	26.0 (6.4)
Missing data	*2*
Ethnicity	
White British	450 (89.8)
Other White	23 (4.6)
Mixed	19 (3.8)
Other	9 (1.8)
Missing data	*11*
Deprivation – national IMD quintile	
1 – most deprived	92 (18.0)
2 – second most deprived	194 (37.9)
3 – third most deprived	94 (18.4)
4 – second least deprived	75 (14.6)
5 – least deprived	57(11.1)
Urban/rural classification	
Urban	435 (85.0)
Town and fringe	34 (6.6)
Village, hamlet, isolated dwellings	43 (8.4)
Pregnancy/postnatal characteristics	
Parity	
First child	285 (56.0)
Second child	113 (22.2)
Third or later child	111 (21.8)
Missing data	*3*
Breastfeeding at six weeks	
Formula	358 (70.6)
Partially	59 (11.6)
Exclusive	90 (17.8)
Missing data	*5*
Smoking characteristics	
Smoking at six week review	
Yes	238 (46.5)
No	274 (53.5)
Father or other householder smoking	
Yes	301 (62.2)
No	183 (37.8)
Missing data	*28*

4.2 Smoking relapse

Of the 512 women who quit smoking whilst pregnant, 238 (46.5%) women had relapsed smoking by the six week review. Factors associated with smoking relapse were living in a more deprived area (χ^2= 22.1, p<0.001) with a significant trend of greater likelihood of smoking relapse with increasing levels of deprivation. Women in the most deprived areas were significantly more likely to have relapsed at the six week review relative to women from the least deprived areas (unadjusted OR 5.3, 2.5 to 11.4). There were significant differences in the relapse rates by urban/rural classification of where women live (χ^2= 13.8, p=0.001), with those in non-urban areas having a decreased likelihood of relapse relative to women in urban areas. Women with a higher parity were more likely to have relapsed by the six week review with women who were having a third or later child significantly more likely to relapse relative to first-time mothers (unadjusted OR 4.1, 2.6 to 6.6). Breastfeeding was found to be a significant protective factor in smoking relapse, with women who were breastfeeding at six weeks postpartum having a decreased likelihood of smoking relapse by the six week review (unadjusted OR 0.5, 0.4 to 0.8). The most important factor for smoking relapse was living with other smokers (father or other household member). Women who were around other smokers were significantly more likely to have relapsed relative to women who were not around other smokers (unadjusted OR 5.8, 3.8 to 8.8). Relapse rates by the six week review showed no differences between maternal age groups and a higher relapse rate was found in non-white women compared to white women, but the difference was not significant (56.4% vs 45.7%, χ^2= 1.7, p=0.20). (Table 4)

Table 4: Smoking relapse at six weeks (n=512 quitters)

Characteristic	Relapse Number (%)	Odds ratio of relapsing (95% CI)
Socio-demographic characteristics		
Age		
<20 years	38 (46.3)	1.0 (0.6 to 1.6)
20 years or over	198 (46.3)	Referent
Ethnicity		
White	216 (45.7)	Referent
Non-white	22 (56.4)	1.5 (0.8 to 3.0)
Deprivation – national IMD quintile[a]		
1 - most deprived	54 (58.7)	5.3 (2.5 to 11.4)
2 – second most deprived	97 (50.0)	3.8 (1.9 to 7.5)
3 – third most deprived	44 (46.8)	3.3 (1.6 to 7.0)
4 – second least deprived	31 (41.3)	2.6 (1.2 to 5.8)
5 – least deprived	12 (21.1)	Referent
Urban/rural classification[a]		
Urban	217 (49.9)	Referent
Town and fringe	8 (23.5)	0.3 (0.1 to 0.7)
Village, hamlet, isolated dwellings	13 (30.2)	0.4 (0.2 to 0.9)
Pregnancy/postnatal characteristics		
Parity[a]		
First child	93 (32.6)	Referent
Second child	68 (60.2)	3.1 (2.0 to 4.9)
Third or later child	74 (66.7)	4.1 (2.6 to 6.6)
Breastfeeding at six weeks[b]		
No	182 (50.8)	Referent
Yes	53 (35.6)	0.5 (0.4 to 0.8)
Smoking characteristics		
Father/other household smoker[a]		
No	38 (20.8)	Referent
Yes	181 (60.1)	5.8 (3.8 to 8.8)

[a] $p<0.01$ χ^2 test, [b] $p=0.02$ χ^2 test Numbers do not add to the total due to missing data

4.3 Multivariate analyses

To determine the best set of predictors while controlling for potential confounding between variables, all variables were entered into the logistic regression model via the backwards stepwise entry method. Table 7 shows the adjusted odds ratios for explanatory factors that remained in the final model. To assess the ability of the final model to correctly discriminate between women who did and did not relapse smoking by the six week review, predicted probabilities were generated in SPSS[30] and a Receiver Operating Characteristic curve (ROC curve) was used to quantify how well the predictors of the logistic regression model discriminate between those who relapsed postpartum and those who did not.[29] The area under the ROC curve gives an assessment of the performance of the test[31] and in this instance the area under the curve was 0.784, that is, the logistic regression model has a probability of 78.4% of choosing at random a woman who relapsed exceeding choosing a woman who remained abstinent.[32] Due to missing data for some of the variables, the logistic regression analysis is based on 476 women who quit smoking whilst pregnant.

