Maternal Postpartum Depression Effects on Child's Health

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Preliminary work, please do not circulate.

Abstract

This paper aims at empirically assessing the impact of maternal postpartum depression on child's health development. Several studies indicate that children, whose mother experienced postpartum depression, are at greater risks of emotional, behavioural, cognitive and interpersonal problems later in life. However, the maternal postpartum depression might influence child's development by affecting her/his health outcomes. Using data from the Millennium Cohort Study (UK data service), we investigate whether maternal postpartum depression has an impact on early child health development. In detail, we study the effects of maternal postpartum depression on a range of potential child health diseases at ages of 3, 5, 7 and 11 years, and on the number of injuries or accidents occurred at the child, for which s/he was taken to the hospital. Our findings show a non-negligible impact of maternal postpartum depression on those child health issues enhanced by a stressful environment: wheezing and hay fever throughout childhood. At later ages (7 and 11 years), children with a mother who experienced postpartum depression are also more likely to suffer from asthma. Furthermore, results indicate a significant strong effect of maternal postpartum depression on the accident rate at the ages of 3 and 5 years (the incidence-rate ratios are of 1.193 and 1.280 respectively).

Keywords: Maternal postpartum depression; early childhood development; health.
JEL classification: I120, I140, J130.

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1 Introduction

According to the World Health Organization, 13% of mothers who have just given birth suffer of a mental disorder, primarily diagnosed as depression. It represents a relevant public health issue affecting women and their families (Warner et al., 1996). Mothers provide the largest share of human contact with the infants and mediate their contact with the external world (Grace et al., 2003). The family environment is the primary source of experience of a child and it is characterized by its own social and economic resources, including: parenting skills and education, cultural practices and approaches, intra-familial relations and the health status of family's members indeed (Irwin et al., 2007).

Several studies indicate that children of a mother with depression are at greater risks of emotional, behavioral, cognitive and interpersonal problems later in life (Luoma et al., 2001; Beck, 1998; Carter et al., 2001). According to Murray (1992), maternal postpartum depression appeared to make offspring more vulnerable to adverse effect of lower social class and male gender (boys appear to be at a greater risk of poor development than girls). Infants of 18 months of age, with a mother who suffered from postpartum depression, performed worse on object concept tasks, showed more fragile bond with their mothers and more mild behavioural difficulties.

Moreover, the maternal postpartum depression might influence child's development by affecting her/his health outcomes. Early child health and development (ECD) is important for health in later life (Case et al., 2002; Irwin et al., 2007). Inequalities in health, as well as in cognitive development and socio-emotional functioning, emerge early in life (Doyle et al., 2009; Case et al., 2002). Poor health experienced in childhood has been associated with poorer health, adverse educational and labor market outcomes in adulthood (Case et al., 2005). Therefore, unhealthy children represent a cost for the society in the short run, since it increases the demand for health resources, and in the long run due to the losses in economic productivity (Doyle et al., 2015).

Actions taken in order to reduce the social gradient in child development, might have an impact on later social gradients in health (Campbell et al., 2014). A strong body of research demonstrates that early intervention is more efficient in biologically and economically terms, since at early stages, development is more malleable to external stimuli (Halfon et al., 2001).

The aims of the present study are to investigate whether maternal postpartum depression has an impact on (i) child's health outcomes at ages of 3, 5, 7 and 11 years, (ii) and on the number of injuries or accidents occurred at the child, for which s/he was taken to the hospital. We want to assess whether any effect exists and if it persists as the child grows up. In our analysis, we use the UK-Millennium Cohort Study (MCS), a longitudinal birth cohort study administered by the Centre for Longitudinal Studies and available through the UK Data Service.

The rest of the paper proceeds as follows: in Section 2 an overview of the literature on child health inequalities and maternal postpartum depression is provided, in Section 3 the model specification is outlined, in Section 4 the empirical analysis is described, and in Section 5 conclusions are drawn.

2 Literature review

Every child is born with an initial health endowment as birth-weight and gestation age. However, her/his health status might be affected by several factors even before birth. Evans and Kantrowitz

(2002) reported that in utero exposure to environmental toxins[1] might lead to teratological effects. Even in low doses, toxins may produce cognitive and behavioral abnormalities, including attentional and memory disorders, lower Intelligent quotient, and poorer academic achievement. In addition to this, other behavioural problems as impulse control, frustration intolerance, and aggression have also been associated with several toxins exposure. Moreover, the toxicological effects appear to be especially dangerous during the critical period of fetal development (Evans and Kantrowitz, 2002). Not only exposure to environmental toxins seems to be dangerous to fetal development but also exposure to stressful situation might harm child health as well. Quintana-Domeque and Ródenas-Serrano (2017) investigated the effect of in utero exposure to a sustained terrorist conflict on birth outcomes. Focusing on ETA[2] terrorism in Spain in the period between 1980 and 2003, they found that exposure to terrorism early in pregnancy, measured by the number of bomb casualties in the mother's province of residence, is associated with a major prevalence of low birth weight, and lower fraction of 'normal' babies. Moreover, focusing on the most tragic ETA attack in the '80, the authors found that exposure to bomb casualties increases fetal deaths. They claimed that their results are consistent with the fact that many bio-active mediators of maternal stress are also associated with pathophysiology of stillbirth. Other studies have investigated the effect mainly on birth-weight of in utero exposure to maternal stressors at an aggregate level such as: hurricanes, landmines-explosions, number of injuries in the al-Aqsa Intifdada, and homicide rates (Torche, 2011; Camacho, 2008; Mansour and Rees, 2012; Koppensteiner and Manacorda, 2016).

