# TITLE PAGE

*Authors*

Eleonora P Uphoff, Neil Small, Kate E Pickett

E P Uphoff, PhD, Bradford Institute for Health Research, Temple Bank House, Bradford Royal Infirmary, Duckworth Lane, Bradford, BD9 6RJ, UK.

N Small, Professor of Health Research, Faculty of Health Studies, University of Bradford, Richmond Road, Bradford, BD7 1DP, UK.

K E Pickett, Professor of Epidemiology, Department of Health Sciences, Seebohm Rowntree Building, University of York, Heslington, York, YO10 5DD, UK.


Correspondence to:

E Uphoff

Email: noortje.uphoff@york.ac.uk

Phone: 01904 32 1612

# ABSTRACT

*Introduction*

Despite the well-known link between stress and smoking, evidence for associations between economic recession, financial stress and smoking is contradictory. In this study we assess whether women were more likely to continue smoking during pregnancy if they were exposed to the UK 2008-2010 economic recession during pregnancy than those who were unexposed, and whether this relationship is mediated by financial stress.

*Methods*

We used cross-sectional data on 2775 pregnant women who were regular smokers before pregnancy and who were enrolled in the UK Born in Bradford cohort study between March 2007 and December 2010. The cut-off date for exposure to recession was set at August 1, 2008, based on local and national economic data. Multivariable logistic regression analysis included potential confounders: maternal age, parity, cohabitation, ethnicity and maternal age. The mediating role of financial stress was analysed using 'worse off financially' and a 'difficult financial situation' as indicators of financial stress in Sobel-Goodman mediation tests with bootstrap resampling.

*Results*

After taking into account potential confounders, exposure to recession was associated with continued smoking during pregnancy (OR 1.19, 95% CI 1.01; 1.41, p=0.03). A worse financial situation and difficult financial situation were identified as mediators, explaining 8.4% and 17.6%, respectively, of the relationship between exposure to recession and smoking during pregnancy.

*Conclusions*

Smoking during pregnancy is associated with exposure to the UK 2008-2010 economic recession during pregnancy, and this relationship is partly mediated by financial stress.

# IMPLICATIONS

Health inequalities in smoking during pregnancy are affected by economic recession, as those who are most likely to smoke are also most likely to experience the financial stress resulting from economic recession. Socioeconomic conditions at the societal and individual level are important targets when aiming to reduce rates of smoking during pregnancy.

# INTRODUCTION

## Social gradients in tobacco smoking

Tobacco smoking in pregnancy is more prevalent among those who have a lower socioeconomic status as indicated by a range of socioeconomic measures ranging from education and employment status to poor childhood circumstances, housing tenure and job strain[1-4]. In an analysis of continued smoking during pregnancy in 15 European countries, Smedberg and colleagues[2] found an average prevalence rate of 26.2%, compared to 43.2% in the lowest educational category. In England, a combination of socioeconomic indicators showed a very steep social gradient with 6% of women smoking during pregnancy in the highest and 62% of women smoking in the lowest socioeconomic group[4]. An analysis of data from the Millennium Cohort Study showed that smoking and heavy smoking during pregnancy were associated with a range of factors more common among lower socioeconomic groups, including leaving school before eighteen, not having a bank account, and financial difficulties[5].

## Tobacco smoking and financial stress

Financial stress appears to play a significant role in explaining these social gradients, although most of the evidence comes from smoking in the general population. In Australia, financial stress according to an 8-item scale relating to shortage of money was associated with a lower likelihood of quitting and a higher likelihood of relapse[6]. This finding was confirmed in a survey with data from the United States (US), United Kingdom (UK), Canada and Australia. Smokers experiencing financial stress had an increased interest in quitting, but were less likely to make an attempt and consequently their odds of succeeding was half that of the group without financial stress[7]. Involuntary job loss among older workers was associated with increased odds of a relapse in smoking, defined as reported smoking point prevalence after quitting[8]. A US community-based sample was used to demonstrate that women are less likely to quit smoking in response to an adverse financial event, and more likely to relapse as a result of such an event[9].

## Tobacco smoking during the 2008-2010 economic recession

Given that financial stress affects those of lower socioeconomic status disproportionally, and macro-economic circumstances such as economic recession can evoke financial stress, it is reasonable to assume that the economic recession, which hit Europe between 2008 and 2010, would have increased rates of smoking during pregnancy. Women who were regular smokers may have been less able to quit smoking as financial strain placed a burden on their cognitive, social and emotional capacities. The evidence however, which is largely based on tobacco use in the general population, is contradictory.

Based on US economic data Ruhm concluded that smokers, especially heavy smokers, cut down on smoking during economic downturns[10]. Others have showed that increased wages lead to increased cigarette use[11], and larger than expected declines in smoking during the economic recession have been found in Iceland[12,13] and in Greece[14].

