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Does unemployment worsen babies' health? A tale of siblings, maternal behaviour, and selection☆

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ABSTRACT

We study in-utero exposure to economic fluctuations on birth outcomes by exploiting geographical variation in the unemployment rate across local areas in England, and by comparing siblings born to the same mother. Using rich individual data from hospital administrative records for 2003–2012, babies' health is found to be strongly pro-cyclical. This overall result masks marked differences between babies born in the most affluent areas whose health at birth improves in a recession, and babies born in the average-to-lowest income deprived areas whose health deteriorates. Maternal alcohol consumption, smoking, and delay in the first antenatal care assessment - combined with parental income loss, are found to drive the results. While differences in maternal risky behaviours can explain the heterogenous effects.

1. Introduction

Health at birth is known to affect many subsequent outcomes throughout the lifecycle. As a consequence, prenatal events which influence new-borns' outcomes, have been documented to be the origins of large inequalities in early life that map into future disparities in health and economic outcomes, including educational attainment and wages (Almond and Currie, 2011a; Almond et al., 2018; Almond and Currie, 2011b). It is then not surprising that scholars have been trying to investigate how business cycles affect health at birth, starting from the pioneering work by Dehejia and Lleras-Muney (2004). Economic busts may decrease the material

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resources available to families and particularly pregnant women, but also reduce employment and social services. Nevertheless, the results of this literature are mixed. In fact, new-borns' health has been found to be counter-cyclical in the United States, Spain and Sweden (Aparicio et al., 2020; van den Berg et al., 2020; Dehejia and Lleras-Muney, 2004), while pro-cyclical in Iceland and The Netherlands (Alessie et al., 2018; Olafsson, 2016).[1]

One possible reason for these contradictory conclusions is how scholars have dealt with selection into fertility. The choice to conceive is also influenced by economic fluctuations leading to potential biases in the estimated effect of unemployment on baby's health. An accurate way to control for this type of selection, is to use a mother fixed effect (FE) design to compare siblings born to the same mother, but who in-utero are exposed to different points of the business cycle. While only a few studies adopt this identification strategy, even here the evidence is mixed (van den Berg et al., 2020; Dehejia and Lleras-Muney, 2004; Olafsson, 2016; Salvanes, 2013).

Our paper contributes to this ongoing debate by studying the effect of unemployment on birth outcomes, by focusing on a different context, by adopting a family fixed effect design to adjust for selection into fertility, and by shedding some light on the mechanisms - maternal antenatal behaviour and parental income loss - behind these effects.

We combine a unique administrative dataset of about 2 million sibling births delivered in National Health Service (NHS) hospitals with local area unemployment rates in England exploiting their large geographical variation over a period of ten years, 2003-12, including the Great Recession.[2]

We first show that mothers from the most affluent areas tend to have more babies when unemployment increases, while the opposite is true for fertility amongst women living in the poorest areas.

We then replicate existing studies, like Dehejia and Lleras-Muney (2004), by performing a pooled OLS analysis of unemployment on birth outcomes and find health to be counter-cyclical, albeit all estimated coefficients are insignificant. Nevertheless, when we include maternal fixed effects in the analysis, we show that the health of English babies is negatively and highly statistically significantly associated with an increase in the unemployment rate. On a range of metrics a sibling born in a recession will on average be less healthy, ceteris paribus: a one-percentage point increase in the unemployment rate leads to a decrease in birthweight by 0.2%, and in foetal growth by 0.3%; an increase in small-for-gestational-age (SGA) new-borns by 3%, and in stillbirth by 9%. Our results are then consistent across a variety of health outcomes, and do not focus only on birthweight, which has been recently found to provide a limited picture of the prenatal environment (Conti et al., 2020).

We continue by showing that these adverse effects of unemployment are found to be greater for mothers from middle to most deprived areas; whereas conversely, for babies conceived in the most prosperous areas, recession improves their outcomes. This is particularly relevant in the UK where stark differences in infants' health by social class already exist (Marmot et al., 2010; Weightman et al., 2012), and where middle income families with children now more closely resemble poor families than in the past (Belfield et al., 2016).

The difference between the pooled OLS and maternal FE estimates is explained by the positive selection into fertility; and the heterogeneous influence of unemployment in which the health of high social classes' babies is less damaged by unemployment. Thus, as fertility among mothers from the richer areas rises with higher unemployment, the negative influence of unemployment on health is ameliorated.

Lastly, we investigate empirically three mechanisms that may explain both our overall result that babies' health is pro-cyclical, and the heterogenous effects of recession on birth outcomes. First, we explore how high unemployment may affect maternal health behaviour. By using the diagnoses registered at the time of the delivery, we find that economic downturn increases the probability of the mother being diagnosed for drinking- and smoking-related problems.[3] Second, we explore whether an economic crisis results in a postponement of the first prenatal visit that is registered by the hospital. We find that this visit is delayed by almost one week, indicating that a mother's opportunity cost of time to attend prenatal checks increases in a recession. Suggestive evidence shows that of all these maternal behaviour, antenatal care seems to be the strongest mediating factor. Finally, we provide some evidence on a third indirect channel: parental income loss. Unemployment might lead to unexpected earnings losses. We find the female unemployment rate to have a larger negative influence on health than male unemployment. Given that female unemployment is a better proxy for maternal unemployment, its larger effect might point towards worse maternal mental health induced by the financial distress. We also find that two-parent households cope better than single-parent households, by largely mitigating the effect of unemployment on health, and possibly the income loss. Adopting a sibling fixed effect design, Lindo (2011) also shows how an income reduction could be an important mechanism for the decrease in birthweight induced by job displacement. While our three channels can explain the pro-cyclicality in health observed among the low-to-middle SES families, a reduction in alcohol and smoking use may be a mechanism for the counter-cyclicality found among the high SES.

[1] In low-middle income countries, the consensus tends towards pro-cyclicality of babies' health (e.g., Bhalotra, 2010; Bozzoli and Quintana-Domeque, 2014). The same holds true for the medical literature (e.g., Eiríksdóttir et al., 2013; Finch et al., 2019; Kana et al., 2017; Varea et al., 2016). Related economic research shows that layoff announcements (Carlson, 2015), or job displacement (Lindo, 2011) are negatively associated with health at birth.

[2] Previous related studies in the medical and social science literature have used small or selective samples or representative (but still small) surveys, such as the British Household Panel Survey or Millennium Cohort Study (e.g., Chevalier and O'Sullivan, 2007; Del Bono et al., 2012a).

[3] There is a literature showing that these behaviours are less frequent in a recession, because the available income might be less (Ruhm, 2000; Ruhm and Black, 2002). Other studies show instead an increase in drinking and smoking (Charles and DeCicca, 2008; Deb et al., 2011) possibly due to behavioural health responses to job loss, and often among the low socioeconomic status (SES) groups (Dehejia and Lleras-Muney, 2004).

This paper adds to the existing literature in two main ways. *Firstly*, we compare pooled OLS estimates of the effect of unemployment with estimates using family FE to control for maternal time-invariant characteristics, rather than to offer one or the other. We are able to explain a positive bias in pooled OLS estimates induced by positive selection into birth. Once this selection is taken into account, babies' health is found to be strongly pro-cyclical. Dehejia and Lleras-Muney (2004) are the first to control for mother fixed effects for a Californian subsample, and do not find significant effects of unemployment on birth outcomes. Insignificant associations are also reported for Norway (Salvanes, 2013); while van den Berg et al. (2020) and Olafsson (2016) find new-borns' health to be respectively counter-cyclical in Sweden, and pro-cyclical in Iceland. Crucially, our overall finding masks marked heterogenous effects across the population. While for the majority of pregnancies, exposure to the crisis leads to worse outcomes at birth, positive effects for the babies born in the most affluent areas are identified. Contrarily, van den Berg et al. (2020) find that the positive effects of recessions on very low birth weight are stronger for low-SES parents. Our SES measure is at the local-area level, while van den Berg et al. (2020) consider individual specific educational level. While differences in context and hardship of the Great Recession may influence these opposite findings, we believe that our result is relevant to understanding some of the factors leading to the persistence in health inequality at birth, and as a consequence, other dimensions of the limited UK social mobility.

Secondly, we provide new evidence on the mechanisms. We test the channels of maternal behaviour and prenatal care by using new medically verified indicators. These measures are more reliable than the self-reported information considered so far in the literature, such as in Dehejia and Lleras-Muney (2004) or Aparicio et al. (2020) where survey data are used. In addition, our analysis helps to identify some hidden heterogeneous mechanisms. Our results complement Olafsson (2016) and Carlson (2015) who claim that higher stress experienced by the woman during the pregnancy linked to the financial uncertainty leads to worse new-borns' health. While we cannot directly test this channel, increasing stress due to income or wealth declines could also influence the higher smoking and alcohol consumption that we observe in a bust and particularly for the women living in the less prosperous areas.

This paper is structured as follows. Section 2 describes the main features of the UK institutional context. Section 3 presents the empirical specification and the data. Section 4 empirically tests the association between unemployment and fertility, and discusses selection in-utero. Section 5 presents our main results, sensitivity analysis, and heterogeneity analysis. Section 6 provides evidence on three potential mechanisms. Section 7 concludes.

2. UK institutional context

The impact of high unemployment on birth outcomes may operate either through the financial consequences of job loss, or higher uncertainties, but the degree to which baby's health is affected may depend partly on the generosity of the country's welfare institutions. In this section we describe some characteristics of the UK system that differ from those systems in other western countries where similar studies have been performed.

The UK has a mature and moderately generous benefits system, that aims to provide financial and practical support for people in need. The means-tested support primarily targets the jobless who are looking for work, and those having either low earnings, or families with children (Van Lancker et al., 2015). Unemployment benefit in the UK is called Jobseeker's Allowance (JSA), and it is paid by the government to people who are unemployed and actively seeking work.[4] To be eligible for JSA, claimants need to prove they are actively looking for work, and certify that they are doing so by "signing on" at their local Job Centre every two weeks. There is a maximum amount a person can get, but how much she is entitled to depends on her age. A person can get up to six months of unemployment benefits.

Compared to other similar wealthy countries, unemployment protection is not a priority in the UK social security system. The JSA is not earnings-related, hence being in employment in the UK does not confer additional income protection with respect to most Western and Nordic European countries including the US. Its minimum income benefit is also less generous than in any country apart from the US and Sweden. Support for out of work families is instead quite high, exceeding the value of the minimum income benefit. Nevertheless, in the UK the net disposable income excluding housing allowances for a couple with two children, reliant on unemployment insurance or on minimum income benefits is among the lowest compared with other similar OECD countries (Gaffney, 2015).

The generosity of benefits for unemployed people can be expressed as the replacement rate, which is a percentage of earnings when in work. In terms of replacement rates, the JSA is one of the lowest unemployment insurance benefit across all OECD and EU nations (Esser et al., 2013). This holds true also averaging over different family types, unemployment durations and wage levels (Grzegorzewska and Thevenot, 2013).[5]

In terms of medical assistance, the National Health Service (NHS) provides medical care through primary care, hospitals, and community health care. All treatments under the NHS are free at point of delivery to the patient, and care to pregnant women and new mothers is provided through midwives and/or doctors. Midwives can give information to help women have a healthy pregnancy, including advice about choices for care during pregnancy, labour and birth. Prenatal care consists of services including ultrasound scans, antenatal screening tests, and blood tests.

[4] For more details, please see here: https://www.gov.uk/jobseekers-allowance.

[5] In 2015, the UK net replacement rate (ratio of net income while out of work divided by net income while in work) was about 68% of average wage. The comparable rate in the US was 86%, with also similar European regimes being more generous than the UK (e.g., in 2015 the net replacement rate was 81% in Sweden; 85% in Norway, 90% in Italy, 91% in Germany, 83% in France, 93% in Denmark, 88% in Spain, and 79% in The Netherlands. These figures come from the OECD.STAT, Net Replacement Rate in Unemployment, https://stats.oecd.org/Index.aspx?DataSetCode=NRR.