Apart from stress generated by natural disasters or terrorism attacks, a large proportion of mothers, up to 70%, experience a brief psychological disturbance after delivery called postnatal blues (Robertson et al., 2003). Maternity blues should not be confused with postpartum depression. The former occurs within a few days after childbirth (on day 3 or 4), and persists for hours up to several days. It is characterized by mood lability, irritability, tearful, generalized anxiety, and sleep and appetite disturbance. No treatment is required rather reassurance (Kennerley and Gath, 1989; Robertson et al., 2003). The latter is met within the first 12 months after childbirth and most cases require treatment by a health professional. The symptoms include the ones of maternity blues as well as poor concentration and memory, feelings of guilt, of being inadequate and unable to cope with the infant (Robertson et al., 2003). Postpartum depression is estimated to affect approximately $10 - 15\%$ of women following childbirth (Warner et al., 1996). Untreated postpartum depression can persist for months to years, affecting health and psychological well-being of the mother (Cooper et al., 1988; Beck, 2001; Blom et al., 2010).

Extreme severe depressive episodes with psychotic symptoms, are attributed instead to puerperal psychosis which affect only the $0.1\% - 0.2\%$ of mothers. It involves extreme disorganization of thought, bizarre behaviour and unusual hallucinations. Conversely to postpartum depression, the puerperal psychosis outbreaks within the first two weeks after delivery and it requires immediate intervention due to the risk of infanticide and suicide (Kendell et al., 1987; Wisner et al., 2002).

The symptoms in women with postpartum depression are similar to those in women who have depression unrelated to childbirth (Wisner et al., 2002), except from the content which might be associated with the child (Robertson et al., 2003). Epidemiological studies have identified a set of risk's factors which might increase the probability of developing postpartum depression. These are: history of depression, prenatal anxiety, low social support and poor marital relationship (O'hara and Swain, 1996; Beck, 2001). Using a large birth cohort study in the Netherlands embedded in

[1]Principally identified in heavy metals (e.g., lead), solvents (e.g., cleaning fluids), and pesticides.

[2]ETA, abbreviation of Basque Euskadi ta Askatasuna (Basque Homeland and Liberty), was a terrorist organization who sought to gain independence for a Basque homeland in northern Spain and southern France.

the Generation R study, Blom et al. (2010) found that several perinatal complications were significantly associated with postpartum depression. In particular, they observed that preeclampsia[3], hospitalization during pregnancy, emergency caesarean section, suspicion of fetal distress, a medically indicated delivery provided by an obstetrician, and hospital admission of the baby increased the risk of postpartum depression. In their study, postpartum depression was assessed with the Edinburgh postnatal depression scale distributed to mothers after 2 months from delivery. The authors claimed that several mechanism might explain the association between pregnancy and delivery complications with postpartum depression. These could be: physical and hormonal changes in the woman, her physical health, personality differences as well as psychological mechanism. Expectations about pregnancy, delivery, and postpartum period might lead to feelings of disappointment and failure when complications occurred. Conversely, unplanned pregnancy was not found associated with maternal distress. In her review, Heh (2003) reported that social support is an important factor to reduce the effect of postnatal depression. Mental health and physical well-being can be promoted through instrumental and emotional support.

A number of studies has found an association between early maternal depression and adverse cognitive and emotional child development (Murray and Cooper, 1997; Kelly et al., 2011). In their study, Murray and Cooper (1997) supposed that the association between the occurrence of postnatal depression and adverse infant outcomes might be mediated by three different mechanisms: (i) child's exposure to the mother's depressive symptoms; (ii) parenting difficulties associated with the occurrence of maternal depression; (iii) third factor variables (environmental adversity, genetic factors).

According to epigenetic studies, the relationship between early life experience, including perinatal environment, and health in adulthood might be partially mediated by parental influences on the development of neuronal systems that underlie the expression of behavioral and endocrine responses to stress. Most of the epigenetic literature on the environmental regulation of the development of responses to stress derives from postnatal handling research with rodents (experiments on humans are forbidden for obvious reasons). Weaver et al. (2004) found that maternal behavior in rats is responsible for stable long-lasting alterations of DNA methylation and chromatic structure. In particular, maternal behavior permanently alters the development of hypothalamic-pituitary-adrenal responses to stress through tissue-specific effects on gene expression. However, the authors showed that the epigenomic state of a gene can be established through behavioral programming, and that is potentially reversible.

Excessive hypothalamic-pituitary-adrenal and sympathetic responses to stress are associated to an increased risk, for both humans and non-humans populations, of a variety of disorders, including heart disease, diabetes, anxiety, depression and drug addiction. Stress is a risk factor for a wide range of diseases indeed, going from autoimmune disorders to mental illness (Meaney, 2001). Neuroendocrine or immunologic changes induced by stress may affect airway inflammation and reactivity through immunologic and neural pathways that may lead to wheeze (Wright et al., 2002).

Epidemiological studies suggest that maternal distress may lead to the development of childhood wheezing and asthma. In a cohort of 490 families with a history of asthma or allergy, Wright et al. (2002) found that parental stress, measured when the child was 2 to 3 months of age, predicted childhood wheeze at 14 months of age. Using Canada's health care and prescription databases (Manitoba), Kozyrskyj et al. (2008) found an association between continued exposure to maternal

[3]Hypertensive condition in pregnancy characterized by high blood pressure, sometimes also with fluid retention and proteinuria.

distress (from postpartum period up to 7 years) and asthma at the age of 7 years for those children living in high-income households. Though, exposure to maternal depression and anxiety only in the first year of life was not associated with asthma at later ages. Similar evidence was found by Turney (2011), who analysed the impact of maternal depression on children health outcomes at the age of 5 years, using US data from the Fragile Families and Child Wellbeing Study. The author reported that children of chronically depressed mothers, compared to their counterparts with never depressed mothers, were about twice as likely to have had an asthma attack, hay fever or respiratory allergies, or eczema or skin allergies in the last year (when they were 4 years old). In the analysis, maternal chronic depression was found to worse general health of the offspring at the age of 5 years. Moreover, children whose mother has experienced persistent depression, are more likely to have gone to the emergency room in the previous year, while the association between maternal depression and doctor visits for accident or injuries is only marginally significant.