These findings have come with nuances and reservations. The authors of the Greek study pointed out that more effective enforcement of tobacco control legislation may partly explain their

findings[14]. Gallus and colleagues argued that the number of unemployed people grows during a recession, so that a small decrease in smoking is seen at the ecological level because the downward trend in smoking prevalence for employed people is slightly larger than the increase in smoking among the unemployed during economic recession[15]. In a study of UK parents, financial strain during the recession was associated with an increased risk of persistent tobacco use and relapse[16].

In summary, most of the literature would suggest that experiences of financial stress, which are likely to result from an economic recession, might increase the likelihood of continued smoking during pregnancy. Although these associations are plausible, the literature on recession and smoking suggests an effect in the opposite direction. An analysis specifically testing associations between economic recession and smoking during pregnancy, including the mediating effect of financial stress, might clarify previous findings.

### Hypothesis

In a deprived UK community hit hard by the UK 2008-2010 economic recession, women who smoke regularly will be more likely to continue smoking during pregnancy if they were exposed to the recession during pregnancy compared to those unexposed, and this relationship is mediated by financial stress.

## METHODS

This study follows guidance on reporting set out in the STROBE statement (Table A1, Appendix).

### Data

The Born in Bradford (BiB) cohort was set up to examine the impact of social, environmental, psychological, behavioural and biological factors on maternal and child health and well-being[17]. Pregnant women (N=12 450) were recruited around 26 to 28 weeks pregnancy at Bradford's only maternity unit when attending universal screening for gestational diabetes, between March 2007 and December 2010[18].Ethical approval for data collection was granted by Bradford Research Ethics Committee (Ref 07/H1302/112).

After excluding pregnancies without baseline questionnaire data (N=2377), stillbirths (N=61), second and third pregnancies to the same mother in the cohort (N=1323), and twins and triplets (N=142), a dataset of 10035 mother-infant pairs was obtained. A dataset with complete data for the exposure variable and covariates was used. This dataset of 8952 pregnant women was used to explore relationships between exposure to recession and financial stress. In this dataset, 2775 women were regular smokers and reported information on smoking during pregnancy and relevant covariates.

### Setting

Bradford is a deprived and ethnically diverse city in the North of England with a population of over half a million[19]. Employment is more reliant on manufacturing industry than the UK average and this sector has been in decline for decades, making the city particularly vulnerable to the effects of economic recession. There was a sharp increase in the proportion of claimants for Job-Seeker's

Allowance (JSA) (the main form of financial support for unemployed people identified as actively seeking work) in Bradford from August 2008, with a peak in JSA claimants at 5.0% in September 2009 (Figure 1)[20]. In November 2007, JSA-claimant-rates in Bradford were 133% higher than for England as a whole; by November 2015, rates were 181% higher in Bradford than the average for England.

**Main exposure**

The definition of recession as "A period of temporary economic decline during which trade and industrial activity are reduced, generally identified by a fall in GDP in two successive quarters"[21] may not correspond with the lived experience of recession. We used reports in national and local media[22] (Box A1, Appendix) in combination with data on unemployment related benefit claims[21] (Figure 1) to inform the decision of a cut-off date for recession start date to be the first of August 2008; an estimated conception date from 01-08-2008 onwards was therefore classified as 'exposed'. No 'end of exposure' cut-off was used as Figure 1 indicates the economic impact of the recession lasted well beyond the study recruitment period.

The percentage of study participants reporting to be financially worse off than a year ago increases from 15.3% (N=60) at the beginning of May 2008 to 24.2% (N=88) around the beginning of June 2008 (Figure 2). In an exploration of different measures of exposure we found no evidence for an annual worsening of individual's financial situation (analyses available upon request). A binary cut-off before and since 01-08-2008 was therefore considered an appropriate measure of exposure to recession.

**Mediating factors**

Financial stress was operationalised through two variables; perceived financial situation and change in perceived financial situation. Women were asked how well they and their partner were managing financially, with response categories ranging from 'living comfortably' to 'difficult' ('very difficult' and 'just about getting by' were merged with 'difficult'). Change in perceived financial situation was measured with the question 'Compared to a year ago, how would you say you and your husband/partner are doing financially now?', with answer categories 'better off', 'about the same' or 'worse off'.

**Outcomes**

Data on maternal smoking were obtained from the study baseline questionnaire. A binary variable of continued smoking during pregnancy for those who reported to smoke regularly was derived from questions on smoking during pregnancy three months before pregnancy, in the first three months of pregnancy and since the beginning of the fourth month. Women who reported to have stopped smoking in the first month of pregnancy and did not report smoking any cigarettes since the beginning of the fourth month were counted as non-smokers during pregnancy.