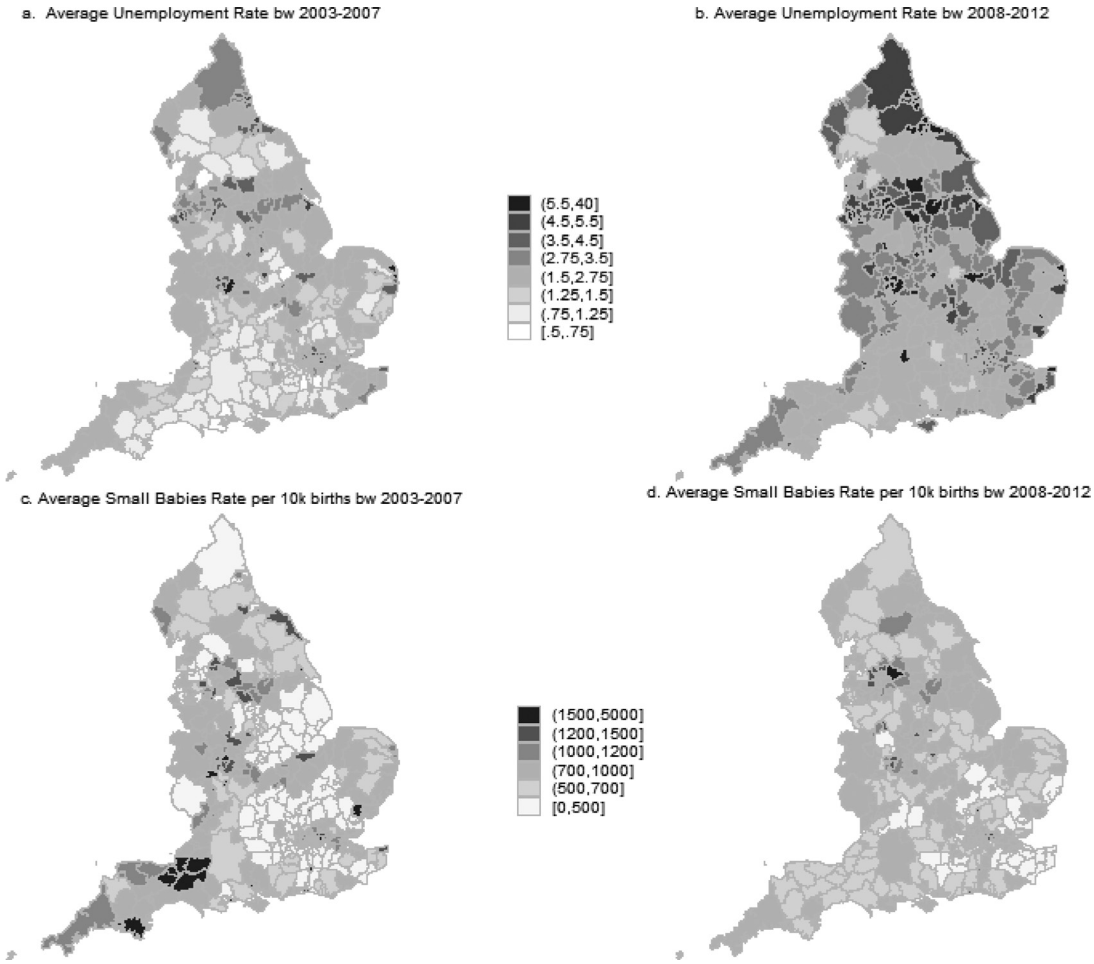

Fig. 1. Unemployment rate and small-for-gestational-age in England *Note: The maps a. and b. report respectively the average unemployment rate between 2003–2007 and 2009–2012 in each Local Authority District (LAD), while the maps c. and d. show the average rate of small-for-gestational-age babies between 2003–2007 and 2009–2012 in each Local Authority District (LAD). The unemployment rate corresponds to the ratio of JSA claimants divided by the working age population at LAD-year level.*

3. Data and empirical strategy

3.1. Unemployment indicator

The Job Centre geographies map directly into local authority districts (LAD), which are the boundaries we utilise for our labour market areas. In England, there are 314 LADs with populations of 174,000 to 1.1 million. To control for possible spillovers across areas and for the loss of statistical power, we later construct unemployment rates at respectively larger and smaller geographical areas than districts (Lindo, 2015). A further reason to consider districts is that some of the variables used in the sensitivity analysis come from the Annual Population Survey, a survey representative at LAD level.

We construct our indicator of unemployment by using monthly data on all JSA claimants available from the Office for National Statistics (ONS), from 2003 until 2012, and in each LAD.[6] We divide this figure by the population aged 16–64 (working-age population) by month and LAD, to obtain a measure of the proportion of people claiming unemployment-related benefit. We are mainly interested in the in-utero effect of unemployment on new-borns' health (as in van den Berg et al., 2020). Towards this aim we construct an unemployment rate that is the average unemployment rate among 16-64-year-old in the nine months following conception. To study selection into fertility we instead focus on the unemployment rate in the year of conception. In Section 5.2, we provide extensive sensitivity analysis with the use of different indicators of unemployment.

Fig. 1 at the top shows two maps (panels *a* and *b*) representing the average unemployment rate i) pre-recession (2003-07), and ii) during and post-recession (2009-12). As can be seen there is clear geographical variation in the unemployment rate across districts.

[6] The data can be downloaded from the Nomis platform https://www.nomisweb.co.uk.

After moderate national unemployment variation prior to the crisis (2003-07), there was a large (58%) increase in unemployment from 5.2% in 2008:1 to a peak of 8.2% in 2011:4 before falling to 7.8% at the end of our sample period, 2012:4.

UK labour market dynamics in the recession and recovery following the 2008 crisis differed to that in the more 'flexible' US market. The UK experienced only a slow recovery in productivity, and more gradual falls in unemployment were delayed until after 2011. Given this, with respect to the US and some other European countries, a comparatively high proportion of the UK unemployed have long spells of unemployment: of the UK male (female) unemployed in 2008 - the mid year in our sample - 37.7% (46.8%) had been unemployed for under 3 months; whereas 28.5% (18.1%) had been unemployed for over one year. The longer spells of unemployment in the UK are also present prior to the crisis. In the US the importance of short spells is evident in the comparable figures for short and long term male (female) unemployment 63.8% (64.9) and 10.9% (10.3) (OECD, 2021). Thus for both men and women the prospect of quickly leaving unemployment was less likely in the UK, and the resulting impact of unemployment potentially more arduous.

3.2. Hospital Episode Statistics Data and an aggregate measure of SES

We use administrative Hospital Episode Statistics (HES) data on new-born infants and maternal characteristics at the individual level. In particular, HES data provide individual information concerning all inpatients and outpatients admitted to NHS hospitals from 1989 90. Each patient record contains detailed clinical information, patient characteristics, such as age, gender, residence, method of admission, and hospital of treatment. Since our focus is birth outcomes, we restrict our analysis to delivery admissions, and consider the years from 2003 until 2012. Each episode of delivery reports the following information: mother's age, mother's Lower Super Output Area (LSOA) of residence,[7] mother's ethnicity, length of gestation, gestation period in weeks at first antenatal assessment, result of the pregnancy (live birth or stillbirth), number and type of diagnoses, delivery information (method, type of doctors attending the delivery, etc.), date of admission to the hospital, date of discharge, as well as, new-born's gender and birthweight.

One variable missing from the HES data is the socioeconomic background of the patients. We complement this lack of information, by linking the HES data to an aggregated measure of socioeconomic status, the Economic Deprivation Index (EDI). This index is provided by the UK Government, and it is a measure of deprivation at area level which comprises two domains: Income and Employment. The two domains are given equal weighting within the overall EDI. The EDI is available for the years 1999–2009.[8] For our analysis we consider only the Income Deprivation Domain (IDD) to avoid correlation with our main explanatory variable, the unemployment rate. The IDD represents the proportion of people aged under 60 in an area that are living in low-income households claiming certain means-tested social security benefits. We create a categorical variable that takes five values corresponding to the five quintiles of IDD, where the first quintile corresponds to the least deprived (IDD1), and the fifth quintile to the most deprived areas (IDD5). In an attempt to avoid endogeneity we have attached to each mother by LAD and year of conception the three-year-lagged IDD quintiles with the HES, which we assume to be exogenous.[9]

3.3. Siblings sample

The individual HES data are linked to the unemployment rate, through the mothers area of residence, and the month and year of conception.[10] The HES data do not contain the date of conception which we derive by using the date of admission for a delivery episode, the length of pregnancy in weeks, the first antenatal assessment date and the gestation period in weeks at first antenatal assessment. For example, the date of conception is equal to the date of admission minus length of pregnancy (in weeks); or if the length of pregnancy is missing then the date of conception is equal to the date of first antenatal assessment minus the gestation period at first antenatal assessment.

We construct our sample starting from the universe of deliveries registered in NHS hospitals between 2003 and 2012 - that is about five million (which we will now refer to as the "full sample"). We exclude twins, and both private and home births that are not accounted in the HES data, which represent about 5% of the total births.[11] We then restrict the data to mothers aged 16–49 years. For our main analysis which compares siblings, we focus on mothers who had at least two live births in our time frame, and consists of roughly half of the initial sample (2,423,402). About 13% of these siblings are born in different LADs. Since local labour market conditions can affect moving behaviour, we also restrict our data to the sample of non-movers to obtain a more homogenous population, and avoid potential selection into migration.[12] This leads to a final analytic sample of 2,097,691 births. About 78% of these are sibling pairs, 18% are three siblings, and the rest are more than three siblings families.

[7] The LSOA is a small geographical area developed by the Office for National Statistics containing on average 1500 individuals and 650 households. For more details see http://www.neighbourhood.statistics.gov.uk.

[8] The index is constructed in a consistent manner over time and can be used to track the progress of deprived neighbourhoods. A different index is the Index of Multiple Deprivation (IMD) that includes also other domains such as education, skills and training deprivation, health deprivation and disability, crime, barriers to housing and services, and living environment deprivation. This index is only available every three years (e.g., for our period in 2004, 2007 and 2010). The EDI was produced to overcome the difficulties in comparing the different IMDs as different methodologies were used.

[9] Since EDI is available until 2009, we link the 2008–2009 average index to year of conception 2011, and the 2009 index to year of conception 2012.

[10] The mother's area of residence is reported at LSOA level. We map every LSOA into its respective LAD to merge the HES with LAD-level data.

[11] The percentage of women giving birth at home is very low in the UK, it was 2.6% in 2005, and 2.3% in 2015 (ONS, 2015).

[12] A different form of selectivity is hospital choice. Hospital choice was implemented for elective care in 2006 to allow patients to decide where to get treated. Maternity care was not included in this reform (see Garcia et al., 2021), hence pregnant women usually deliver in the closest hospital.

Using the baby's birthweight, the length of gestation, and the result of the pregnancy, we create the following outcome variables: birthweight in grams, very low birthweight (VLBW - dummy variable equal to one if birthweight is below 1.5 kg), small-for-gestational-age (SGA - dummy variable equal to one if birthweight is below the 10th percentile for the length of the pregnancy), foetal growth in grams (ratio between birthweight and length of the pregnancy), and stillbirth (dummy variable equal to one if the baby is born dead after 24 completed weeks of pregnancy).

3.4. Empirical strategy

We present here the empirical strategy. In line with the literature, we first study selection into fertility by estimating the following equation:

$$Y_{jt} = \alpha + \beta UR_{jt} + \theta_t + \xi_j + \gamma_j t + \epsilon_{ijt}, \tag{1}$$

where Y_{jt} corresponds to an outcome for all births conceived in year t and local area j. We consider birthrates given by the number of births per 1000 women in their reproductive window 16–49. UR_{jt} corresponds to the unemployment rate for area j and year t, and the coefficient of interest is β which indicates the effect of unemployment on the birthrate. Year fixed effects are captured by θ_t and control for any year specific factors that could affect both infant's health and the economy. We include area fixed effects, ξ_j, to adjust for differences in the unemployment across labour market areas. $\gamma_j t$ represents area-linear trends that allow for omitted trends that vary by areas. In these regressions we weight for the number of births given the area size differences, and we cluster the standard errors at the area level.

To study the effect of unemployment on babies' health, we compare outcomes of siblings born in different years, and adopt a mother fixed effect approach. We then control for unobserved time-invariant characteristics of the mother, which may be correlated with selection into fertility at times of high unemployment. We slightly modify Eq. 1, and estimate the following equation:

$$Y_{ijt} = \alpha_i + \beta UR^p_{jt} + \theta_t + \gamma_j t + X_i^{'}\zeta + \epsilon_{ijt}, \tag{2}$$

where Y_{ijt} corresponds to a birth outcome for baby of mother i living in area j and conceived in year t. UR^p_{jt} corresponds to the unemployment rate during pregnancy proxied by the average unemployment rate amongst those 16-64 years old in the nine months following conception in local area j. Note that in Eq. (1) we use unemployment in the year of conception because we are interested in studying fertility outcomes and not birth outcomes as in Eq. (2). The key parameter, β, is the effect of unemployment on the birth outcome. The mother fixed effect is captured by α_i and implicitly incorporates an area fixed effect. X_i includes extra individual controls such as month of conception to adjust for seasonality, new-born's gender, maternal age and ethnicity.[13] The standard errors are clustered at the mother level.[14]

3.5. Descriptive statistics

Table 1 presents descriptive statistics of the main variables considered. In columns (1)-(3), we present statistics derived from the full sample, and in columns (4)-(6) statistics for the sample of siblings, our main focus. There are not major differences across the two samples. The birthweight is on average about 7 g less in the full sample than in the analytic sample, the prevalence of VLBW is approximately 1%, while about 10% of babies are small compared to their gestational age, and the prevalence of stillbirth is 0.5-0.6%. The baseline unemployment rate is 3.1. As expected in the siblings' sample, families are larger with on average 1.37 children, compared to 1.18 in the full sample. We also observe a slightly smaller prevalence of old mothers over 35 (16%) compared to the same group in the full sample (20%). The opposite is true for the prevalence of young and middle age mothers.