In the British context instead, Propper et al. (2007), using cross-sectional data from the Avon Longitudinal Study of Parents and Children, identified a strong association between a mother with poor mental health measured at the 17th week of gestation, and poor general health of her child at various ages in early- to mid-childhood (from 6 months to 7 years). The researchers investigated also the association of maternal perinatal distress with child asthma and body mass index at the age of 7. It was found that maternal poor mental health increases child's probability of suffering from asthma, but has no effect on his/her body mass index.

An other study by Violato et al. (2009), using the first three surveys of the UK Millennium Cohort Study, found that maternal psychological distress is associated with an increasing probability of suffering from wheeze at age of 5 years, but not at previous age. In addition to this, no effect of maternal distress was identified on the probability of suffering from asthma. In this study, maternal depression was measured with a time lag with respect to the time in which child health outcomes were measured.

The literature on the consequences of maternal depression for the offspring is growing, although few studies focus on the impact of postpartum depression on physical child health outcomes and even fewer assess whether it persists throughout the childhood until adolescence. The present paper contributes to the existing literature by assessing whether maternal postpartum depression has an impact on a specific set of child health outcomes, using a large, cohort study not restricted to high-risk children.

3 Model specification

Childhood health is the result of an initial health endowment as well as parents and external inputs. Following the framework of Grossman (2000) and Jacobson (2000), as outlined by Noonan et al. (2018), we can express the child-health production function as follows:

$$CH_{i,t} = \alpha_0 + \alpha_1 h_{i,t=0} + \alpha_2 X_{i,t} + \alpha_3 Ln(Y_{i,t}) + \sum_{z=1}^{Z} \alpha_{z,PS} PS_{z,i,t} + \sum_{j=1}^{J} \alpha_{j,PI} PI_{j,i,t} + \sum_{s=1}^{S} \alpha_{s,PS} OP_{s,t} + \epsilon_{i,t} \tag{1}$$

where $CH_{i,t}$ represents the child health, i denotes the child, t the time; $h_{i,t=0}$ is the child initial stock of health (e.g., birth-weight, gestational age); $X_{i,t}$ is a set of family characteristics other than income and some child characteristics; $Y_{i,t}$ is the family income considered in its logarithm form;

while the three summation terms are related to 'parental stress', 'parental investment' and 'other family related pathways'; and $\epsilon_{i,t}$ is the error term. In the present study, we are mainly interested in the impact of maternal postpartum depression on child health outcomes. Therefore, our estimation model can be expressed as follows:

$$CH_{i,t} = \alpha + \beta PPD_{i,t=0} + \varepsilon_{i,t} \tag{2}$$

where $CH_{i,t}$ is the child health outcome, i and t denote respectively the child and her/his age in years, $PPD_{i,t=0}$ is maternal postpartum depression, and $\varepsilon_{i,t}$ is the error term. However, some risk factors in the newborn's health, might be the same that trigger postpartum depression. This is the case for maternal longstanding illness, health problems during pregnancy, social support and family income. They might affect child health outcomes directly, and consequently the exclusion of these variables from our first estimation model (2) could arise endogeneity issues.
We can define maternal postpartum depression with the following equation:

$$PPD_{i,t=0} = \alpha + \beta_1 X_{i,t=0} + \beta_2 Z_{i,t=-1} + \beta_3 W_{i,t=0} + \beta_4 Ln(Y_{i,t=0}) + \beta_5 K_{i,t=0} + u_{i,t} \tag{3}$$

where $PPD_{i,t=0}$ is the postpartum depression detected when the child is less than 12 months old; $X_{i,t=0}$ is a set of maternal characteristics including demographic characteristics, longstanding illness and previous history of depression; $Z_{i,t=-1}$ is a set of maternal characteristics referred only to the pregnancy period, such as employment status and health attitudes (e.g. smoking habit, alcohol consumption); $W_{i,t=0}$ is a set of variables describing the labour and any health issues occurred during it or after childbirth; $Y_{i,t=0}$ is the family income expressed in its logarithm form; while $K_{i,t=0}$ comprehends a set of background variables in order to control for social support and environmental risk factors measured after the birth of the child (e.g. child's father present in the household, grandparents alive), and $u_{i,t}$ is the error term. Adjusting for the common risk factors, child's health model can be rewritten in a restricted form as follows:

$$CH_{i,t} = \alpha + \beta PPD_{i,t=0} + \gamma_1 h_{i,t=0} + \gamma_2 LN(Y_{i,t=0}) + \gamma_3 X_{i,t} + \zeta_{i,t} \tag{4}$$

where $h_{i,t=0}$ is the initial child health endowment (e.g. born preterm, underweight); $Y_{i,t=0}$ is the family income considered in its logarithm form; $X_{i,t}$ is a set of variables including child, mother, family and environmental characteristics which are risk factors for both maternal postpartum depression and child's health; and $\zeta_{i,t}$ is the error term. In order to avoid reverse causality between maternal postpartum depression and child health status, we did not considered as dependent variables child health outcomes at the time that postpartum depression is detected but we included them as control variables.