After controlling for confounding (age, ethnicity, deprivation, urban/rural, parity, breastfeeding), the most important predictor of women relapsing around six weeks postpartum is being around other smokers, with women where the father or other household member smokes having an adjusted OR of 5.6 (3.5 to 8.8) relative to women who are not around other smokers. A higher parity increases the likelihood of relapse, with women who are having their third or later child significantly more likely to relapse relative to first time mothers (adjusted OR 3.8, 2.3 to 6.5). After controlling for confounders, breastfeeding is a protective factor for smoking relapse, with women who were breastfeeding at six weeks postpartum significantly less likely to relapse relative to women who were not (adjusted OR 0.6, 0.4 to 0.9). Living in non-urban areas was associated with decreased odds of relapse, but not significantly so. Variables that were removed in the stepwise regression as not making a significant difference to how well the model fit the observed data[30] were all socio-demographic factors: maternal age, ethnicity and national deprivation quintile.

Table 5: Predictors of smoking relapse after controlling for confounding

Characteristic	Odds ratio of relapsing (95% CI)
Father/other household smoker	
No	Referent
Yes	5.6 (3.5 to 8.8)
Parity	
First child	Referent
Second child	3.0 (1.8 to 5.0)
Third or later child	3.8 (2.3 to 6.5)
Breastfeeding at six weeks	
No	Referent
Yes	0.6 (0.4 to 0.9)
Urban/rural classification[NS]	
Urban	Referent
Town and fringe	0.4 (0.2 to 1.0)
Village, hamlet, isolated dwellings	0.5 (0.2 to 1.1)

[NS]Not significant

Chapter 5: Discussion

The aim of this study was to determine factors associated with a relapse of smoking by six weeks postpartum for women who had quit smoking during pregnancy. The findings provide support to the hypotheses that being around family and friends who smoke, socio-demographic (deprivation, urban/rural classification) and pregnancy-related (parity) factors influence smoking relapse; and breastfeeding was found to be a protective factor in preventing smoking relapse.

Among mothers who reported stopping smoking during pregnancy, about half (47%) were currently smoking at the six week review. This is similar to previous research which showed a 50% relapse rate at six to 10 weeks[33] but is a higher percentage than has been reported elsewhere,[34] although both these studies were pilot studies with small sample sizes which limit their use in validating the findings. The UK Infant Feeding Survey reported that 19% of women were smoking at four to 10 weeks postpartum[1] however the definition of when women stopped smoking includes around a year pre-conception, and is therefore not comparable. By six months postpartum between 47-63% of women have returned to smoking[34-39] and this study suggests that relapse could be occurring in the immediate postpartum period. The NICE public health guidance 26 specifically mentions that support from NHS Stop Smoking Services should go beyond the pregnancy[14] and this study highlights that supporting mothers to remain abstinent is crucial from the time of the baby's birth.

In the eligible population for the study, 18% of women continued to smoke during pregnancy. This is slightly higher than the national 2008/09 percentage of mothers smoking at time of delivery (15%).[13]

The literature review identified a number of studies that can be used to validate the findings of this research, however, it is acknowledged that most studies are

generally not from the UK, use a variety of different definitions for maternal smoking behaviours and breastfeeding, and cover a variety of different postpartum periods, mainly focusing on six months following birth. This study identified independent characteristics significantly associated with smoking relapse as being around other smokers, parity and breastfeeding. This is consistent with evidence from other studies.[37-45] Living in urban areas was independently associated with relapse, but not significantly so, and has previously not been reported. Higher relapse rates were seen with increasing levels of deprivation however deprivation did not remain in the final logistic regression model as an independent predictor. Deprivation was removed from the multivariate analyses due to confounding and would have been accounted for by mothers who are around other smokers and mothers not breastfeeding, as populations from more deprived areas have a higher smoking prevalence[46] and mothers of lower socio-economic and education status are less likely to breastfeed.[1] In contrast with other studies[35-39], maternal age and ethnicity showed no significant differences between those who had relapsed or remained abstinent at six weeks postpartum.