**Covariates**

The Directed Acyclic Graph created in DAGgity V2.3 and published on the Daggity website (http://dagitty.net/mLWfIRw) shows the hypothesised causal relationships between exposure to recession, continued smoking during pregnancy and covariates[23]. Parity (nulliparous versus other), maternal age, cohabitation with a partner (yes/no) ethnic group (White British, Pakistani, other), and

education of the mother (< 5 GCSE, 5 GCSE, A level, > A level, other, or equivalents of these qualifications) were identified as potential confounders.

**Statistical analyses**

Firstly, sample characteristics were explored and differences tested between the subsample exposed to recession during pregnancy and the unexposed group. Chi-square tests were used for binary variables and t-tests for continuous variables.

Multivariable logistic regression analysis was used to model the relationship between exposure to economic recession and continued smoking during pregnancy, after which mediation analysis was performed to assess the role of financials stress.

The mediating role of financial stress was tested with Sobel-Goodman mediation analyses in Stata 12, using the 'sgmediation' and 'bootstrap' commands[24]. This method has been found to be more rigorous and more likely to identify a true mediation effect than the widely used causal steps outlined by Baron and Kenny [25-27]. We avoided violation of the normality assumption of the Sobel-Goodman test by performing a bootstrap analysis with 5000 sampling repetitions[26].

# RESULTS

The sample consists of 2775 women who were regular smokers before pregnancy, and Table 1 shows an overview of their characteristics. As opposed to those recruited before the economic recession, pregnant women who were recruited after the start of the recession and were thus exposed were more likely to be nulliparous (first child), to have a higher level of education, to be in a difficult financial situation, and to be worse off than a year ago. Prevalence rates of smoking during pregnancy varied from 40.0% among those who reported to be managing well financially, to 65.2% among mothers who reported their financial situation was difficult/ very difficult.

**Multivariable analysis**

After taking into account potential confounders, exposure to recession was associated with continued smoking during pregnancy (OR 1.19, 95% CI 1.01; 1.41, p=0.03) (Table 2). All other factors being equal, this represents a 3.7% difference in smoking prevalence, with 53.1% of women in the unexposed and 56.8% of women in the exposed group smoking during pregnancy.

**Mediation analysis**

Results of the mediation analysis are summarised in Table 3.

When a worse financial situation than a year ago is used as the indication of financial stress, bootstrap results for the Sobel-Goodman test suggests a modest mediation effect (observed coefficient 0.003, 95% CI 0.00; 0.01). Of the total relationship between exposure to recession and continued smoking during pregnancy, 8.4% is estimated to be mediated by the effect of a worse financial situation.

When financial stress is operationalised as a current difficult financial situation (compared to comfortable/ doing alright), a modest mediation effect is again present (observed coefficient 0.006,

95% CI 0.00; 0.01). The proportion of the relationship between exposure to recession and continued smoking during pregnancy mediated by the effect of a difficult financial situation is 17.6%.

By taking into account the influence of financial stress, either through the inclusion of a worse or difficult financial situation variable, the direct effect of exposure to the economic recession on smoking during pregnancy is no longer statistically significant.

## CONCLUSIONS

This study demonstrates that exposure to economic recession is associated with continued smoking during pregnancy for regular smokers, and that this relationship is partly mediated by financial stress.

Exposure to the UK 2008-2010 economic recession during pregnancy was associated with a difficult financial situation and being worse off than a year ago for women in the Born in Bradford cohort study who were regular smokers. After taking into account key confounders, pregnant women exposed to recession were more likely to continue smoking during pregnancy than those not exposed. Mediation analyses showed that the relationship between exposure to recession and continued smoking during pregnancy was partly explained by financial stress, either measured by a difficult or worsened financial situation of the household. With the inclusion of financial stress in the model, the relationship between exposure to recession and smoking during pregnancy was no longer statistically significant.

### Limitations

Even though covariates were included to adjust for differences between the 'exposed' and 'unexposed', there might be alternative explanations for our findings.

Couples who get pregnant during an economic recession may be different from those who choose not to. This may explain differences between the unexposed and exposed group shown in Table 1. Economic recession and unemployment have been found to be associated with a decline in fertility rates, particularly for young women having their first child[28,29], and fertility rates in England and Wales declined between 2008 and 2010 in all age groups except for mothers aged 35 and over[30]. If couples who were more strongly affected by recession were more likely to delay pregnancies, we have underestimated the relationship between economic recession, financial stress and smoking during pregnancy.

Our study is limited by missing data and by its cross-sectional design. Despite our careful considerations of the cut-off for exposure to recession by using area-specific and national data, it is possible we did not identify correctly after which date people were likely to experience the economic recession in their lives. In addition to misspecification of the exposure cut-off, data on key covariates may be influenced by date of data collection, as researchers will have gradually become more experienced in the administration of the questionnaire. It is likely that data are not missing at random.