In addition to the impact of maternal postpartum depression on child health outcomes, we are interested in whether a mother suffering from postpartum depression could lead to a more vulnerable home environment for the child. In order to assess it, we took into consideration as potential outcome the number of accidents or injuries for which the child has been needed to be taken to the doctor or hospital. Postpartum depression may affect the way mothers watch over their offspring. We can express the impact of maternal postpartum depression on the number of accidents occurring to a child with the following equation:

$$ACC_{i,t} = \alpha + \beta PPD_{i,t=0} + \eta_{i,t} \tag{5}$$

where $ACC_{i,t}$ is the number of accidents occurring at time t for individual i; $PPD_{i,t=0}$ is maternal postpartum depression; and $\eta_{i,t}$ the error term. Though, as for the child health outcomes, it is important to adjust the model for other variables that might influence both PPD and the number of accidents. Therefore, equation (5) becomes:

$$ACC_{i,t} = \alpha + \beta PPD_{i,t=0} + \gamma_1 h_{i,t=0} + \gamma_2 LN(Y_{i,t=0}) + \gamma_3 X_{i,t} + \nu_{i,t} \tag{6}$$

where $h_{i,t=0}$ is the initial child health endowment; $Y_{i,t=0}$ is the family income considered in its logarithm form; $X_{i,t}$ is a set of variables including child, mother, family and environmental characteristics which are risk factors for both maternal postpartum depression and child's health; $\nu_{i,t}$ is the error term.

4 Empirical Analysis

4.1 Data description

The Millennium Cohort Study (MCS) is a multidisciplinary survey, following the life of around 19,000 children born in the United Kingdom between September 2000 and January 2002. The sample design allowed for an oversampling of families living in disadvantaged areas, in the smaller nations of the UK, and in areas with high ethnic minority populations in England. These are the groups of families who are usually hard to reach (Connelly and Platt, 2014). Data were collected when children were around 9 months of age, in a series of follow-up surveys at the ages of 3, 5, 7, 11 and most recently at 14 years.

At each sweep, home visits interviews were conducted and parents answered also to some questions via self-completion. It was gathered a wide range of information regarding socioeconomic circumstances, demographic characteristics, home learning, family routine, parental health, parenting activities and attitudes. At the age of 9 months extensive information was collected about antenatal care, labour and delivery, breastfeeding, cohort member's health and development. Starting from the second sweep, when cohort member was 3 years old, the interviewer conducted a number of age-appropriate cognitive assessments with the cohort member. Information about cohort members socioemotional difficulties was collected as well. At the age of 7 years, for the first time cohort members completed a short questionnaire on their own, covering topics including their daily lives, activities, schooling, friendships and parents. In addition to this, a postal questionnaire was submitted to cohort members' class teachers.

The MCS provides longitudinal data particularly suited to our empirical analysis since it contains information on mother's physical and mental well-being when the cohort member is 9 months old, and cohort member's health outcomes as s/he grows up until adolescence. We use data from the first five sweeps of the survey; the first sweep includes 18,552 families (18,818 cohort members), but due to attrition the sample size drops to 15,590 families in the second sweep and to 15,246 in the third one, even counting for new included families. In the fourth and fifth sweep, the sample counts 13,857 and 13,287 families respectively. We restrict our investigation to singleton children whose natural mother answered to the first survey, the analysis is then conducted on four Millennium Cohort Study samples based on the availability of cohort member's health information and number of accidents at the ages of 3, 5, 7 and 11 (summary statistics for the samples used in the analysis are provided in Appendix A).

4.2 Variables definitions

Child health outcomes

We considered child health outcomes at the ages of 9 months and of 3, 5, 7, 11 years. We selected the diseases whose outbreak might be eased by a stressful environment according the existing literature. These are: wheezing/whistling in the last 12 months, asthma, eczema and hay fever[4]. As far as child health outcomes at the age of 9 months are concerned, we could recover the information whether the child had ever suffered from wheezing/asthma, skin problems (including eczema), and other breathing problems. Moreover, in order to run a placebo test, we took into consideration other child health issues with no evidence of being advanced by a stressful environment in the literature. These are recurring earing infections at the age of 3 years and hearing problems at the age of 5, 7 and 11 years. Even if the information gathered is based on mothers responses rather than medical records, we are not worried about over or under-reporting due to the nature of the diseases themselves which are hard to neglect. All child health outcomes are measured using binary variables.

Number of accidents or injuries

The number of accidents or injuries measured the number of times that cohort member had an accident or injury for which the child was taken to the doctor, health center, or hospital. At the age of 3 years (sweep 2), it was asked if an accident or injury had ever happened until that moment, while at the ages of 5, 7 and 11 years (sweep 3, 4 and 5) it was limited to the ones occurred since the previous interview. Few children were reported to be involved in more than four accidents at any sweep. For our analysis we decided to take into consideration only the cases where no more than four accidents were reported to exclude the most severe vulnerable situations from our study.

Maternal Postpartum depression

Maternal postpartum depression was measured using a modified version of the Malaise Inventory, where only 9 items were selected, as documented in the technical report of the first MCS sweep. The mother answered via self-completion to 9 'yes-no' questions regarding her mental well-being[5]. The set of questions are used to detect physical and psychological symptoms of anxiety and depression. A score of 4 or above, out of 9, was considered a signal of psychological distress. Therefore, as done in Flouri et al. (2010) and Malmberg and Flouri (2011), we constructed our indicator of maternal postpartum depression as a binary variable which takes value equal to one in the case in which the Malaise Inventory score is equal or higher than four. In order to take account of recursive missing values in the Malaise Inventory, we constructed a binary variable equal to one if the mother answered at least to one question but did not complete the questionnaire. We excluded from the analysis those observations for which all the answers to the Malaise Inventory are missing. Furthermore, we added in the model the interaction between maternal postpartum depression and the presence of other siblings living in the household, presuming that a mother who has already taken care of other children would have acquired a certain experience on how to handle child's needs and soften in this way the possible negative consequences of postpartum depression.