Fig. 1 at the bottom shows two maps (panels *c* and *d*) representing the average rate of small-for-gestational-age babies between 2003-07 and 2009-12 in each local area. While pre-2008 there seems to be larger geographical variation in the rate of SGA, post-2008 the rate increases in most districts (white areas become light grey areas) mirroring the maps for unemployment which we presented above (panels *a* and *b*).

4. Fertility and selection

4.1. Selection into fertility

Despite a large literature finding fertility to be pro-cyclical (Adsera, 2005; Sobotka et al., 2011), the UK presents a singular exception.[15] In fact, the increasing fertility experienced in the UK following the Great Recession contrasts with the baby bust observed in other countries in Europe (e.g., Goldstein et al., 2013) and the US (e.g., Schaller, 2016; Schneider, 2015).[16]

Each pregnant woman in England is assigned to a midwife in the local area of residence. The mother can give birth at home, in a unit run by midwives or in a hospital. The NHS guidance is that the midwife discusses with the patient the options about where to have her baby. This depends on special needs, risks and, to some extent, where the mother lives (more information can be found here https://www.nhs.uk/pregnancy/labour-and-birth).

[13] Unfortunately, ethnicity is missing for many individuals, but we include in the ethnicity variable the category ethnicity unknown. Ethnicity is used in pooled OLS estimates of Eq. 2.

[14] The main results do not change if we cluster the standard errors at district-area level. This analysis is available upon request.

[15] Goldstein et al. (2013) find that in Northern European countries where the economic crisis did not lead to great economic hardships, unemployment has not impacted fertility substantially.

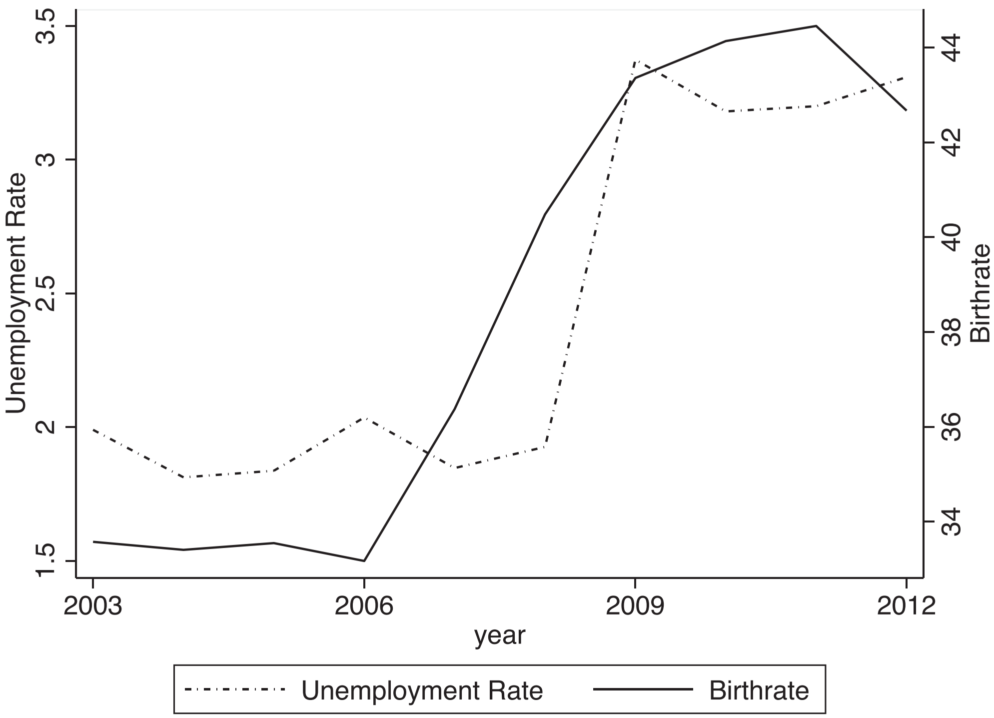

Fig. 2. Unemployment rate and birthrate over time in England *Note: This Fig. reports the unemployment rate and the birthrate for the period 2003–2012. The unemployment rate corresponds to the ratio of Jobseeker Allowance (JSA) claimants divided by the working age population 16–64. The birthrate is given by the total number of births in the same year of conception per 1000 divided by all women aged 16–49.*

In Fig. 2, we plot the unemployment rate and the overall birthrate for England over time using the full sample of births. Both the unemployment rate and the birthrate correspond to the year of conception. The birthrate is given by the number of births per 1000 divided by all women aged 16–49. Birth and unemployment rates follow similar trends. Unemployment is stable at about 2% until 2007, when it starts to increase, reaching almost 3.5% at the peak of the recession, before it declines. The birthrate is around 33 births per 1000 women until 2006, from which time it gradually rises to 43–44 in 2009-10, and then decreases.[17]

Economic downturns might also widen socioeconomic differences in childbearing. For example, Dehejia and Lleras-Muney (2004) find that White mothers who give birth during a recession are typically less educated than those giving birth in a boom, while the reverse is true for Black mothers. Del Bono et al. (2012b) show that highly skilled women postpone pregnancies when there is an economic shock, leading to a drop in fertility. Chevalier and Marie (2017) instead find that following the economic uncertainty due to the collapse of the Berlin wall and the communist regime, women with lower parenting skills were more likely to conceive.

In Table 2, we examine the association between the unemployment rates in the year of conception and different group-specific birthrates for mothers in England. We create birthrates by maternal age groups and birth order using individual level characteristics from the HES data, and by income deprivation quintiles using our area-level aggregate measure as explained in Section 3.2. Age-specific birthrates are constructed using the age-specific number of women as denominator, while birthrates by birth order or IDD quintiles are constructed using all women aged 16–49 as denominator.[18] We estimate Eq. (1) using our analytic sample of siblings. Our preferred specification includes local area linear trends to further reduce omitted variable bias (column (2)), but we also report results without trends (column (1)). We find no statistically significant effect of unemployment on overall birthrate, albeit the association is positive. While an increase of one-percentage point in the unemployment rate leads to an increase in fertility among 25–34 year old mothers by 6%, and an increase in the birthrate of first born by 13%, but only marginally statistically significant. A clear socioeconomic gradient emerges if we consider the effect of unemployment on birthrates by income deprivation. We find higher fertility for the mothers in the top two quintiles of the income distribution, and a decrease in babies born to the mothers living in the poorest areas.

To test whether and how fertility changes over time and in spite of the Great Recession, we slightly modify Equation (1) and include also the interactions between unemployment and year dummies, controlling for local area linear trends. Fig. A.1 shows the estimated coefficients of these interactions for birthrates in the different groups. Looking at age-specific birthrate, fertility among

[16] Cumming and Dettling (2020) show how a monetary policy pass-through to lower mortgage interest rates boosted UK fertility.
[17] This trend resembles the one reported by the ONS (ONS, 2016).
[18] For example, we take the total number of first born divided by the total number of women aged 16–49 in each area and year, or we take the total number of births born in one IDD1 area in each year divided by the total number of women aged 16–49 living in the same IDD1 area and year.

Table 1
Descriptive statistics.

	Full sample			Analytic sample		
	Mean (1)	SD (2)	N (3)	Mean (4)	SD (5)	N (6)
Outcomes						
Birthweight in grams	3358.156	582.236	4,794,763	3365.477	585.928	2,087,499
Prop born below 1500 g	0.010	0.101	4,794,763	0.011	0.102	2,087,499
Prop small-for-gestational-age	0.101	0.301	4,030,279	0.097	0.297	1,757,887
Foetal growth	85.612	13.821	4,030,279	85.947	13.941	1,757,887
Prop stillbirth	0.005	0.068	4,822,960	0.006	0.079	2,097,691
Unemployment indicators						
Unemployment rate 16–64 (baseline)	3.118	1.528	4,745,505	3.116	1.522	2,064,569
Unemployment 16–24	4.890	2.260	4,745,505	4.920	2.263	2,064,569
Unemployment 16–49	3.560	1.742	4,745,505	3.567	1.739	2,064,569
Male unemployment	4.413	2.170	4,745,505	4.442	2.178	2,064,569
Female unemployment	1.832	0.967	4,745,505	1.799	0.945	2,064,569
Model-based unemployment†	6.931	2.695	4,342,686	6.867	2.671	1,914,959
Unemployment - denominator from APS†	4.280	2.243	4,343,036	4.267	2.24	1,915,043
Maternal or new-born characteristics						
Prop female new-born	0.490	0.500	4,755,930	0.489	0.500	2,069,174
Birth order	1.179	1.355	4,012,933	1.366	1.374	1,876,232
Prop Birth order 1	0.365	0.481	4,012,933	0.274	0.446	1,876,232
Prop Birth order 2	0.338	0.473	4,012,933	0.376	0.484	1,876,232
Prop Birth order 3	0.165	0.371	4,012,933	0.196	0.397	1,876,232
Prop Birth order $\geqslant$ 4	0.131	0.338	4,012,933	0.154	0.361	1,876,232
Prop ethnicity White	0.723	0.447	4,822,960	0.752	0.432	2,097,691
Prop ethnicity Indian	0.084	0.277	4,822,960	0.104	0.306	2,097,691
Bangladeshi and Pakistani						
Prop ethnicity Black	0.051	0.221	4,822,960	0.050	0.218	2,097,691
Prop ethnicity Other	0.068	0.251	4,822,960	0.062	0.240	2,097,691
Prop ethnicity Unknown	0.074	0.262	4,822,960	0.032	0.176	2,097,691
Prop mothers aged 16–24	0.250	0.433	4,822,960	0.270	0.444	2,097,691
Prop mothers aged 25–34	0.555	0.497	4,822,960	0.569	0.495	2,097,691
Prop mothers aged $\geqslant$ 35	0.196	0.397	4,822,960	0.161	0.367	2,097,691
Weeks 1st antenatal visit	13.706	7.967	4,160,677	13.344	7.599	1,806,717
Alcohol diagnosis††	0.005	0.069	4,822,960	0.005	0.069	2,097,691
Smoking diagnosis††	0.107	0.309	4,822,960	0.109	0.312	2,097,691

Note: The analytic sample corresponds to the sample of siblings non-movers (see Section 3 for details). Each unemployment rate is constructed by first taken the ratio of JSA claimants divided by the population of reference at LAD-month level, and then the average unemployment rate in the nine months following conception. Except the model-based unemployment rate that is at yearly level, the other rates correspond to rates during the pregnancy. †The model-based unemployment rate is constructed by combining unemployment estimates from the Annual Population Survey (APS) with claimant counts. The unemployment rate - denominator from APS is based on the ration of JSA claimants divided by the economically active population taken from the APS. See Section 5.2.0.2 for details. †† Alcohol diagnosis (Smoking diagnosis) is a dummy equal to one if the mother has at least one diagnosis related to alcohol use (smoking) where the diagnosis are listed in Panel A (B) of Table A4.

16–24 years old mothers declines significantly over time, while the opposite is true for mothers above 35 years old. Differently from results reported in Table 2, unemployment is negatively associated with the birthrate of first born, with effects that become higher rise over time even if highly imprecise. Consistent across Table 2 and Fig. A.1 is the increasing positive association between unemployment and fertility among mothers from the richest areas which rises over the years particularly from 2009.

Collectively, these results appear to indicate that recession encourages childbearing among mothers more likely to be from upper SES classes, and discourages fertility among mothers that come from disadvantaged areas. Results on maternal age and birth order are inconclusive as in previous work.[19] Our SES findings indicate a positive selection into fertility that contrasts previous research (e.g. Dehejia and Lleras-Muney (2004), Chevalier and Marie (2017)).[20] This further motivates the need to control for time-invariant unobserved heterogeneity and adjust for different selection into pregnancy. In the rest of the paper we study the effect of changes

[19] van den Berg et al. (2020), Aparicio et al. (2020), and Salvanes (2013) do not find clear associations between unemployment and parental age; while Dehejia and Lleras-Muney (2004) find fewer young and more middle age mothers represented in a recession.