The most important predictor of a women's return to smoking was being around other smokers and this is consistent with other studies both quantitative and qualitative. After adjusting for confounders (age, ethnicity, deprivation, urban/rural, parity, breastfeeding), women around other smokers were significantly more likely to relapse (OR 5.6, 3.5 to 8.8). This is higher than has previously been reported[39] but within the estimated range for the total population. Helping partners and other household members to stop smoking is one of the key recommendations of the NICE public health guidance 26[14] in regards to helping women stopping smoking during pregnancy. This research emphasises the importance of addressing partner and other household members smoking behaviours beyond the pregnancy period to support mothers to sustain smoking abstinence. Understanding which factors are the most important in predicting smoking relapse is essential from a practical point of view in terms of the best use of resources and targeting interventions, which is

particularly pertinent in the current climate as the NHS is facing "perhaps the toughest financial climate it has ever known."[47]

Parity was the second most important factor for relapse with the likelihood of relapse increasing with the number of previous children. Across other maternal and infant health aspects, first time mothers display behaviours that reduce the risk of adverse health outcomes such as higher levels of breastfeeding intitiation.[1,48] Parity is not a characteristic that health professionals can influence. Women with previous children can draw on their experiences and knowledge from before, and in the PCT, unless they were deemed vulnerable or not known to the PCT's health visiting service, they do not receive the level of contact that a first time mother would. This study highlights that maternal smoking is an area where women who have had previous children may need the same level or possibly more support than first time mothers.

Breastfeeding was found to be a significant protective factor of smoking relapse. This an area that receives much focus in regards to improving children's health and wellbeing, as reflected by the national six to eight week breastfeeding prevalence target. This study suggests that efforts to increase breastfeeding initiation and duration could positively impact on postpartum smoking behaviour and that women should be encouraged to breastfeed as part of smoking relapse prevention. Infants of mothers who both breastfeed and smoke have been shown to have a tenfold higher level of cotinine in their urine compared to formula-fed babies of smoking mothers[49] however, it is still recommended for women who smoke that they continue to breastfeed and try and do so in a way to minimise the infant's exposure to nicotine.[50]

The relapse rate seen in this study at just six weeks highlights how crucial mothers need support from the first few days and as relapse rates will likely increase with time, continued support is needed. At 12 months postpartum the

percentage of women who have returned to smoking either occasionally or daily has been reported as high as 80%.[51]

This study helps understand the scale of the issues around smoking relapse and associated factors, however, assessing health need is also about understanding the effectiveness and cost-effectiveness of interventions.[52] Few studies have been found that focus on relapse prevention as most research is about maintaining cessation throughout pregnancy.[53] Systematic reviews of randomized controlled trials (RCT) for interventions to prevent relapse, improve cessation and reduce smoking intensity in the postpartum period, including one Cochrane review, found no evidence of interventions that significantly impacted on smoking outcomes.[54,55] In developing the NICE public health guidance 26, the evidence review, which using NICE methodology is wider than just looking at RCTs, found no evidence of effective interventions for relapse prevention from what has currently been trialled and recognises it as an area where further research is needed.[14] This study can help inform that evidence base as recognising factors that predict smoking relapse can help direct where and when interventions may be needed.

The risks of smoking during pregnancy has received much attention and qualitative research has identified that mothers who stop smoking during pregnancy may not view themselves as actually having quit, but as temporarily stopping for the sake of the baby.[42,56] This could suggest there is a need to increase knowledge and awareness of the risks to children of second-hand smoke exposure, therefore influencing postpartum smoking behaviours. A survey on smoking-related behaviour and attitudes in Great Britain in 2008/09 found that the majority of adults thought second-hand smoke exposure could increase the risk of children getting chest infections and asthma (92% and 82% respectively), however, just over half of adults (58%) thought second-hand smoke increases the risk of SUDI and only 35% thought it increases the risk of ear infections.[46]

Smoking remains one of the leading causes of health inequalities[3] and the likelihood of relapse was greater with increasing levels of deprivation. As identified in the Marmot Review, reducing health inequalities needs to start from early infancy.[17] Inequalities in smoking and infant outcomes were demonstrated in this study by family and friends smoking and women not breastfeeding accounting for deprivation in the final regression model. The Marmot review suggests monitoring smoking levels during pregnancy but with high relapse rates so early in postpartum period, monitoring whether the mother or other household members smoke in the first year of an infant's life could also be a useful indicator.

5.1 Limitations of the study

As with most research in this area, smoking status was based on self-report. Self-reported smoking status has been shown to underestimate the prevalence of smoking amongst pregnant women when compared to biochemical markers[57-79] likely due to the pressure not to smoke whilst pregnant.[14] There is less available evidence on the validity of self-report smoking status during the postpartum period, when mothers may feel the pressure not to smoke has subsided and does not have as much stigma as smoking during pregnancy.

It was assumed that women remained abstinent throughout pregnancy. Smoking status was defined as current smoker yes/no, with no further definition as to the frequency or amount smoked for the mother or father/other household member. Using a loose definition of smoking makes it unclear as to how women could classify themselves, for example, if on just one or two occasions they had smoked but had not returned to regular smoking.