Finally, smoking during pregnancy is a stigmatized behaviour which is likely to be underreported when relying on self-report measures, which means our prevalence rates of smoking during pregnancy are likely to underestimate true prevalence rates.

**Implications for research and society**

This study contradicts findings which suggest a beneficial effect of economic recession on smoking, and fits with literature on the role of stress, including financial stress, in a person's ability to quit smoking and prevent relapse[5-9,16].

In our sample, prevalence rates of smoking during pregnancy increased over time, while there is a slow but steady decline in smoking during pregnancy nationally[31]. In Scotland, the introduction of a smoking ban in public places led to reduced rates of smoking during pregnancy[32]. Our data shows no such effect on smoking during pregnancy around the time the smoking ban took effect in England in July 2007. Any downward trends in smoking prevalence may have been counteracted by the larger impact of the economic recession.

All women in this study were sampled from a UK city characterised by deprivation and health inequalities. The increased burden placed on this already disadvantaged community was by no means unavoidable. Research shows that strong social policies can prevent health impacts of recession[34,35]. Our study shows that socioeconomic conditions, both at the societal and individual level, are important targets when aiming to reduce rates of smoking during pregnancy. If there is ever a time to invest in protecting the vulnerable to the advantage of society as a whole, the period during and after recession is such a time.

**Declaration of interests**

The authors report no conflicts of interest.

**References**

1. Goedhart G, van der Wal MF, Cuijpers P, Bonsel GJ. Psychosocial problems and continued smoking during pregnancy. *Addict Behav.* 2009;34(4):403-406.
2. Smedberg J, Lupattelli A, Mårdby AC, Nordeng H. Characteristics of women who continue smoking during pregnancy: a cross-sectional study of pregnant women and new mothers in 15 European countries. *BMC Pregnancy Childbirth.* 2014;14(1):213.
3. Graham H, Hawkins SS, Law C. Lifecourse influences on women's smoking before, during and after pregnancy. Soc Sci Med. 2010;70(4):582-587.

4.  Penn G, Owen L. Factors associated with continued smoking during pregnancy: analysis of socio-demographic, pregnancy and smoking-related factors. *Drug Alcohol Rev.* 2002;21(1):17-25.

5.  Pickett KE, Wilkinson RG, Wakschlag LS. The psychosocial context of pregnancy smoking and quitting in the Millennium Cohort Study. *J Epidemiol. Community Health.* 2009;63:474-480.

6.  Siahpush M, Carlin JB. Financial stress, smoking cessation and relapse: results from a prospective study of an Australian national sample. *Addiction.* 2006;101(1):121-127.

7.  Siahpush M, Yong HH, Borland R, Reid JL, Hammond D. Smokers with financial stress are more likely to want to quit but less likely to try or succeed: findings from the International Tobacco Control (ITC) Four Country Survey. *Addiction.* 2009;104(8):1382-1390.

8.  Falba T, Teng HM, Sindelar JL, Gallo WT. The effect of involuntary job loss on smoking intensity and relapse. *Addiction.* 2005;100(9):1330-1339.

9.  McKee SA, Maciejewski PK, Falba T, Mazure CM. Sex differences in the effects of stressful life events on changes in smoking status. *Addiction.* 2003;98(6):847-855.

10. Ruhm CJ. Healthy living in hard times. *J Health Econ.* 2005;24(2):341-363.

11. Xu, X. The business cycle and health behaviors. *Soc Sci Med.* 2013;77:126-136.

12. Ásgeirsdóttir, TL, Corman H, Noonan K, Ólafsdóttir Þ, Richman NE. Was the economic crisis of 2008 good for Icelanders? Impact on health behaviors. *Econ Hum Biol.* 2014;13:1-19.

13. McClure CB, Valdimarsdóttir UA, Hauksdóttir A, Kawachi I. Economic crisis and smoking behaviour: prospective cohort study in Iceland. *BMJ Open.* 2012;2(5):e001386.

14. Filippidis FT, Schoretsaniti S, Dimitrakaki C, et al. Trends in cardiovascular risk factors in Greece before and during the financial crisis: the impact of social disparities. *Eur J Public Health.* 2014;24(6): 974-979.

15. Gallus S, Ghislandi S, Muttarak R. Effects of the economic crisis on smoking prevalence and number of smokers in the USA. *Tob Control.* 2013;24(1):82-88.

16. McKenna CS, Law C, Pearce A. Financial strain, parental smoking, and the Great Recession: An analysis of the UK Millennium Cohort Study. *Nicotine Tob Res.* 2016:ntw269. Doi: https://doi.org/10.1093/ntr/ntw269.