[20] Unemployment is differently associated with mothers with lower education or income depending on their age or birth order (Stone and Berrington, 2017). Unfortunately, with the data at hand, maternal age and birth order interactions with SES might be masked and cannot be studied with our aggregate measure of SES.

Table 2
The effect of unemployment in the year of conception on birthrates.

	No trends (1)	With trends (2)
Birthrate	0.044	0.234
	(0.350)	(0.338)
Mean of Dep. Var.	16.76	16.76
% change	0.26	1.39
Mother's age 16–24	-3.385***	-0.323
	(0.682)	(0.521)
Mean of Dep. Var.	18.51	18.51
% change	-18.29	-1.74
Mother's age 25–34	3.945***	2.220***
	(0.706)	(0.716)
Mean of Dep. Var.	35.42	35.42
% change	11.14	6.27
Mother's age above 35	-0.468***	0.158
	(0.159)	(0.183)
Mean of Dep. Var.	5.702	5.702
% change	-8.21	2.76
Birth order 1	-0.793***	0.543*
	(0.228)	(0.307)
Mean of Dep. Var.	4.212	4.212
% change	-18.84	12.88
Birth order 2	0.528**	0.082
	(0.259)	(0.291)
Mean of Dep. Var.	5.648	5.648
% change	9.35	1.45
Birth order 3	0.442***	-0.125
	(0.101)	(0.149)
Mean of Dep. Var.	2.788	2.788
% change	15.87	-4.48
Birth order above 4	0.347***	-0.153
	(0.087)	(0.127)
Mean of Dep. Var.	2.065	2.065
% change	16.81	-7.42
Female	0.016***	0.038***
	(0.006)	(0.007)
Mean of Dep. Var.	0.329	0.329
% change	4.85	11.42
IDD1-Richest†	-0.005	0.816***
	(0.248)	(0.239)
Mean of Dep. Var.	2.909	2.909
% change	-0.16	28.06
IDD2	0.228	1.427***
	(0.240)	(0.350)
Mean of Dep. Var.	3.195	3.195
% change	7.14	44.67
IDD3	-0.275	0.612*
	(0.208)	(0.346)
Mean of Dep. Var.	2.993	2.993
% change	-9.20	20.43
IDD4	0.258	-0.916
	(0.404)	(0.770)
Mean of Dep. Var.	3.435	3.435
% change	7.51	-26.67
IDD5-Poorest	-0.163	-1.705**
	(0.416)	(0.776)
Mean of Dep. Var.	4.230	4.230
% change	-3.85	-40.32

Note: Standard errors in parentheses. Every coefficient corresponds to a separate regression of the birthrate on the unemployment rate. The unemployment rate used is the unemployment rate among 16-64-year-olds in the year of conception. Birthrates are given by the number of births in the same year of conception and local authority in a given subgroup per 1000 women aged 16–49. Age-specific birthrates are constructed using the age-specific number of women as denominator. Percentage changes are calculated by dividing the unemployment effect by the mean of the outcome in every regression. † indicates characteristics available at the area level. Richest (poorest) corresponds to the women in our sample who live in the first (fifth) quintile of the distribution of the Income Deprivation index (see Section 3.2 for details). Every regression includes year fixed effects, and local authority fixed effects. In column (2) we also control for local authority specific linear trends. Regressions are weighted by the number of births. The standard errors are clustered at the local authority level. *** p<0.01, ** p<0.05, * p<0.1

Table 3
The effects of unemployment on new-borns' health.

	Birthweight (1)	VLBW (2)	SGA (3)	Foetal growth (4)	Stillbirth (5)
Panel A: Pooled OLS					
Unemployment	2.770	-0.025	-0.143	0.057	-0.027
	(1.707)	(0.036)	(0.097)	(0.068)	(0.043)
% change	0.08	-2.35	-1.46	0.07	-4.31
% change lower bound	-0.17	-9.04	-3.40	-0.08	-17.93
% change upper bound	0.18	4.38	0.49	0.22	9.20
Panel B: Mother FE					
Unemployment	-5.296***	0.006	0.257***	-0.289***	0.058***
	(1.050)	(0.024)	(0.073)	(0.027)	(0.018)
% change	-0.16	0.60	2.62	-0.34	9.25
% change lower bound	-0.21	-3.90	1.17	-0.39	4.76
% change upper bound	-0.10	5.04	4.10	-0.27	14.92
Observations	2,026,670	2,026,670	1,715,335	1,715,335	2,036,117
Mean of Dep. Var.	3364	1.051	9.784	85.90	0.630

Note: Standard errors in parentheses. Every coefficient corresponds to a separate regression. The unemployment rate used is the average unemployment rate among 16-64-year-olds in the nine months following conception. Coefficients and means for VLBW, SGA and Stillbirth are scaled up per 100 infants. Percentage changes are calculated by dividing the unemployment effect by the mean of the outcome in every regression. Percentage changes upper/lower bound refer to the upper and lower bound of the 95% confidence interval. Every regression includes year and month fixed effects, maternal age, baby's gender, and local authority specific trends. In Panel A the regressions include ethnicity fixed effects. The standard errors are clustered at the district level in Panel A and at mother level in Panel B. *** p<0.01, ** p<0.05, * p<0.1

in the unemployment rate within mothers over time. If economic downturn affects health, this should be attributed to behavioural changes given that selection is accounted for by the family fixed effects design.

4.2. *Selection in-utero*

Another form of selectivity that could affect our sample is selection in-utero. Financial stress due to high unemployment may also influence the health of unborn children, and particularly the levels of miscarried and aborted children (Hogue et al., 2013). If weaker infants die because of higher unemployment, we would end up with a sample of stronger infants. Unfortunately, there are no available or accessible data on miscarriages nor on abortions. If nothing else, it seems that in the UK the abortion rate decreased despite the austerity (Lima et al., 2016).

Male foetuses are more sensitive to foetal stress and are more likely to miscarry, so that a higher probability of having a female might indicate a higher level of miscarriage (Low, 2015). In Table 2 (and Fig. A.1) we study whether the female birthrate is influenced by the unemployment rate (and unemployment rate over time), and find opposite findings, making this analysis inconclusive. We then prefer to control for new-born's gender in the main regressions to possibly correct for potential selection in-utero.

5. Results

5.1. *Main results*

In this section, we study how unemployment during the pregnancy influences five birth outcomes: birthweight, VLBW, SGA, foetal growth, and stillbirth. The unemployment indicator used corresponds to the average unemployment rate among 16-64-year-old in the nine months following conception. In Table 3 we report estimates of Eq. (2) using pooled OLS in Panel A; and maternal fixed effects in Panel B. We control for year and month fixed effects, local authority specific trends, maternal age and baby's gender. Ethnicity fixed effects are also included in the regressions in Panel A.

Estimates in Panel A suggest that new-born's health is counter-cyclical, but all relevant coefficients are statistically insignificant. Here, we are comparing individuals that are subject to different levels of unemployment. In Panel B instead, we compare siblings exposed to different economic hardship over time. The estimates show a clear negative association between health and economic downturn. A one-percentage point increase in the unemployment rate during the pregnancy leads to a decrease in birthweight by 0.2%, and in foetal growth by 0.3%. The probability of VLBW is not significantly affected. The probability of SGA and stillbirth instead increases by respectively 3% and 9%, when the unemployment rate goes up by one-percentage point. Overall, we find that babies born at troughs of the cycle are less healthy than siblings not born at troughs.

The contrasting conclusions inferred from Panels A and B underline the importance of adjusting for selection into fertility. The comparison of the fixed effect estimates with the pooled OLS appear to indicate that women who conceive in a recession tend to have healthier babies, offsetting the negative effect of recession on health. This confirms results presented in Section 4 providing some evidence of positive selection.

In terms of effect sizes, the differences in the estimates with and without fixed effects are not always sizeable. In Panel A - Pooled OLS - the 95% confidence intervals are large and the effects of unemployment on health could either be positive or negative. In the case of birthweight (stillbirth) the OLS estimates could be negative (positive) and as small (large) as 0.2% and 9.2% respectively, hence very close to the FE estimates. The differences between the OLS and FE estimates are instead substantial for SGA and foetal growth. The probability of SGA could in fact increase by as much as 0.5% in the pooled OLS regressions, while effect sizes in FE regressions span between 1.2% and 4.1%. Foetal growth is reduced by at most 0.2% in the pooled OLS regressions, but between 0.3% and 0.4% in the FE regressions.

Overall, our findings (both OLS and FE estimates) are slightly larger than those of previous studies of various developed countries; in particular, Dehejia and Lleras-Muney (2004), and Aparicio et al. (2020) who find a reduction in VLBW by 0.5-0.7% and in neonatal mortality by 0.2-0.6% for the United States and Spain. A better comparison is with studies that control for family fixed effects. Our findings are in line with Olafsson (2016) who shows that having been exposed to the 2008 crisis in the first trimester leads to an increase in LBW by 1.9 percentage points in Iceland. van den Berg et al. (2020) instead find that an increase in the unemployment rate by one-percentage point results in a decrease in VLBW by about 13% and in neonatal mortality by about 11% in Sweden which are larger in magnitude than our estimates, except stillbirth; while Salvanes (2013) and Dehejia and Lleras-Muney (2004) find insignificant effects of unemployment on health outcomes for Norway and California, respectively.

5.2. Robustness checks

In this section we show that our main results are robust to the inclusion of different controls, the use of different indicators of unemployment, timing of the unemployment effects, higher and lower geographical aggregation of the unemployment rate, and different employment contracts.

Different controls. In Table 4, for each of the health outcomes, we present four columns where we iteratively add different controls to our main specification (Eq. (1)). In column (1), we include year and month of conception fixed effects. In column (2) the demographic controls maternal age and new-born's gender are added. In column (3) we include birth order, while in column (4) we add local authority linear trend. The estimated coefficients slightly vary, but move in the same direction once we include different controls. Their magnitude is partly reduced when birth order is added, and the effect of unemployment on stillbirth is no longer statistically significant (columns (3)-(4)). Birth order is likely a bad control as it might be influenced by the economic recession, affecting the baby's health outcomes and being potentially endogenous. Given the evidence provided in Section 4, our preferred specification is then column (2) of Table 4 but with the inclusion of local authority linear trends as in Table 3 and in the rest of the analyses that follow.

Different indicators of unemployment.

At the outset, we calculate the unemployment rate by dividing the total number of JSA claimants, by all individuals aged 16–64, who are in employment, actively searching for a job, or are inactive. Since this might be measured with error, and is not addressed by maternal fixed effects, we perform three sensitivity exercises.[21]

First, we use a *model-based unemployment rate* constructed by the ONS. It combines data on unemployed estimates from the Annual Population Survey (APS) with the claimant count to produce an estimate that is more precise.[22] This rate is available at LAD-year level from 2004, and will capture economic conditions in the year of conception.[23]

Second, we adjust the denominator in our unemployment rate to include only active individuals. We do that by taking the LAD-year percentage of economically active population from the APS and multiplying it by the population 16–64. Given that the numerator includes the monthly counts of claimants, we are able to construct a new unemployment rate during the pregnancy (called *Unemployment rate - denominator from APS*).

Third, we consider *age-specific unemployment indicators*. It is possible that a recession could affect only some categories of workers, and for this reason we focus on the unemployment rate by age. Using the available age-stratification of the claimant count, we create two new rates for the age groups 16–24 and 16–49.

Fig. A.2 reports the trends in these different unemployment rates over time, while Table 1 shows their means and standard deviations. In Fig. A.2, we plot the baseline unemployment rate together with the rate by gender and age, the model-based rate and the one with the adjusted denominator. All unemployment indicators present the same trend, with a relatively constant rate up to 2007, followed by a sharp increase corresponding to the Great Recession. The average model-based unemployment rate is more than double the baseline rate, and the indicator based on the adjusted denominator is 4.3 on average instead of 3.1 for the baseline rate. This is probably due to the different count of the economically active individuals. Finally, considering unemployment by age, we find that youth unemployment is highest, as reported by Bell and Blanchflower (2010).

Table 5 presents the estimates of Equation (2) using the different indicators described above. In the first row, we report our baseline estimates. The effects of the model-based unemployment rate on health are halved, while the ones of the indicator with adjusted denominator are one third smaller, and in both cases the associations with stillbirth are insignificant. Also, the youth

[21] All data used to construct these unemployment rates can be downloaded from https://www.nomisweb.co.uk.

[22] For some areas, the APS estimates are in fact based on very small samples therefore unreliable.

[23] This rate has not been constructed by gender, and being available at yearly level, we are not able to construct a precise unemployment rate covering the 9-month pregnancy period.