[4]In the second sweep, the interviewer asked to cohort member's parents whether the child had ever suffered from eczema or hay fever in the same question, consequently the affirmative answer of the parents might regards one of the two diseases or even both. While in the third and following sweeps, it was asked separately if the child had suffered from eczema and hay fever.

[5]Whether she felt tired, miserable or depressed, worried, often get into a violent rage, become scared, easily upset or irritated, keyed up and jittery, every little thing get on her nerves and wear them out, and heart often race like mad.

Child's characteristics

In order to control for child's characteristics, we considered: gender, age of the child at the interview, ethnicity, her/his health stock (birth weight, preterm), the presence of siblings living in the household when s/he was born. To define the ethnic group to which the child belong, we used the 6 category Census class (White, Mixed Ethnicity, Indian, Pakistani and Bangladeshi, Black or Black British, and other ethnic group). The samples are balanced in terms of gender (in the second sweep 51% is composed by males), more than four fifths are White (87% in the second sweep).

Males are exposed to a greater probability of premature birth and deformity, at birth they are physically less developed than females and they are more likely to experience a developmental disorder as they grow up (Kraemer, 2000; Gualtieri and Hicks, 1985). However, previous researches have reported that there is no specific difference in wheeze severity between males and females even if at preschool age there is a significantly greater prevalence of wheeze among boys than girls (Luyt et al., 1994). The presence of older siblings seems to protect against the development of eczema, hay fever, and asthma after the age of 2 years, while it appears to increase the incidence of early asthma (McKeever et al., 2001). Using data from Tucson Children's Respiratory Study, Ball et al. (2000) found that child's exposure to other children in or out of the home, during the first six months of life, leads to more frequent wheezing during preschool years. In contrast, such exposure protects against the development of asthma and frequent wheezing later during childhood.

As it regards ethnicity, Forno and Celedon (2009) pointed out that ethnicity is correlated with racial ancestry, which might affect health disparities through differences in the frequency of disease-susceptibility alleles. In particular, they focused their attention on the causes of ethnic disparities in asthma and argued that ethnic group influence disparities in asthma morbidity through diverse mechanisms that go beyond genetic predisposition. One of the main mechanism is definitely the socioeconomic status, indeed certain minority ethnic groups are disproportionately represented among the poor, and poverty has been associated with increased asthma morbidity as well.

Mother's characteristics

As far as mother's characteristics are concerned, we created a set of dummies respectively: if the mother was younger than 30 years old at childbirth; if she had a longstanding[6] illness, disability or infirmity; if she suffered from any problems during pregnancy, if she was working while pregnant, if she attended an ante-natal classes, if she breastfed more or less than 6 months or not at all, and maternal smoking as well as consumption of alcohol during pregnancy.

More educated mother may combine health inputs more efficiently (Grossman, 1972), e.g., be involved in preventative care and changing health behaviours during pregnancy (Doyle et al., 2015). On the other hand, Violato et al. (2009) found an association between higher maternal education and child suffering from asthma/wheezing. The researchers suggested that more educated mothers may be more interested in pursuing a professional career, spending more time at work and consequently pay less attention to the regular prevention and management of childhood respiratory diseases. Smoking during pregnancy has been shown to reduce birth weight and to longer gestation (Rosenzweig and Schultz, 1982), it appears to be related to childhood obesity as well (von Kries et al., 2002).

On top of the usual socio-demographic and health variables, we decided to include attendance at ante-natal classes as control because during the course the mother might have received some pre-

[6]It refers to anything that has troubled the person over a period of time or that is likely to affect her over a period of time.

cious instructions on how to take care of the child that make her feel more self-confident and aware of the difficulties that she had to face in the months following child-birth. Moreover, she might have been informed about the risks of postpartum depression and that she might find support in health care services whenever she needs. In order to measure maternal mental well-being at the time child health outcomes were detected, we considered the Kessler Screening scale for psychological distress[7] (K6), a questionnaire widely used to screen for non specific psychological distress (kes; fur; Mitchell and Beals, 2011). At a given value of the screening scale different thresholds may be used to detect mental illness since the probabilities of clinical records vary with population prevalence (fur), anyway higher score in K6 questionnaire signals higher distress. However, maternal mental well-being in second and following sweeps is influenced by having suffered from postpartum depression or not (in all chi-squared tests we rejected the hypothesis of indecency at the 1% significance level), adding any measure of K6 to the model would mean to include bad controls. To remove the effect of maternal postpartum depression on the K6 total score, we followed the procedure adopted by Behrman and Rosenzweig (2002) to remove the effect of father's schooling from father's earnings in the estimation of offspring's schooling (schooling and earnings are positively correlated, the estimate of the father's schooling effect on his children's schooling would be biased downward if earnings are included in). Firstly, we estimated the regression of K6 score on maternal postpartum depression. Secondly, we predicted the value of K6 score based on the previously estimated results. Thirdly, we subtracted from the true value of K6 score the predicted effect from postpartum depression, and eventually the obtained residuals were added to the regression models.

Difficulties at birth

We took into consideration any reported difficulties at birth or in the first week, such as: delay in breathing, jaundice requiring hospital treatment, infection or suspected one, breech birth, other abnormal lie (shoulder first during labour), long or rapid labour, fetal distress during labour and caesarean section delivery. They might affect child health development, as well as they might have an impact on maternal well-being rising feeling of inadequacy in the mother.