This study used routinely collected data and therefore not all possible predictors of relapse were available. Feelings of stress[34,36] and depression[34,35,39] are associated with smoking relapse but this information was not available for the study. Elements of socio-economic status (lower education, low income) has been associated with smoking relapse.[35,37,39] In the literature review, research was found that suggested that associations between maternal and infant health and neighbourhood deprivation may be a reflection of individual-level socioeconomic confounders,[60] and therefore in the absence of the socio-economic status of the mother, national IMD 2007 quintile was used as a proxy.

Smoking intensity pre-pregnancy is associated with smoking relapse[37,39] and high efficacy levels[61] and spontaneous quitters[38] may be protective factors. Women's smoking status during pregnancy was defined as *'did mother stop smoking during pregnancy (yes/no/not applicable)?'* No further information was collected as to what stage of the pregnancy they stopped smoking, how much they were smoking pre-pregnancy or how they quit. In England 10% of women quit smoking on confirmation of pregnancy with only 1% quitting later in the pregnancy.[1]

The exact nature of the relationship between smoking relapse and breastfeeding could not be determined as whether mothers actually initiated breastfeeding could not be accounted for. As the study relates to at six weeks postpartum and so in that sense is cross-sectional, it would not be possible to determine whether smoking relapse or stopping breastfeeding came first.

Valid smoking data were only available for 55% of women. It had been expected that smoking information would be available for a higher percentage of the eligible population, given that it is collected and recorded on the same form that is used to monitor breastfeeding rates for national targets, of which one is the coverage of knowing feeding status at six to eight weeks. In this

study, data used were from when the information collection form was first introduced (2008/09), and the coverage of feeding status known for the PCTs for that year was higher than the percentage of women who had valid smoking data recorded in this study.[62] This may be due to health visitors adjusting to the new data collection with the emphasis on collecting the breastfeeding data due to the national target. Coverage for both smoking and breastfeeding would have been affected by the time taken to develop and refine the process with the health visiting service and Child Health department to maximise the amount of data recorded and entered on the CHS. There was a slight bias in smoking status having been recorded in the lesser deprived areas, where smoking levels may be lower.

5.2 Implications for practice and further research

The rate of smoking relapse found in this study in the early postpartum period is a public health concern and an area that needs to be developed further in how best to support these women. As has been identified by NICE, there remain many gaps in the evidence base for effective and cost effective interventions to reduce maternal smoking both pregnancy and postpartum-related. This study highlights the need to implement NICE public health guidance 26 at the local level and for health professionals to be aware of risk factors for postpartum relapse. Being around other smokers and number of previous children were the two most important predictors, both of which can be identified at the first contact of pregnancy-related care. For women who have had previous children, they may not receive the same level of support from maternity and health visiting services that a first time mother would, and this study indicates that in regards to smoking behaviours, extra support may be needed. As breastfeeding was found to have a protective effect, women should be encouraged to initiate and continue to breastfeed as part of smoking relapse prevention. Higher smoking levels and poorer maternal and infant outcomes can indicate health inequalities.

Whether the mother or father/other household member was smoking in the postpartum period could be used as an inequalities indicator.

This study demonstrates the usefulness of data routinely collected by health visitors and if smoking and breastfeeding data were recorded at every health visitor assessment and entered into the CHS, it would provide an opportunity to explore the timing of smoking relapse and the relationship between stopping breastfeeding. Depression and stress were identified in the literature review as possible predictors of smoking relapse. It may be worth exploring with the health visiting service whether this information on mother's mental wellbeing is systematically collected and recorded, which could then be used to provide a local scientific evidence base to the level of need around such issues, and explore any relationships with other maternal health behaviours and outcomes.

Chapter 6: Conclusion

Reducing smoking rates during pregnancy is an area that has received much attention since the *Smoking Kills* white paper. High relapse rates so early in the postpartum period show that in regards to maternal smoking behaviours, the focus needs to go beyond the pregnancy period. Although further research is needed into smoking behaviours in the postpartum period, for women who quit smoking during pregnancy significant factors that increase the likelihood of postpartum relapse have been found and can be used to help identify those most vulnerable to relapse. Reducing mother's levels of relapse and smoking in the postpartum period cannot be viewed in isolation and is part of wider maternal and infant health behaviours and outcomes such as breastfeeding and mental wellbeing. Despite the efforts that reducing smoking in pregnancy has received, the continued levels of smoking throughout pregnancy and in the postpartum period show it is still an area of great public health concern. This, together with being around other smokers as the most important predictor of postpartum smoking relapse demonstrates that maternal smoking is very much part of the wider tobacco control agenda, and that mainly focussing on helping women to quit smoking during pregnancy will not go far enough.

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