Table 4
The effects of unemployment on new-borns' health adding different sets of controls.

Birthweight	No demographic controls (1)	Demographic controls (2)	Demographic controls and birth order (3)	Demographic controls, birth order and linear trend (4)
Unemployment	-7.245***	-5.853***	-2.555**	-2.166**
	(1.044)	(1.041)	(1.082)	(1.090)
Observations	2,054,406	2,026,670	1,810,234	1,810,234
Mean of Dep. Var.	3364	3364	3360	3360
% change	-0.21	-0.17	-0.08	-0.06
Very low birthweight (VLBW)				
Unemployment	0.018	0.012	-0.030	-0.034
	(0.024)	(0.024)	(0.025)	(0.025)
Observations	2,054,406	2,026,670	1,810,234	1,810,234
Mean of Dep. Var.	1.059	1.051	1.052	1.052
% change	1.74	1.11	-2.83	-3.24
Small-for-gestational-age (SGA)				
Unemployment	0.306***	0.274***	0.184**	0.177**
	(0.072)	(0.072)	(0.076)	(0.077)
Observations	1,735,985	1,715,335	1,524,556	1,524,556
Mean of Dep. Var.	9.774	9.784	9.921	9.921
% change	3.13	2.80	1.86	1.78
Foetal growth				
Unemployment	-0.338***	-0.301***	-0.228***	-0.222***
	(0.027)	(0.027)	(0.028)	(0.028)
Observations	1,735,985	1,715,335	1,524,556	1,524,556
Mean of Dep. Var.	85.91	85.90	85.85	85.85
% change	-0.39	-0.35	-0.26	-0.26
Stillbirth				
Unemployment	0.053***	0.054***	0.000	0.006
	(0.018)	(0.018)	(0.019)	(0.019)
Observations	2,064,569	2,036,117	1,818,621	1,818,621
Mean of Dep. Var.	0.637	0.630	0.631	0.631
% change	8.27	8.55	0.035	1.02

Note: Standard errors in parentheses. Every coefficient corresponds to a separate regression. The unemployment rate used is the average unemployment rate among 16-64-year-olds in the nine months following conception. Coefficients and means for VLBW and SGA are scaled up per 100 infants. Percentage changes are calculated by dividing the unemployment effect by the mean of the outcome in every regression. Every regression includes year and month fixed effects, and maternal fixed effects. Demographic controls include maternal age and baby's gender. Linear trends are local authority specific trends. The standard errors are clustered at the mother level. *** p<0.01, ** p<0.05, * p<0.1

unemployment has a much smaller effect on new-born's health than the baseline unemployment. The 16–49 unemployment rate produces effects on health that are very similar to the baseline ones, suggesting that the economic conditions in this age group, which represent most parents, are driving the results. Overall, the pro-cyclical associations with birthweight, SGA and foetal growth are all confirmed.

Gender-specific unemployment. Here we test whether male and female unemployment affects new-born's health in the same way. Participation of women in the English labour market is high.[24] Women make up 65 percent of the public sector workforce (ONS, 2010). In our sample, the average male unemployment percent rate is 4.4 (SD 2.2), and more than twice the female one, 1.8 (SD 0.9). In Fig. A.2, we plot the trend in both unemployment rates. The two rates run in parallel except when the recession deepened, when there is a much higher jump in the male unemployment rate. This may be due to the fact that a larger share of men works in the private sector, which is more sensitive to the business cycle. At the bottom of Table 5, we report the gender-specific unemployment effects. A one-percentage point increase in male unemployment leads to a decrease of 0.1% in birthweight, and 0.2% in foetal growth, and an increase of 2% and 4% in SGA babies and stillbirth. These effects are slightly smaller in magnitude compared to the main

[24] In 2014 for example, almost as many women with children (74.1%) participated in the UK labour force as women with no children (75%) (ONS, 2017). In Austria, Denmark, Portugal, Slovenia and Switzerland more than 75% of mothers with children aged 0–14 are in work, with rates particularly high - at around 82–83% - in Denmark and Sweden. Contrarily, in countries likes Greece, Hungary, Italy, and Spain the maternal employment rate is less than 60% (OECD, 2014).

Table 5
Sensitivity to different indicators of unemployment.

	Birthweight (1)	VLBW (2)	SGA (3)	Foetal growth (4)	Stillbirth (5)
Unemployment (baseline)	-5.296***	0.006	0.257***	-0.289***	0.058***
	(1.050)	(0.024)	(0.073)	(0.027)	(0.018)
% change	-0.16	0.60	2.63	-0.34	9.25
Unemployment model-based	-2.834***	0.010	0.093**	-0.131***	-0.005
	(0.564)	(0.013)	(0.039)	(0.014)	(0.010)
% change	-0.084	0.97	0.94	-0.15	-0.88
Unemployment from APS	-3.589***	0.011	0.135**	-0.175***	0.022
	(0.768)	(0.018)	(0.053)	(0.019)	(0.013)
% change	-0.11	1.10	1.40	-0.20	3.47
Unemployment 16-24y	-2.049***	0.009	0.187***	-0.158***	0.039***
	(0.608)	(0.014)	(0.042)	(0.015)	(0.010)
% change	-0.06	0.81	1.92	-0.18	6.13
Unemployment 16-49y	-4.145***	0.001	0.279***	-0.251***	0.050***
	(0.868)	(0.020)	(0.060)	(0.022)	(0.015)
% change	-0.12	0.13	2.85	-0.29	7.89
Male unemployment	-2.194***	0.003	0.214***	-0.164***	0.025**
	(0.702)	(0.016)	(0.049)	(0.018)	(0.012)
% change	-0.06	0.28	2.19	-0.19	3.91
Female unemployment	-13.273***	0.017	0.056	-0.490***	0.140***
	(1.591)	(0.036)	(0.108)	(0.040)	(0.026)
% change	-0.39	1.66	0.57	-0.57	22.18

Note: Standard errors in parentheses. Every coefficient corresponds to a separate regression. Unemployment model-based is the unemployment rate constructed by Nomis using both claimant and survey data in the year during which most of the pregnancy occurred. Unemployment from APS refers to the average unemployment rate among economically active 16-64-year-olds in the nine months following conception. Age and gender specific unemployment is constructed taking the respective number of claimants divided by the population of reference in the nine months following conception. Coefficients for VLBW, SGA and Stillbirth are scaled up per 100 infants. Percentage changes are calculated by dividing the unemployment effect by the mean of the outcome in every regression. Every regression includes year and month fixed effects, mother fixed effects, local authority specific trends, maternal age and baby's gender. The standard errors are clustered at the mother level. *** p<0.01, ** p<0.05, * p<0.1

results reported in the first row but qualitatively similar. Looking at female unemployment, the effects sizes are instead more than twice as large compared to the baseline, with a decline of 0.4% in birthweight and 0.6% in foetal growth, while an increase of 22% in stillbirth, and of only 0.6% in SGA babies albeit insignificant.[25] We will further discuss these results in Section 6 in relation to the potential indirect channel of parental job loss.

Unemployment effects pre-conception and post-delivery. In this paper we are mainly interested in the in-utero influence of unemployment. We should then find smaller or insignificant effects of unemployment pre-conception and post-delivery. In Table A1, we test the timing of effects by regressing our health outcomes on the average unemployment rate one, two and three years before conception, and one, two, and three years after delivery. Given the strong autocorrelation in the unemployment rate over time, we still find some significant pre-conception and post-delivery effects. While the direction of the estimates is the same as in our baseline regressions, the magnitude is much smaller, and the statistical significance is reduced, except for the effect of the unemployment rate one year before conception. A growing literature in medicine underlines the importance of the pre-conception period as crucial for a successful pregnancy and the delivery of a healthy child (Stephenson et al., 2018). It could be that the recession affects the maternal pre-conception health in ways that can influence the new-born's health too. We restrain from making strong claims as the data at hand do not allow to further explore or disentangle how unemployment affects mothers around their pregnancy.

Different geographical aggregation of unemployment. Economic conditions might have different effects on health depending on their level of geographical aggregation (Lindo, 2015). Estimates based on more disaggregated analysis can be more precise and improve power because they consider variation in unemployment that is masked by more aggregated measures. However, more aggregated measures of unemployment rates, at LAD level, might include possible spillover effects across micro areas within a LAD. In Table A2, we report new analyses at Middle Layer Super Output Area (MSOA) and county level. In England, there are 6791 MSOAs and 152 counties. To be consistent with our main analysis we create two new subsamples where we include only the siblings born in the same MSOA or county. We then run our baseline specification controlling for area-specific fixed effects and trends. Since monthly

[25] Aparicio et al. (2020) only consider male unemployment in the Spanish context, and van den Berg et al. (2020) show that in Sweden, the effect of unemployment on infants' health is mainly driven by male unemployment. In related work, Page et al. (2019) find a deterioration of children's health with improvements in women's employment opportunities.

Table 6
Heterogeneous effects of unemployment by income deprivation on different infants' outcomes.

	Birthweight (1)	VLBW (2)	SGA (3)	Foetal growth (4)	Stillbirth (5)
Unemployment	-4.966***	-0.002	0.434***	-0.235***	0.033
	(1.845)	(0.040)	(0.125)	(0.047)	(0.031)
Unemployment×IDD1	19.540***	0.057	0.111	0.416***	0.225***
	(3.063)	(0.063)	(0.212)	(0.084)	(0.050)
Unemployment×IDD2	13.731***	-0.030	-0.192	0.390***	0.068*
	(2.380)	(0.050)	(0.161)	(0.065)	(0.037)
Unemployment×IDD4	1.139	-0.007	-0.007	0.034	0.104***
	(1.737)	(0.037)	(0.118)	(0.045)	(0.029)
Unemployment×IDD5	0.836	0.016	-0.216*	-0.060	0.016
	(1.629)	(0.035)	(0.110)	(0.042)	(0.027)
Observations	2,000,100	2,000,100	1,551,104	1,551,104	2,016,876
Mean of Dep. Var.	3364	1.051	9.917	85.81	0.633
% change for Unemployment in IDD3	-0.15	-0.23	4.38	-0.27	5.26
P-value test Unemployment×IDD3-Unemployment×IDD1	0.000	0.467	0.236	0.000	0.003
P-value test Unemployment×IDD3-Unemployment×IDD2	0.000	0.711	0.009	0.000	0.540
P-value test Unemployment×IDD3-Unemployment×IDD4	0.065	0.282	0.558	0.000	0.197
P-value test Unemployment×IDD3-Unemployment×IDD5	0.079	0.483	0.004	0.000	0.000
P-value test Unemployment×IDD2-Unemployment×IDD1	0.069	0.180	0.171	0.777	0.002
P-value test Unemployment×IDD2-Unemployment×IDD4	0.000	0.612	0.208	0.000	0.285
P-value test Unemployment×IDD2-Unemployment×IDD5	0.000	0.300	0.862	0.000	0.105
P-value test Unemployment×IDD1-Unemployment×IDD4	0.000	0.948	0.048	0.001	0.012
P-value test Unemployment×IDD1-Unemployment×IDD5	0.000	0.799	0.101	0.039	0.750
P-value test Unemployment×IDD4-Unemployment×IDD5	0.800	0.396	0.013	0.002	0.000

Note: Standard errors in parentheses. Every column corresponds to a separate regression. The unemployment rate used is the average unemployment rate among 16-64-year-olds in the nine months following conception. Coefficients for VLBW, SGA and Stillbirth are scaled up per 100 infants. The reference category is IDD3 that corresponds to the middle class of the distribution of income deprivation. The quintiles are constructed as explained in Section 3.2. Percentage changes are calculated by dividing the unemployment effect (for the reference category IDD3) by the mean of the outcome in every regression. Every regression includes year and month fixed effects, maternal fixed effects, local authority specific trends, maternal age and baby's gender, and IDD quintile dummies. The standard errors are clustered at the mother level. *** p<0.01, ** p<0.05, * p<0.1

claimant counts are not available for areas smaller than LAD, we use unemployment in the year of conception instead of during the pregnancy. The larger the area, the higher the effects of unemployment should be in line with the existence of spillover effects. No such clear pattern emerges. This could be because of the different samples used. Nevertheless, the estimates are very similar confirming a negative association between birth outcomes and unemployment. Moreover, now also the probability of VLBW increases by 4% (6%) when MSOA-specific (county-specific) unemployment rate goes up by one-percentage point.