Family's characteristics and environmental risks

Finally, we considered family's characteristics, whether the mother could count on family's support, as well as environmental risks at urban local area. In detail, we generated a dummy if nobody was present at birth (during labour and delivery), if natural father was present in the household at time of the first interview, if maternal parents were alive at time of the first interview and finally, if pollution, grime, environmental problems were common at time of the first interview. Furthermore, to assess the economic family's status, we considered the logarithm of the predicted equalised weekly net family income at the time of the first interview. We chose not to include the frequency of visits of grandparents to the newborn and if they help the mother in any way because it might be influenced by postpartum depression indeed. If grandparents perceive that the mother needs help in caring for the child and herself, they might visit the new-family more often. It might be also the case that the mother, if suffering from psychological distress, asks for support to her parents. For the same reasons, we could not include information on how often the mother met her friends and whether she attended religious services at the time of the first interview.

[7]Respondents rate how often they felt nervous, hopeless, restless or fidgety, so sad that nothing could cheer them up, that everything was an effort, and worthless in the last 30 days.

4.3 Empirical strategy

We perform logistic regression models to investigate the impact of postpartum depression on child health outcomes, which are all dichotomous variables. While, for analysing the effects of postpartum depression on the number of accidents we use Poisson regression models, since the dependent variable is a counting variable with an asymmetric distribution. Separate regressions were run for each outcome variable at ages of 3, 5, 7 and 11 years. In order to take into account the clustered sample design and the unequal probability of being sampled, the SVY command was used throughout the analysis. The study population was stratified by UK country, namely England, Wales, Scotland and Northern Ireland. In sweep 2, advantaged and disadvantaged areas were identified within each country, only in England it was additionally recognized an ethnic area. Therefore, all models adjust for the official UK country where the interview took place, when using data from the second sweep the detailed geographical partition was adopted.

4.4 Results

Results for all regression models are entirely reported in Appendix B. In the following tables, we present the estimated marginal effect of maternal postpartum depression, and most relevant controls, on child health outcomes, as well as on the number of accidents at the ages of 3, 5, 7 and 11 years.

In Table 1, it is shown that maternal postpartum depression has a positive and significant effect in increasing the probability that at the age of 3 years the child has suffered from wheezing in the previous 12 months. Children whose mother experienced postpartum depression, are 5.97% (significant at 1% level) more likely to suffer from wheezing at the age of 3 years with respect to other children. In addition to this, the presence of siblings living in the household appears to increase the probability of suffering from wheezing. However, the interaction between maternal postpartum depression and siblings is negative.

When testing for the significance of the sum of maternal postpartum depression and the interaction between it and siblings, it is not statistically different from zero, meaning that maternal postpartum depression has an impact on child wheezing only if s/he is the first-born one. The experience that the mother acquired in taking care of a previous child may protect the new-born from making her/him less vulnerable to wheezing, even if the mother suffered from postpartum depression after cohort member's birth. The impact of postpartum depression on child's wheezing persists as child grows up. When the child is 5 years old, having a mother who suffered from postpartum depression makes her/him 4.40% more likely to suffer from wheezing (significant at 5% level). When the child is 7 years old, the marginal effect of maternal depression on child wheezing seems to decrease to 2.85% (significant at 10% level). While at the age of 11 years, it is estimated to be equal to 5.90% (significant at 5% level). We tested whether the differences between the marginal effects across the ages are statistically different from zero. However, we fail to reject the hypothesis that the differences are statistically different from zero; we cannot claim that the impact of maternal postpartum decreases in magnitude as the child grows up.

Even if wheezing is often associated with asthma, we do not observed a similar pattern in the association between maternal postpartum depression and child suffering from asthma (Table 1 and 2). When the cohort member is around 7 years old, the past exposure to maternal postpartum depression makes her/him 3.10% more likely to suffer from asthma (significant at 10%). While, as teenagers, the marginal effect of maternal postpartum depression is estimated to be equal to 5.05% (significant at 5%). However, the differences between marginal effects at different ages are not

statistically different from zero. This connection between postpartum depression and child asthma at later age, might be due to the fact that asthma takes more time to outbreak and wheezing might be a risk factor itself.

Different pattern can be seen in the link between maternal postpartum depression and other child health diseases. At the age of 3, a child whose mother experienced postpartum depression seems 6.16% more likely to suffer from eczema or hay fever (significant at 5% level). Conversely, no relationship arises between maternal postpartum depression and child suffering from eczema at following ages. On the other hand, estimations in Table 1 show a significant association between suffering from hay fever at the age of 5 and maternal postpartum depression. Children whose mother suffered from postpartum depression, are 3.67% more likely to suffer from hay fever, with respect to their counterpart (significant at 5% level). At the ages of 7 and 11, the marginal effect of maternal postpartum depression on suffering from hay fever is equal to 3.35% and 4.32% respectively (significant at 10% level). When the cohort member was 3 years old, the information regarding eczema and hay fever was declared together, so we could not show the impact of maternal postpartum depression on eczema and hay fever separately. However, we might infer that the effect we found at the age of 3 was mainly driven by the relationship between maternal distress and child suffering from hay fever.

Focusing our attention on the relationship between maternal postpartum depression and the accidents rate, Table 3 presents the incidence-rate ratio of accidents from the age of 3 to the age of 11 years due to postpartum depression and other cofounders. Results indicate a strong impact of mother's postpartum depression on increasing the incidence rate ratio at 3 and 5 years. At the age of 3 years, children whose mother experienced postpartum depression are expected to have a rate of 1.19 times greater for the number of accidents with respect to children whose mother had no mental distress (significant at 5% level). While, at the age of 5, the incidence ratio is equal to 1.28 (significant at 1% level). As the child grows the effect of maternal postpartum is no more significant.