17. Raynor P, Born in Bradford Collaborative Group. Born in Bradford, a cohort study of babies born in Bradford, and their parents: protocol for the recruitment phase. *BMC Public Health.* 2008;8:327.

18. Wright J, Small N, Raynor P, et al. Cohort Profile: The Born in Bradford multi-ethnic family cohort study. *Int J Epidemiol.* 2013;42(4):978-991.

19. Office for National Statistics (ONS). *Jobseeker's Allowance with rates and proportions.* Newport: Wales;2016. https://www.nomisweb.co.uk/ Accessed January 28, 2016.

20. Office for National Statistics (ONS). *Population Estimates for UK, England and Wales, Scotland and Northern Ireland.* Newport, Wales; 2016. http://bit.ly/1ObV5s7. Accessed June 28, 2016.

21. *Oxford English Dictionary.* Oxford, UK: Oxford University Press; 2016. www.oed.com. Accessed July 7, 2016.

22. LexisNexis UK; 2016. www.nexis.com. Accessed June 23, 2016.

23. Textor J, Hardt J, Knüppel S. Dagitty: A graphical tool for analysing causal diagrams. *Epidemiology.* 2011;22(5):745.

24. StataCorp. 2011. *Stata Statistical Software: Release 12.* College station, Texas: StataCorp LP.

25. Baron RM, Kenny DA. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *J Pers Soc Psychol.* 1986; 51(6): 1173-1182.

26. Hayes, AF. Beyond Baron and Kenny: Statistical mediation analysis in the new millennium. *Commun Monogr.* 2009;76(4):408-420.

27. Zhao X, Lynch JG, Chen Qimei. Reconsidering Baron and Kenny: Myths and truths about mediation analysis. *J Cons Res.* 2010;37(2): 197-206.
28. Sobotka T, Skirbekk V, Philipov D. Economic recession and fertility in the developed world. *Popul Dev Rev.* 2011;37(2):267–306.
29. Goldstein J, Kreyenfeld M, Jasilioniene A, Örsal DDK. Fertility reactions to the" Great Recession" in Europe: Recent evidence from order-specific data. *Demographic Res.* 2013;29:85–104.
30. Office for National Statistics (ONS). Birth Summary Tables, England and Wales: 2014. Newport, Wales; 2015. http://tinyurl.com/h99xmxq. Accessed July 21, 2016.
31. Health & Social Care Information Centre (HSCIC). *Statistics on Women's Smoking Status at Time of Delivery, England - Quarter 4, 2013-14.* Leeds, UK; 2014. http://www.hscic.gov.uk/catalogue/PUB14258. Accessed July 21, 2016.
32. Mackay DF, Nelson SM, Haw SJ, Pell JP. Impact of Scotland's smoke-free legislation on pregnancy complications: retrospective cohort study. *PLoS Med.* 2012;9(3):e1001175.
33. Catalano R, Goldman-Mellor S, Saxton K, et al. The health effects of economic decline. *Annu Rev Public Health.* 2011;32:431–450.
34. Bacigalupe A, Escolar-Pujolar A. The impact of economic crises on social inequalities in health: what do we know so far? *Int J Equity Health.* 2014;13(1):1–6.
35. Stuckler D, Basu S, Suhrcke M, Coutts A, McKee M. The public health effect of economic crises and alternative policy responses in Europe: an empirical analysis. *Lancet.* 2009;374(9686):315–323.

**Table 1. Participant characteristics by exposure group**

| Participant characteristics | **Unexposed N=1362** | **Exposed N=1413** | **Total N=2775** | **p-value test of difference between groups*** |
|---|---|---|---|---|
| Maternal age (years) | 25.79 | 26.13 | 25.97 | 0.06 |
| Parity | | | | 0.03 |
| *Nulliparous* | 50.44% | 54.56% | 52.57% | |
| *Multiparous* | 49.56% | 45.44% | 47.43% | |
| Ethnicity | | | | 0.35 |
| *White British* | 77.97% | 76.57% | 77.26% | |
| *Pakistani* | 12.19% | 11.89% | 12.04% | |
| *Other* | 9.84% | 11.54% | 10.70% | |
| Maternal education | | | | <0.01 |
| *< 5 GCSE* | 25.40% | 23.50% | 24.43% | |
| *5 GCSE* | 38.11% | 36.73% | 37.41% | |
| *A-level* | 13.44% | 18.75% | 16.14% | |
| *> A level* | 14.54% | 15.64% | 15.10% | |
| *Other* | 8.52% | 5.38% | 6.92% | |
| Cohabiting | | | | |
| *Yes* | 69.53% | 66.67% | 68.07% | 0.11 |
| *No* | 30.47% | 33.33% | 31.93% | |
| Financial situation | | | | |
| *Comfortable* | 23.79% | 21.80% | 22.77% | 0.02 |
| *Doing alright* | 40.53% | 37.30% | 38.88% | |
| *Difficult* | 35.68% | 40.91% | 38.34% | |
| Change in financial situation | | | | |

| | | | | |
|---|---|---|---|---|
| *Same/better off* | 74.23% | 69.57% | 71.86% | <0.01 |
| *Worse off* | 25.77% | 30.43% | 28.14% | |
| Continued smoking during pregnancy | | | | 0.14 |
| *Yes* | 53.52% | 56.33% | 54.95% | |
| *No* | 46.48% | 43.67% | 45.05% | |