Different types of contract. We do not know the employment status of the mother, but there could be mothers that have different types of employment contracts that allow them to better cope with the recession. To test this, we consider the percentage of part-time workers, which is available from the APC survey from 2003 until 2012 by gender. In Table A3, Panel A, we study how unemployment affects part-time work. We find that a one-percentage point increase in unemployment leads to an increase in part-time work by 1.4% and female part-time work by 3.6% (as in Bell and Blanchflower, 2010). In Panel B1, we run our baseline specification controlling for part-time work. In Panel B2, we replicate Panel B1 analysis but we instead focus on the effect of female unemployment rate on health, while controlling for the percentage of female part-time work. Adding the fraction of part-time workers in the regressions does not change our main findings. There is only a negative statistically significant association between overall and female part-time work and SGA (Panels B1 and B2), and female part-time work and stillbirth (Panel B2), suggesting that working less reduces the chances of having a small or stillborn baby.

5.3. Heterogeneous effects by SES

Given our finding that overall unemployment is bad for babies' health, we now consider whether there are heterogeneous effects across SES, which we proxy by area-level measures of income. Disadvantaged women have fewer 'buffers', including less savings and greater vulnerability to changes in economic conditions. They also tend to work in low-quality jobs where they are more likely to encounter high physical and mental health risks (Kim et al., 2008). They might also experience worse health compared to advantaged women (Currie et al., 2015b).

The effects of unemployment on birth outcomes by SES are depicted in Table 6. Here, we estimate Equation (2) by adding dummies for the IDD quintiles, and the interaction terms between unemployment rate and those dummies. We find that a one-percentage point increase in unemployment is associated with a decrease of about 0.2% in birthweight and 0.3% in foetal growth for the mothers living in the middle to most deprived areas. Conversely, for babies conceived in the richest areas, a one-percentage point increase in unemployment rate is associated with an increase in birthweight and foetal growth by respectively 0.4% and 0.3%. Babies born in middle class areas are 4.4% more likely to be small, while the probability of a stillbirth increases mostly for the pregnancies occurring in the richest, but also in the second poorest areas.

These findings suggest that the influence of the cycle on new-born's health has an important social class gradient. About 10% of our sample of siblings live in the top quintile of IDD, 14% in the second, 15% in the third, 24% in the fourth, while 37% in the bottom or IDD5. Our main pro-cyclical results could then depend on the larger number of children born into the most deprived neighbourhoods.

6. Potential mechanisms

In this section we provide evidence on three potential channels through which unemployment affects infant's health: maternal health behaviour, prenatal care, and parental job loss. We also explore whether for the first two channels there is an appropriate response by SES, that could explain the heterogeneous response of babies health to unemployment.

6.1. Maternal health behaviour and prenatal care

Mothers' behaviour during the pregnancy is known to affect their offspring's birth outcomes. Cigarette smoking and nutrition affect the intrauterine growth, while length of gestation is influenced by smoking and stress (Koppensteiner and Manacorda, 2016; Torche, 2011). Heavy prenatal alcohol exposure has been found to have adverse effects on new-borns by crossing the placenta and passing to the foetus, and by decreasing the supply of oxygen and nutrients (Goodlett and Horn, 2001; Jones and Smith, 1973; West et al., 1994).

The HES data do not contain information about the mother's behaviours, but they report diagnoses identified throughout the pregnancy. The diagnoses are registered by the hospital in different moments of the pregnancy. The episode of maternity is an inpatient episode, i.e. admission in the hospital. For each admission the hospital has the obligation to report the diagnosis code of each patient. Pregnant women can be assigned diagnoses if they have visited the emergency department before labour, have undergone specialist visits, or as inpatients. The HES data report the first 20 diagnoses using ICD-10 codes (up to three-digit code). In our sample of siblings, the most common first few diagnoses are related to the delivery, while the remaining diagnoses refer to any other type of disease or health problem.[26]

To identify the diagnoses attributable to smoking and alcohol use, we consider a list of ICD10 codes provided by the medical literature (Currie et al., 2015a; Dietz et al., 2010; Health, 2014).[27] Even if these diagnoses represent only very serious cases of either smoking or drinking addiction, or smoking or drinking related-diseases, they are objectively measured, hence more reliable than self-reported behavioural information.

We create two new outcome variables. The first *Alcohol*, is a dummy equal to one if the mother has at least one diagnosis related to alcohol use, where the list of such diagnoses and their prevalence in our analytic sample are reported in Panel A of Table A.13. The second, *Smoking*, is a dummy that takes value one if the mother has at least one diagnosis related to smoking (see Panel B of Table A.13). We finally test whether unemployment has an effect on prenatal care, where prenatal care is measured as the gestation period in weeks at first antenatal assessment, a variable that we call *Week 1st visit*. This visit corresponds to the dating scan to verify how far along the pregnancy is and to check the baby's development. All pregnant women in England are offered this ultrasound scan at around 8 to 14 weeks of pregnancy free-of-charge, as with all recommended prenatal visits. In general, the earlier prenatal care is sought, the better it is for the mother and the baby (Cygan-Rehm and Karbownik, 2020; Evans and Lien, 2005; Kost et al., 1998).

Table 7, Panel A, presents the results of our baseline specification on the outcomes *Alcohol, Smoking* and *Week 1st visit*. A one-percentage point increase in the unemployment rate during the pregnancy is associated with an increase of 6.7% in alcohol-related diagnoses, 18.1% in smoking-related diagnoses, and a postponement of the first visit by almost 6 days, or an increase of 6.2% in the number of weeks before the first antenatal assessment. In recessions, mothers might have less time to attend check-ups because the opportunity cost of time that might otherwise be used to find a job is higher, thus leading to a postponement of the first visit.[28] Considering that the first scan should be done at 8 to 14 weeks, a one week delay seems important.[29]

In Panel B, we consider the maternal behaviours as mediators and we add their proxies in our baseline regression model one at the time. Note that those behaviours are potentially endogenous, hence we refrain from making causal claims. Alcohol consumption reduces birthweight and foetal growth significantly, but it is not an important mediator for unemployment rate as can be seen from the % changes that are unaltered compared to Table 3, Panel B. Smoking only marginally mediates the effect of unemployment on birthweight, SGA and foetal growth decreasing the effect sizes of unemployment to respectively -0.13, 2.44 and -0.32, compared

[26] The most frequent diagnosis is 'Perineal laceration during delivery' (26%, ICD-10 O70) followed by 'Single spontaneous delivery' (15%, ICD-10 O80), and 'Labour and delivery complicated by foetal stress' (14%, ICD-10 O68).

[27] For further details about these diagnoses see https://www.cdc.gov/alcohol/ardi/alcohol-related-icd-codes.html and https://www.aaaai.org.

[28] Similar results are obtained by Bhalotra (2010), while opposite findings are suggested by Dehejia and Lleras-Muney (2004).

[29] Recent research shows how earlier initiation of prenatal care during the first ten weeks of gestation causes a reduction in the likelihood of foetal death, and an increase in birthweight (Cygan-Rehm and Karbownik, 2020).

Table 7
Mechanisms: maternal health behaviour.

Panel A	Alcohol diagnosis (1)	Smoking diagnosis (2)	Week 1st visit (3)
Unemployment	0.0003**	0.0199***	0.8249***
	(0.0001)	(0.0006)	(0.0183)
Mean of Dep. Var.	0.00481	0.110	13.34
% change	6.71	18.14	6.19

Panel B	Birthweight (1)	Birthweight (2)	Birthweight (3)	VLBW (4)	VLBW (5)	VLBW (6)	SGA (7)	SGA (8)	SGA (9)	Foetal growth (10)	Foetal growth (11)	Foetal growth (12)	Stillbirth	Stillbirth	Stillbirth
Unemployment	-5.2832***	-4.4978***	-1.9031	0.0064	0.0074	-0.0495*	0.2567***	0.2389***	0.2307***	-0.2884***	-0.2714***	-0.1951***	0.0582***	0.0584***	0.0475**
	(1.0504)	(1.0504)	(1.1603)	(0.0240)	(0.0240)	(0.0258)	(0.0730)	(0.0730)	(0.0802)	(0.0268)	(0.0268)	(0.0291)	(0.0181)	(0.0181)	(0.0200)
Alcohol diagnosis	-40.4178***			-0.0754			1.0477			-0.9116***			0.1598		
	(9.2966)			(0.2468)			(0.7027)			(0.2494)			(0.1872)		
Smoking diagnosis		-40.2387***			-0.0520			0.9933***			-0.9519***			-0.0034	
		(1.7076)			(0.0427)			(0.1277)			(0.0439)			(0.0317)	
Week 1st visit			-2.3911***			0.0402***			0.0471***			-0.0415***			0.0084***
			(0.0702)			(0.0016)			(0.0048)			(0.0018)			(0.0013)
Mean of Dep. Var.	3364	3364	3368	1.051	1.051	0.989	9.784	9.784	9.675	85.90	85.90	85.75	0.630	0.630	0.618
% change	-0.16	-0.13	-0.06	0.61	0.70	-5.00	2.62	2.44	2.38	-0.34	-0.32	-0.23	9.24	9.26	7.68

*Note: Standard errors in parentheses. In Panel A, every coefficient corresponds to a separate regression, while in Panel B, every column corresponds to a separate regression. The unemployment rate used is the average unemployment rate among 16-64-year-olds in the nine months following conception. Coefficients for VLBW, SGA and Stillbirth are scaled up per 100 infants. Percentage changes are calculated by dividing the unemployment effect by the mean of the outcome in every regression. Alcohol (smoking) diagnosis is a dummy equal to one if the mother has at least one diagnosis related to alcohol use where the diagnosis are listed in Panel A (Panel B) of Table A4. Week 1st visit corresponds to the pregnancy week when the mother had her first hospital visit. Every regression includes year and month fixed effects, maternal fixed effects, local authority specific trends, maternal age and baby's gender. The standard errors are clustered at the mother level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$*

Table 8
Heterogeneous effects of unemployment by income deprivation on maternal behaviour and prenatal care.

	Alcohol diagnosis (1)	Smoking diagnosis (2)	Week 1st visit (3)
Unemployment	0.026	1.346***	0.865***
	(0.023)	(0.115)	(0.032)
Unemployment × IDD1	-0.080**	-0.167	0.540***
	(0.032)	(0.184)	(0.055)
Unemployment × IDD2	-0.047*	0.024	0.280***
	(0.028)	(0.150)	(0.038)
Unemployment × IDD4	-0.019	0.955***	0.964***
	(0.021)	(0.113)	(0.032)
Unemployment × IDD5	0.008	0.511***	-0.386***
	(0.020)	(0.107)	(0.028)
Mean of Dep. Var.	0.481	10.96	13.31
% change for Unemployment in IDD3	5.47	12.29	6.50
P-value test Unemployment × IDD3-Unemployment × IDD1	0.019	0.000	0.000
P-value test Unemployment × IDD3-Unemployment × IDD2	0.089	0.000	0.000
P-value test Unemployment × IDD3-Unemployment × IDD4	0.267	0.0649	0.000
P-value test Unemployment × IDD3-Unemployment × IDD5	0.653	0.000	0.000
P-value test Unemployment × IDD2-Unemployment × IDD1	0.327	0.316	0.000
P-value test Unemployment × IDD2-Unemployment × IDD4	0.270	0.000	0.000
P-value test Unemployment × IDD2-Unemployment × IDD5	0.025	0.000	0.000
P-value test Unemployment × IDD1-Unemployment × IDD4	0.043	0.000	0.085
P-value test Unemployment × IDD1-Unemployment × IDD5	0.003	0.000	0.000
P-value test Unemployment × IDD4-Unemployment × IDD5	0.078	0.000	0.000

Note: Standard errors in parentheses. Every coefficient corresponds to a separate regression. The unemployment rate used is the average unemployment rate among 16-64-year-olds in the nine months following conception. Alcohol (smoking) diagnosis is a dummy equal to one if the mother has at least one diagnosis related to alcohol use where the diagnosis are listed in Panel A (Panel B) of Table A4. Alcohol (smoking) diagnosis are scaled up per 100 infants. Week 1st visit corresponds to the pregnancy week when the mother had her first hospital visit. The reference category is IDD3 that corresponds to the middle class of the distribution of income deprivation. The quintiles are constructed as explained in Section 3.2. Percentage changes are calculated by dividing the unemployment effect (for the reference category IDD3) by the mean of the outcome in every regression. Every regression includes year and month fixed effects, maternal fixed effects, local authority specific trends, maternal age and baby's gender, and IDD quintile dummies. The standard errors are clustered at the mother level. *** p<0.01, ** p<0.05, * p<0.1

to the ones in the baseline, respectively -0.16, 2.6, and -0.34. The most important mediating factor appears to be prenatal care. Postponing the first antenatal assessment decreases health significantly, VLBW included. While unemployment remains negatively associated with health, its effect is two-thirds lower for birthweight when the week of first visit is controlled for, one third lower for foetal growth, 10% lower for SGA, and 20% lower for stillbirth.