Table 1: Marginal effects on child health outcomes at the ages of 3 and 5

	Age 3			Age 5			
	Wheeze	Asthma	Hay fever	Wheeze	Asthma	Hay fever	Eczema
Postpartum depression	0.0597***	0.0118	0.0616**	0.0440**	0.0101	0.0367**	0.0100
	(0.0215)	(0.0146)	(0.0272)	(0.0187)	(0.0160)	(0.0156)	(0.0257)
Missing values in Mal. Inventory	0.143	0.0588	0.100	0.0438	0.107	0.0707	0.105
	(0.0898)	(0.0725)	(0.0985)	(0.0661)	(0.0808)	(0.0591)	(0.0887)
Siblings living in household (S1)	0.0363***	0.0145*	0.000696	0.00787	0.00255	-0.0243***	0.0127
	(0.0117)	(0.00809)	(0.0155)	(0.0107)	(0.00961)	(0.00869)	(0.0149)
Interaction postpartum depression and siblings	-0.0622***	-0.0106	-0.0342	-0.0195	-0.00655	-0.0247*	-0.0279
	(0.0178)	(0.0150)	(0.0321)	(0.0184)	(0.0184)	(0.0132)	(0.0316)
Residuals K6 (S2)	0.00469***	0.0000753	0.00320*				
	(0.00117)	(0.000795)	(0.00166)				
Residuals K6 (S3)				0.00276***	0.00179**	0.0000368	0.00412***
				(0.000984)	(0.000907)	(0.000836)	(0.00155)
Observations	12048	11850	11949	12396	12353	12336	12391
Diffusion observation	20%	12%	37%	16%	15%	11%	35%

Notes: Marginal effects at means of the regressor and most relevant controls (logistic regression models). The models include controls for child's characteristics (gender, age at the interview, ethnicity, birth weight, preterm babies), difficulties at birth or in the first week (delay in breathing, jaundice requiring hospital treatment, infection or suspected one, breech birth, other abnormal lie, long or rapid labour, fetal distress during labour and caesarean delivery), mother's characteristics (age below 30 years at time of birth, longstanding illness, disability or infirmity, asthma, problems during pregnancy, age when left education, working while pregnant, attendance at ante-natal classes, smoking and consumption of alcohol during pregnancy, breastfeeding more or less than 6 months), family's characteristics (logarithm of the predicted equivalised weekly net family income (S1), natural father present in household (S1), maternal parents alive (S1), nobody present at birth during labour and delivery) and area level risk (environmental problems common at time of the first interview).
Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Marginal effects on child health outcomes at the ages of 7 and 11

	Age 7				Age 11			
	Wheeze	Asthma	Hay fever	Eczema	Wheeze	Asthma	Hay fever	Eczema
Postpartum depression	0.0285*	0.0310*	0.0335*	0.0119	0.0590**	0.0505**	0.0432*	0.0431
	(0.0168)	(0.0183)	(0.0193)	(0.0261)	(0.0239)	(0.0220)	(0.0251)	(0.0278)
Missing values in Mal. Inventory	0.0518	0.123	0.0447	0.0534	0.0702	0.0911	0.0285	-0.0100
	(0.0591)	(0.0814)	(0.0699)	(0.0876)	(0.0849)	(0.0872)	(0.0811)	(0.0884)
Siblings living in household (S1)	0.00569	-0.00460	-0.0172	-0.00417	0.00862	0.00597	-0.0113	0.000164
	(0.00996)	(0.0106)	(0.0111)	(0.0156)	(0.0137)	(0.0121)	(0.0144)	(0.0162)
Interaction postpartum depression and siblings	-0.0173	-0.0207	-0.0263	-0.0457	-0.0287	-0.0207	-0.0357	-0.0518*
	(0.0163)	(0.0184)	(0.0199)	(0.0320)	(0.0250)	(0.0225)	(0.0277)	(0.0314)
Residuals K6 (S4)	0.00242***	0.0000888	0.000998	0.00350**				
	(0.000893)	(0.00104)	(0.00106)	(0.00160)				
Residuals K6 (S5)					0.00322***	0.00120	0.00324**	0.00633***
					(0.00118)	(0.00107)	(0.00135)	(0.00144)
Observations	11335	11309	11286	11330	10571	10588	10585	10588
Diffusion observation	12%	17%	15%	35%	22%	18%	25%	32%

Notes: Marginal effects at means of the regressor and most relevant controls (logistic regression models). The models include controls for child's characteristics (gender, age at the interview, ethnicity, birth weight, preterm babies), difficulties at birth or in the first week (delay in breathing, jaundice requiring hospital treatment, infection or suspected one, breech birth, other abnormal lie, long or rapid labour, fetal distress during labour and caesarean delivery), mother's characteristics (age below 30 years at time of birth, longstanding illness, disability or infirmity, asthma, problems during pregnancy, age when left education, working while pregnant, attendance at ante-natal classes, smoking and consumption of alcohol during pregnancy, breastfeeding more or less than 6 months), family's characteristics (logarithm of the predicted equivalised weekly net family income (S1), natural father present in household (S1), maternal parents alive (S1), nobody present at birth during labour and delivery) and area level risk (environmental problems common at time of the first interview). Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Incidence ratios on the number of injuries/accidents occurred to the child