* χ2 test for categorical variables and t-test for continues variables

**Table 2. Exposure to recession in relation to smoking during pregnancy**

| | Model 1. **Bivariate** 'exposure recession' *N=2775* | | Model 2. **Multivariate** 'exposure recession' *N=2775* | |
|---|---|---|---|---|
| | OR | 95% CI | OR | 95% CI |
| **Exposure recession** | **1.12** | **0.96; 1.30** | **1.19** | **1.01;1.41*** |
| Maternal age | | | 0.93 | 0.92; 0.95*** |
| Parity Multiparous | | | 1.37 | 1.14;1.65** |
| Ethnic group *(versus White British)* Pakistani Other | | | 0.61 0.79 | 0.48;0.79*** 0.61;1.04 |
| Maternal education *(versus < 5 GCSE)* 5 GCSE A level > A level Other | | | 0.50 0.40 0.19 0.33 | 0.40;0.63*** 0.31;0.53*** 0.14;0.25*** 0.24;0.47*** |
| Cohabitation Yes | | | 0.53 | 0.44;0.64*** |

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

**Table 3. Results of Sobel-Goodman test with bootstrap analysis**

| | Coefficient | Standard error | 95% CI |
|---|---|---|---|
| **Model with mediator 'worse financial situation' (N=2775)** | | | |
| *Indirect effect** | 0.003 | 0.001 | 0.000;0.001 |
| *Direct effect* | 0.031 | 0.017 | -0.003;0.066 |
| **Model with mediator 'difficult financial situation' (N=2775)** | | | |
| *Indirect effect*** | 0.006 | 0.002 | 0.002;0.011 |
| *Direct effect* | 0.028 | 0.018 | -0.007;0.063 |

* Proportion of the effect that is mediated: 0.084

** Proportion of the effect that is mediated: 0.176

# Appendices

## Table A1. STROBE Statement (https://strobe-statement.org/)

| | Item No | Recommendation | Implementation |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | Abstract: We used cross-sectional data on 2775 pregnant women who were regular smokers before pregnancy and who were enrolled in the UK Born in Bradford cohort study |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | Provided estimate and confidence interval of association exposure – outcome and result of the mediation analysis. |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | Discussion of conflicting evidence on smoking and financial stress/ recession. |
| Objectives | 3 | State specific objectives, including any pre-specified hypotheses | Hypothesis: "In a deprived UK community hit hard by the Great Recession, women who smoke regularly were more likely to continue smoking during pregnancy if they were exposed to the Great Recession during pregnancy compared to those unexposed, and this relationship is mediated by financial stress." |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | Method section; cohort data |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | Detailed description of the setting including on economic conditions relevant to this study. |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants | See 'data' section; recruitment BiB study. |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | See methods; exposure, outcomes, covariates sections. |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is >1 group | See above. |
| Bias | 9 | Describe any efforts to address potential sources of bias | Described rational for mediation analysis and resampling method. |
| Study size | 10 | Explain how the study size was arrived at | See inclusion/exclusion criteria BiB data. |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | See methods; exposure, outcomes, covariates sections. |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | See section 'covariates' about selection of confounders through DAG, see section 'statistical analysis' for info about regression analysis. |
| | | (*b*) Describe any methods used to examine subgroups and interactions | See 'statistical analysis' section; mediation analysis |
| | | (*c*) Explain how missing data were addressed | See section 'data': As data was not missing at random, a dataset with complete data for the exposure variable and covariates was used. |
| | | (*d*) If applicable, describe analytical methods taking account of sampling strategy | - |
| | | (*e*) Describe any sensitivity analyses | - |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | See methods 'data' section + first paragraph results: "The sample consists of 2775 women who were regular smokers before pregnancy." |
| | | (b) Give reasons for non-participation at each stage | - |
| | | (c) Consider use of a flow diagram | - |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | See Table 1 |
| | | (b) Indicate number of participants with missing data for each variable of interest | - |
| Outcome data | 15* | Report numbers of outcome events or summary measures | See Table 1. |

| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | See Table 2. |
| | | (*b*) Report category boundaries when continuous variables were categorized | - |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | Section 'multivariable analysis': "All other factors being equal, this represents a 3.7% difference in smoking prevalence, with 53.1% of women in the unexposed and 56.8% of women in the exposed group smoking during pregnancy." |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | See section 'Mediation analysis' |