Overall, these results indicate that maternal behaviour during the pregnancy are potential channels, even if they do not fully explain the pro-cyclical association of unemployment and health.

In Table 8, we examine how the importance of unemployment for maternal behaviour varies by SES, measured at LAD-year level to support the heterogenous findings on health. We interact unemployment with the quintiles of the Income Deprivation Index as in Table 6. Column (1) shows that a one-percentage point increase in unemployment is associated with a decrease of 4–11% in alcohol-related diagnoses for the mothers who live in the top two least deprived areas, with an increase of about 1–7% for the ones living in the middle to most deprived areas. Column (2) shows that the probability of being diagnosed for smoking-related health problems is higher for everyone when unemployment increases, but mostly for mothers in the two poorest quintiles (plus 17–21%). Women delay their first visit by 4–14 days when unemployment increases by one-percentage point (Column (3)), but there is not a clear social class gradient.

Taken together, these estimates help to explain the heterogenous health response to cyclical unemployment (see Table 6). Mothers from the low SES neighbourhoods are more likely to increase alcohol and smoking consumption following an economic downturn, while less harming behaviour is observed among the mothers living in the high SES areas. Similar results are reported by Currie et al. (2015b) who find that (i) unemployment increases smoking and drug use, and decreases self-reported health status, particularly for disadvantaged mothers - African American, Hispanic, less educated or unmarried; whereas (ii) for White, married women and highly educated mothers unemployment improves mental and physical health.

6.2. Parental job loss

With unemployment, families might experience a job loss that can affect their income. Income reductions can be associated with a decrease in the consumption of detrimental goods, but our previous analysis shows the opposite. Financial uncertainty can also

Table 9
Mechanisms: Parental job loss.

Panel A	Lone parent household (1)	Couple parent household (2)			
Unemployment	0.1310***	-0.5317***			
	(0.0045)	(0.0075)			
Mean of Dep. Var.	9.262	27.34			
% change	1.41	-1.95			
Panel B	**Birthweight (1)**	**VLBW (2)**	**SGA (3)**	**Foetal growth (4)**	**Stillbirth (5)**
Unemployment	-5.0650***	-0.0001	0.1953**	-0.2560***	0.0459**
	(1.1298)	(0.0257)	(0.0776)	(0.0284)	(0.0198)
Lone parent household	-0.1835	0.0019	0.0375**	-0.0083	-0.0069
	(0.2561)	(0.0057)	(0.0180)	(0.0067)	(0.0046)
Couple parent household	0.5615***	-0.0060*	-0.0312***	0.0152***	-0.0057**
	(0.1458)	(0.0032)	(0.0101)	(0.0038)	(0.0026)
Mean of Dep. Var.	3369	1.025	9.629	86.01	0.625
% change	-0.15	-0.00	2.03	-0.30	7.35

Note: Standard errors in parentheses. In Panel A, every coefficient corresponds to a separate regression, while in Panel B, every column corresponds to a separate regression. The unemployment rate used is the average unemployment rate among 16-64-year-olds in the nine months following conception. Coefficients for VLBW, SGA and Stillbirth are scaled up per 100 infants. Percentage changes are calculated by dividing the unemployment effect by the mean of the outcome in every regression. Lone and couple parent household corresponds to fractions of single or couple households with dependent children at local area level. Every regression includes year and month fixed effects, maternal fixed effects, local authority specific trends, maternal age and baby's gender. The standard errors are clustered at the mother level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

lead to maternal stress which has been found to negatively affect both birthweight and length of the pregnancy (Persson and Rossin-Slater, 2018; Wadhwa et al., 1993). Lindo (2011) and Carlson (2015) find that parents' job displacements reduce birthweight via work-induced stress. In Section 5.2, we have seen that female unemployment has a larger detrimental effect on new-born's health than male unemployment. Female unemployment is a better proxy of maternal unemployment suggesting a possible worsening of mental health for pregnant women.

Negative income shocks might be faced differently, depending on the family composition, as in single or two-parent households. We use the Annual Population Survey to derive the prevalence of lone parent households with dependent children that are aged under 16, and those whose dependent children are aged 16 to 18, have never married and are in full-time education; and the prevalence of couple households with dependent children.[30] These prevalences are available at yearly level from 2004 and for each district. In Panel A of Table 9, we regress the prevalence of single or couple households on the unemployment rate adding our baseline set of controls. Unemployment is negatively associated with two-parent households, while positively associated with single parent households confirming previous research that shows how family instability increases with a spouse's job displacement (Charles and Stephens, 2004). In Panel B of Table 9, we find that living in areas where there is a larger prevalence of couple households with dependent children mitigates the effect of unemployment on health. Dual-earner families might in fact be less vulnerable to economic shocks. Parental income loss is also an important mediator reducing the effect of unemployment by 22%, 12% and 21% respectively for SGA, foetal growth and stillbirth (see % changes in Panels B of Tables 3 and 9).

Collectively, the set of estimates presented in Table 9 suggest that parental job loss could be a likely channel.[31]

7. Concluding remarks

In this paper we study the effects of unemployment on a variety of birth outcomes in England between 2003 and 2012, a period of considerable unemployment variation, including the Great Recession. To address in a robust way the potential bias arising from changes to the mix of mothers giving birth over the cycle, we compare the health of siblings whose in-utero experiences occur at different points of the cycle.

We find health to be on average strongly pro-cyclical, with downturns leading to a decline in birthweight and foetal growth, and an increase in the chances of having a small-for-gestational-age baby or a stillbirth. However, the effects are not the same for everyone:

[30] These two prevalences can be downloaded from https://www.nomisweb.co.uk. They do not sum to one-hundred because households with multiple family units are excluded.

[31] Different conclusions are drawn in van den Berg et al. (2020) where the recession seems to operate via channels more general than parental unemployment.

unemployment most adversely affects babies conceived in the average to the lowest socioeconomic areas, while the opposite is true for the ones conceived in the richest areas.

To contribute towards bridging the gap between the few studies which compare siblings with those which exclude maternal fixed effects, we also estimate the effect of unemployment if maternal fixed effects are excluded and find that the overall influence of unemployment is no longer negative, but is statistically insignificant. This bias from excluding family fixed effects can be accounted for by the positive selection into birth combined with the more positive effect of unemployment on the health of children born in more affluent districts.

We provide robust evidence of three channels that can explain the overall negative effect of unemployment on new-borns' health: unhealthy behaviours - namely excessive alcohol consumption and smoking; delays in the take-up of prenatal services; and parental income loss. The postponement of the first antenatal visit and family earnings seam to be the most important mediators. The heterogenous effects of unemployment on health by socioeconomic status appear instead to be explained by differences in behavioural response. Unemployment widens the differences between the behaviours of mothers coming from the least and most disadvantaged areas, but in the case of alcohol and smoking in different ways: in recessions (i) the affluent drink less, and the poor drink more; (ii) the affluent smoke more, but the poor smoke much more.

It should not be especially surprising that the effect of unemployment on new-born's health differs between countries. While our results suggest that omission of maternal fixed effects will positively bias the estimated influence of unemployment, the direction of bias could well vary by country: country-level differences in either selection into fertility, or heterogeneities in the effect of unemployment on health, may be expected to create differences in the overall impact of the recession on birth outcomes in pooled OLS analyses, even if sibling fixed effects estimates were to show similar country effects. In comparing results of sibling studies, variations in findings between countries may result from international differences in the expected costs of becoming unemployed, which depend on policies towards unemployment protection, as well as differences in labour market structures which influence the expected duration of unemployment.

Unemployment may be less damaging to baby's health in countries where unemployment protection for families is higher (e.g., Denmark or Luxembourg), or where the labour market is more flexible and new jobs are readily available (e.g., US), or where there are policies to financially encourage the unemployed to accept public provided jobs after a capped period of unemployment (e.g., Sweden). However, the consequence of considerably longer durations of unemployment in several large EU countries - France, Italy, Germany, Spain, The Netherlands - than in the UK, may result in downturns worsening birth outcomes no less than in the UK, despite their higher levels of social protection.

In England, the average effects hide an unfortunate major repercussion of the recession: an increase in babies' local health inequality. It is widely documented that large differences in health at birth have cascading effects throughout the life course influencing later outcomes, such as education, earnings and disability (Currie, 2011). Our evidence that average to lowest SES babies are most damaged by recessions suggests that safety net programs should not only target the poorest but be wider to ensure that fewer vulnerable families are missed.

Appendix A

Table A1
Sensitivity to pre-conception and post-pregnancy unemployment.

	Birthweight (1)	VLBW (2)	SGA (3)	Foetal growth (4)	Stillbirth (5)
Unemployment three years before conception	1.412	-0.050	0.057	0.070*	-0.008
	(1.584)	(0.038)	(0.106)	(0.039)	(0.031)
Unemployment two years before conception	0.142	0.077*	0.256**	-0.072*	0.025
	(1.763)	(0.043)	(0.117)	(0.043)	(0.037)
Unemployment one year before conception	-4.834***	-0.011	0.202*	-0.209***	0.054
	(1.691)	(0.041)	(0.112)	(0.042)	(0.035)
Unemployment during pregnancy	-4.435***	0.028	0.061	-0.160***	0.009
	(1.680)	(0.041)	(0.112)	(0.042)	(0.035)
Unemployment one year after delivery	2.477	-0.050	-0.058	0.010	0.045
	(1.755)	(0.042)	(0.120)	(0.044)	(0.035)
Unemployment two years after delivery	-0.424	0.010	-0.183	0.026	-0.114***
	(1.810)	(0.043)	(0.125)	(0.046)	(0.037)
Unemployment three years after delivery	-1.108	0.049	0.421***	-0.065*	0.050*
	(1.403)	(0.033)	(0.099)	(0.036)	(0.027)
% change	0.0419	-4.924	0.594	0.0812	-1.325

Note: Standard errors in parentheses. Every column corresponds to a separate regression. Unemployment refers to the average unemployment rate among 16-64-year-olds in each specific period. Coefficients for VLBW, SGA and Stillbirth are scaled up per 100 infants. Percentage changes are calculated by dividing the unemployment effect during the pregnancy by the mean of the outcome in every regression. Every regression includes year and month fixed effects, maternal fixed effects, local authority specific trends, maternal age and baby's gender. The standard errors are clustered at the mother level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

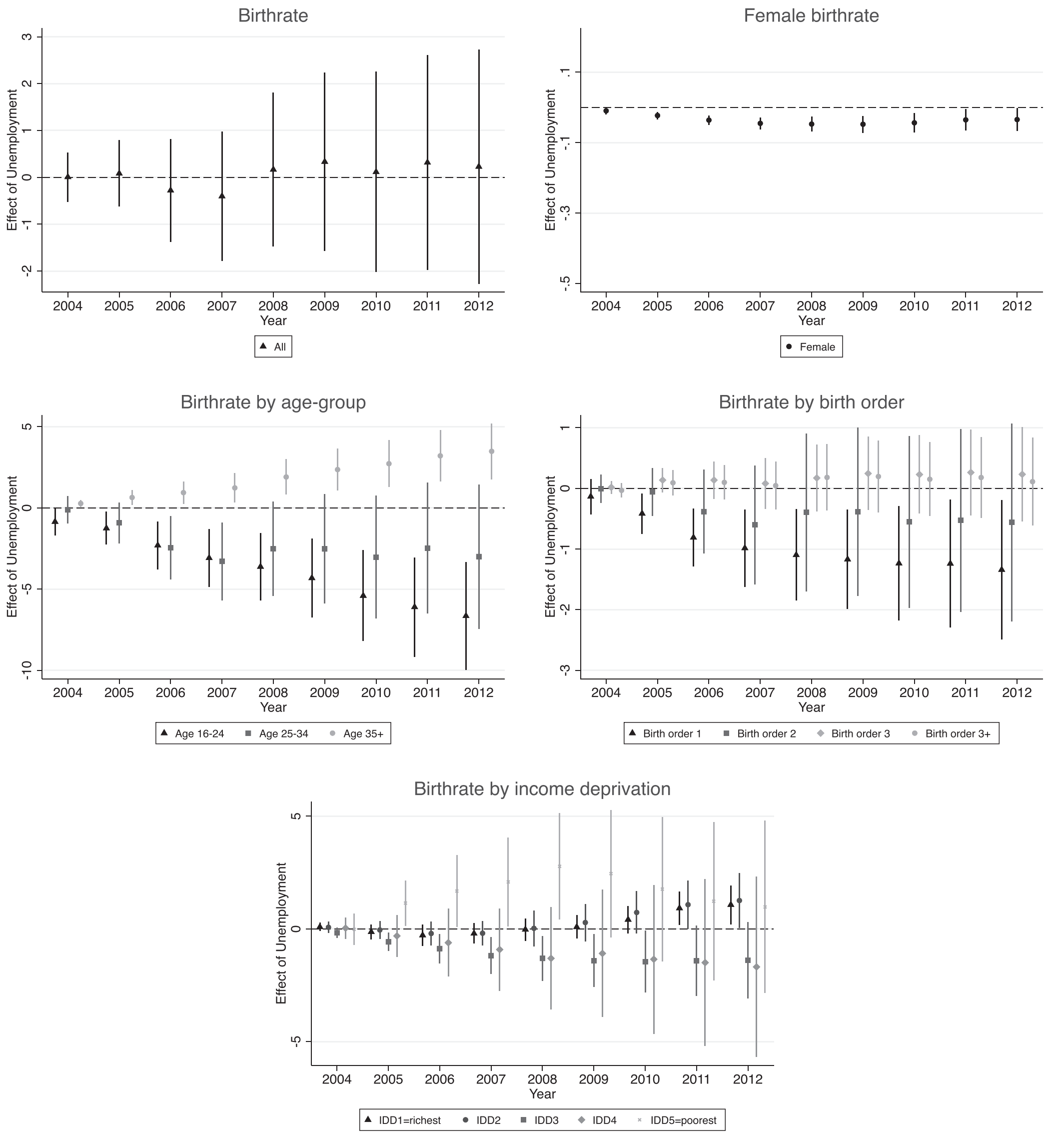

Fig. A.1. Effect of Unemployment on birthrates *Note: This Fig. reports the effect of unemployment on birthrates over time. The different birthrates are constructed using our analytic sample (siblings). Birthrates are given by the number of births in the same year of conception and local authority in a given subgroup per 1000 divided all women aged 16–49. For the age-specific birthrates the denominator corresponds to the total number of women in the specific age group. The regression includes year fixed effects, local authority fixed effects, and local authority specific linear trends. Regressions are weighted by the number of births. The standard errors are clustered at the local authority level.*

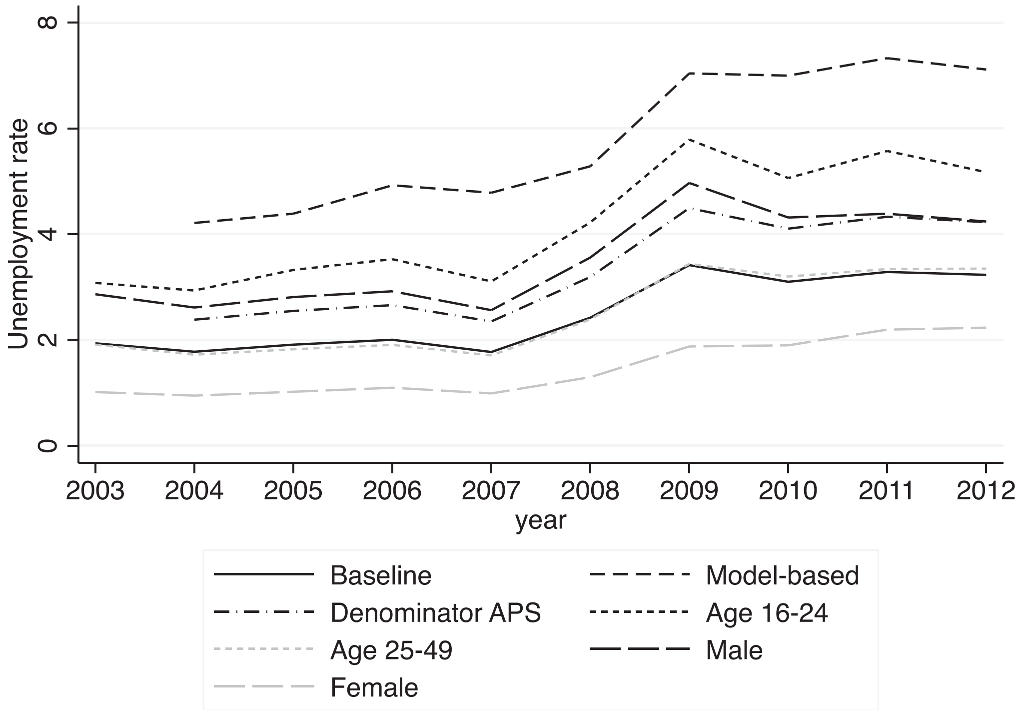

Fig. A.2. Different unemployment rates in England *Note: This Fig. reports different indicators of unemployment. The baseline unemployment rate, and the unemployment rates by gender and age correspond to the ratio of job seeker allowance claimants divided by the population of reference at LAD-year level. The baseline unemployment rate refers to the working age population 16-64-years of age. The model-based unemployment rate is constructed by combining unemployment estimates from the Annual Population Survey (APS) with claimant counts; while the unemployment rate with denominator APS is the ratio of job seeker allowance claimants divided by the economically active population taken from the APS. See Section 5.2.0.2 for further details.*

Table A2
Sensitivity to different geographical levels of unemployment.

	Birthweight (1)	VLBW (2)	SGA (3)	Foetal growth (4)	Stillbirth (5)
Unemployment at MSOA level	-9.854***	0.040**	0.218***	-0.292***	0.025*
	(0.820)	(0.018)	(0.057)	(0.021)	(0.015)
% change	-0.29	3.92	2.31	-0.34	3.73
Unemployment at LAD level	-7.113***	0.017	0.355***	-0.371***	0.046**
	(1.219)	(0.027)	(0.085)	(0.031)	(0.020)
% change	-0.21	1.60	3.63	-0.43	7.30
Unemployment at county level	-5.935***	0.058***	0.212***	-0.239***	0.036**
	(0.987)	(0.023)	(0.067)	(0.025)	(0.017)
% change	-0.18	5.59	2.18	-0.28	5.84

Note: Standard errors in parentheses. Every coefficient corresponds to a separate regression. The unemployment rate used is the average unemployment rate among 16-64-year-olds in the year of conception at specific area level. Coefficients for VLBW, SGA and Stillbirth are scaled up per 100 infants. Percentage changes are calculated by dividing the unemployment effect by the mean of the outcome in every regression. Every regression includes year and month fixed effects, maternal fixed effects, area specific trends, maternal age and baby's gender. The standard errors are clustered at the mother level.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table A3
Sensitivity to different contracts.

Panel A	% part-time work (1)	% female part-time work (2)			
Unemployment	0.006***				
	(0.0001)				
Female unemployment		0.016***			
		(0.0002)			
% change	1.42	3.60			
Panel B1	**Birthweight (1)**	**VLBW (2)**	**SGA (3)**	**Foetal growth (4)**	**Stillbirth (5)**
Unemployment	-5.625***	0.001	0.230***	-0.270***	0.042**
	(1.133)	(0.026)	(0.078)	(0.029)	(0.020)
% part-time work	-3.367	0.272	-3.270***	0.001	-0.335
	(11.420)	(0.267)	(0.826)	(0.291)	(0.210)
% change	-0.17	0.11	2.38	-0.31	6.68
Panel B2	**Birthweight (1)**	**VLBW (2)**	**SGA (3)**	**Foetal growth (4)**	**Stillbirth (5)**
Female unemployment	-12.570***	-0.019	0.025	-0.434***	0.111***
	(1.694)	(0.038)	(0.113)	(0.042)	(0.029)
% female part-time work	0.379	0.202	-3.117***	0.083	-0.531***
	(10.297)	(0.243)	(0.728)	(0.256)	(0.189)
% change	-0.37	-1.84	0.25	-0.50	17.83

Note: Standard errors in parentheses. In Panel A, every coefficient corresponds to a separate regression, while in Panels B1 and B2, every column corresponds to a separate regression. The unemployment rate used is the average unemployment rate among 16-64-year-olds in the nine months following conception. Coefficients for VLBW, SGA and Stillbirth are scaled up per 100 infants. Percentage changes are calculated by dividing the unemployment effect by the mean of the outcome in every regression. % (female) part-time work corresponds to the prevalence of individuals (female) with a part-time contract in each local area. Every regression includes year and month fixed effects, maternal fixed effects, local authority specific trends, maternal age and baby's gender. The standard errors are clustered at the mother level. *** p<0.01, ** p<0.05, * p<0.1

Table A4
Alcohol and smoking related diagnosis.

Panel A: ALCOHOL DIAGNOSIS	Diagnosis codes	Percentage
Alcohol dependance	F10	0.0353
Alcohol polyneuropathy	G62.1	0.0000
Degeneration of nervous system due to alcohol	G31.2	0.0000
Alcoholic myopathy	G72.1	0.0000
Alcohol cardiomyopathy	I42.6	0.0000
Alcoholic gastritis	K29.2	0.0000
Alcoholic liver disease	K70-K70.4, K70.9	0.0013
Fetal alcohol syndrome	Q86.0	0.0001
Foetus and new-born affected by maternal use of alcohol	O35.4, P04.3	0.0024
Alcohol-induced chronic pancreatitis	K86.0	0.0002
Acute pancreatitis	K85	0.0041
Chronic pancreatitis	K86.1	0.0020
Epilepsy	G40, G41	0.4269
Oesophageal varices	I85, I98.2	0.0009
Gastro-oesophageal hemorrhage	K22.6	0.0003
Liver cirrhosis, unspecified	K74.3-K74.6, K76.0, K76.9	0.0089
Portal hypertension	K76.6	0.0010
Alcohol poisoning	X45, Y15, T51.0, T51.1, T51.9	0.0002
Suicide by and exposure to alcohol	X65	0.0000
Excessive blood level of alcohol	R78.0	0.0000
Alcohol-induced pseudo-Cushing's syndrome	E24.4	0.0000
Evidence of alcohol involvement determined by blood alcohol content	Y90	0.0000
Evidence of alcohol involvement determined by level of intoxication	Y91	0.0000
Alcohol use counseling and surveillance	Z71.4	0.0000

(*continued on next page*)

Table A4 (*continued*)

Panel B: SMOKING DIAGNOSIS	Diagnosis codes	Percentage
Nicotine dependance	F17	3.4310
New-born affected by maternal use of tobacco	P04.2	0.0000
Toxic effect of tobacco and nicotine	T65.2	0.0000
Tobacco use counseling; not elsewhere classified	Z71.6	0.0091
Tobacco use not otherwise specified	Z72	3.6607
Contact with and exposure to environmental tobacco smoke	Z77.2	0.0000
Personal history of nicotine dependence	Z87.8	0.0265
Malignant neoplasms of lip, oral cavity and pharynx	C00-C14	0.0003
Malignant neoplasms of oesophagus	C15	0.0000
Malignant neoplasms of stomach	C16	0.0000
Malignant neoplasms of pancreas	C25	0.0000
Malignant neoplasms of larynx	C32	0.0000
Malignant neoplasms of trachea, lung bronchus	C33-C34	0.0002
Malignant neoplasms of cervix uteri	C53	0.0006
Malignant neoplasms of kidney and renal pelvis	C64-C65	0.0000
Malignant neoplasms of urinary bladder	C67	0.0001
Malignant neoplasms of acute myeloid leukaemia	C92.0	0.0000
Coronary heart disease	I20-I25	0.0062
Other heart disease	I00-I09, I26-I28, I29-I51	0.1786
Cerebrovascular disease	I60-I69	0.0079
Atherosclerosis	I70	0.0006
Aortic aneurysm	I71	0.0013
Other arterial disease	I72-I78	0.0259
Chronic lower respiratory diseases	J40-J47	4.4121
Influenza and pneumonia	J10-J11, J12-J18	0.0247
Respiratory conditions due to smoke inhalation	J70.5	0.0000
Prenatal conditions related to smoking	K55.0, P00.0, P01.0, P01.1, P01.5, P02.0, P02.1, P02.7, P07.0-P07.3, P10.2, P22.0–22.9, P25.0-P28.1, P36.0-P36.9, P52.0-P52.3, P77	0.0017

Note: The table shows the diagnoses associated to alcohol (Panel A), and smoking consumption (Panel B). These diagnoses come mainly from the following sources: Currie et al. (2015a); Dietz et al. (2010); Health (2014), and https://nccd.cdc.gov/dph_ardi/info/icdcodes.aspx. The last column reports the percentage of each diagnosis in our analytic sample (100×number of mothers with at least one registered diagnosis/total number of mothers).

CRediT authorship contribution statement

Elisabetta De Cao: Conceptualization, Data curation, Formal analysis, Methodology, Software, Visualization, Writing – original draft, Writing – review & editing. **Barry McCormick:** Conceptualization, Writing – review & editing. **Catia Nicodemo:** Conceptualization, Data curation, Methodology, Software, Visualization, Writing – review & editing.

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