**Discussion**

| Key results | 18 | Summarise key results with reference to study objectives | See first paragraph of conclusions section. |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | See 'limitations' section |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | See 'Implications for research and society' |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | See limitations section; area-level trends in fertility and smoking. |

**Other information**

| Funding | 22 | Give source of funding and the role of the funders for the present study and, if applicable, for the original study on which present article is based | See section 'funding'. |

**Box A1. Media search of reports on UK recession**

National UK newspapers

Source of information:    NEXIS UK[*]

Search terms:    'recession' OR 'economic crisis' OR 'financial crash' OR 'economic downturn' OR 'credit crunch' in headline of UK national newspaper

Search period:    01-08-2007 to 01-09-2008
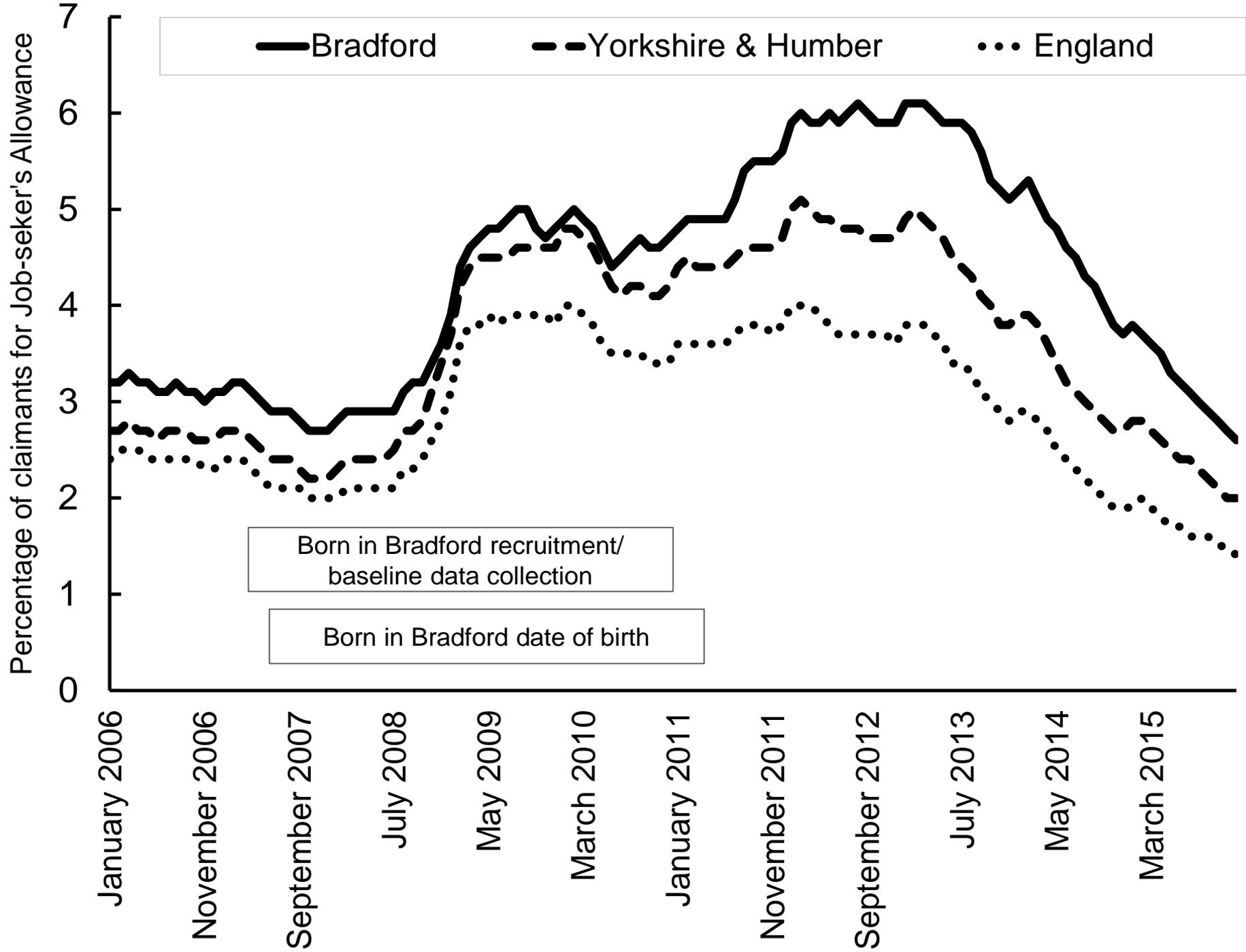
Hits:    N=612

Main findings:
- February 2007; first speculations about US recession mostly dismissed
- End 2007; Increased reporting on likelihood US recession, likelihood of UK recession more widely debated.
- January 2008; reports of start US recession, talks of UK recession dismissed by some as scaremongering and contradictory opinions from politicians.
- March 2008; more articles on high likelihood of recession; more evidence of failing economy.
- July-August 2008; reports that UK recession is unavoidable. Articles playing down likelihood of recession disappear.
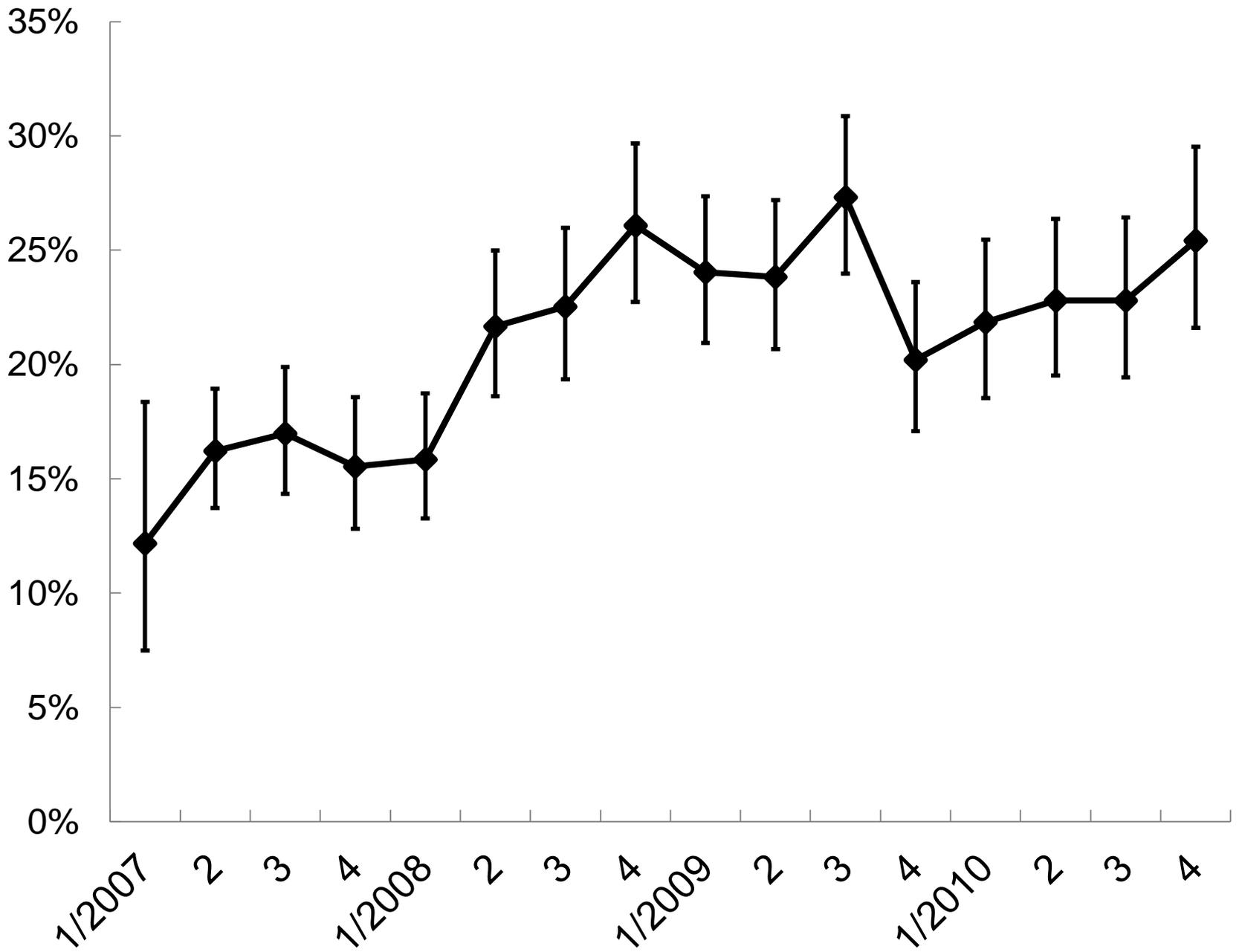
Bradford newspaper Telegraph & Argus

Source of information:    http://www.thetelegraphandargus.co.uk/

Search terms:    'recession' in article

Figure: Line graph showing Percentage of claimants for Job-seeker's Allowance from January 2006 to March 2015 for Bradford, Yorkshire & Humber, and England, with annotations for "Born in Bradford recruitment/baseline data collection" and "Born in Bradford date of birth".