	Age 3	Age 5	Age 7	Age 11
Postpartum depression	1.193**	1.280***	1.120	1.082
	(0.0864)	(0.110)	(0.109)	(0.0853)
Siblings living in household (S1)	1.014	1.203***	1.119*	1.030
	(0.0472)	(0.0635)	(0.0695)	(0.0545)
Interaction PPD and siblings	0.952	0.897	0.982	0.941
	(0.0883)	(0.0954)	(0.123)	(0.106)
Residuals K6 (S2)	1.004			
	(0.00456)			
Residuals K6 (S3)		1.018***		
		(0.00518)		
Residuals K6 (S4)			1.017***	
			(0.00620)	
Residuals K6 (S5)				1.007
				(0.00507)
Observations	12005	12346	11306	10441
Mean of the number of accidents	0.47	0.35	0.29	0.52

Notes: Exponential coefficients of the regressor and most relevant controls (poisson regression models). The models include controls for child's characteristics (gender, age at the interview, ethnicity, birth weight, preterm babies), difficulties at birth or in the first week (delay in breathing, jaundice requiring hospital treatment, infection or suspected one, breech birth, other abnormal lie, long or rapid labour, fetal distress during labour and caesarean delivery), mother's characteristics (age below 30 years at time of birth, longstanding illness, disability or infirmity, asthma, problems during pregnancy, age when left education, working while pregnant, attendance at ante-natal classes, smoking and consumption of alcohol during pregnancy, breastfeeding more or less than 6 months), family's characteristics (logarithm of the predicted equivalised weekly net family income (S1), natural father present in household (S1), maternal parents alive (S1), nobody present at birth during labour and delivery) and area level risk (environmental problems common at time of the first interview).
Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.5 Robustness Checks

In order to test the robustness of our results, we run a placebo test assessing the relationship between maternal postpartum depression and other child health issues for which, to the best of our knowledge, the medical literature do not report evidence of a relationship between the outbreak and a stressful environment. We take into consideration: recurring earing infections at the age of 3 years, and hearing problems at the ages of 5, 7 and 11 years. As previously claimed, the information gathered is based on mother's responses rather than medical records, and all child health outcomes are defined through binary variables. We estimate logistic models[8] for the child health outcome at each age controlling for child's characteristics, difficulties at birth or in the first week, mother's characteristics, family's characteristics and an indicator of environmental risk. As shown in Table

[8]Full tables available upon request.

4, no relevant effect of maternal postpartum depression on first-born can be detected in recurring earing infections and hearing problems.

Table 4: Impact of maternal postpartum depression on first-born child health outcomes (Placebo tests)

	Ear infections[1]
Age 3	0.00745
	(0.0125)
Observations	12032
Diffusion observation	7%
Age 5	-0.0230
	(0.0154)
Observations	12383
Diffusion observation	13%
Age 7	-0.0201
	(0.0162)
Observations	11332
Diffusion observation	12%
Age 11	-0.00930
	(0.0137)
Observations	10591
Diffusion observation	8%

Notes: Marginal effects reported at the mean (logistic regression models). All models adjust for child's characteristics, difficulties at birth or in the first week, mother's characteristics, family's characteristics and area level risk. [1] Ear infections in the second sweep, hearing problems in the third and following sweeps. Standard errors in parentheses. $^{*}p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Eventually, as an additional robustness check, we perform propensity score matching estimators to derive the average treatment effect on treated of having been exposed to maternal postpartum depression on health outcomes and on the number of accidents occurred to the child (results in Appendix D). Assuming that maternal postpartum depression depends on a vector of observable variables, we can compare the health status of the children whose mother suffered from postpartum depression with a sample of children who share the same probability of having a mother with postpartum depression but eventually did not experience it. The covariate information we use for the propensity score matching regards child's characteristics, mother's characteristics, family's and environment's characteristics[9]. In the implementation of the propensity score matching, Abadie-Imbens robust standard errors are considered (Abadie and Imbens, 2016).

On one hand, as far as child health outcomes are concerned, the estimated average treatment

[9]Covariate balance table in Appendix D.

effects on the treated in Table 5 highlight a positive effect of maternal postpartum depression on the probability that the child suffers from wheezing at ages of 3, 5 and 7 years, and from hay fever at the ages of 5 and 11 years. Moreover, it indicates an effect of maternal postpartum depression on child asthma at the ages of 7 and 11 years. We estimate the average effects of maternal postpartum depression also on child health outcomes used in the placebo test, but no association was found. On the other hand, as it regards the number of accidents occurred to cohort member, this is positively associated with maternal postpartum depression at the ages of 3, 5 years (significant at 1% level), and at the age of 7 years (significant at 10% level). These findings are in line with the regressions' estimation results.

Table 5: Propensity score matching: child health outcomes and N. of accidents

	Wheeze (ATET)	Asthma (ATET)	Eczema (ATET)	Hay fever (ATET)	N. of accidents (ATET)	Ear infections^{+} (ATET)
Age 3	0.0313**	0.00496	–	0.0229	0.0856***	-0.00864
	(0.0151)	(0.0134)		(0.0170)	(0.0265)	(0.0101)
Observations	13148	12928		13036	13102	13128
Treated	1854	1816	–	1831	1846	1851
Control	11294	11112		11205	11256	11277
Age 5	0.0233*	0.0120	-0.0233	0.0245**	0.0596***	-0.00326
	(0.0140)	(0.0134)	(0.0171)	(0.0119)	(0.0227)	(0.0119)
Observations	13047	12998	13037	12981	12943	13028
Treated	1846	1838	1843	1833	1828	1841
Control	11201	11160	11194	11148	11115	11187
Age 7	0.0377***	0.0293**	-0.0227	0.00240	0.0420*	0.00656
	(0.0128)	(0.0146)	(0.0176)	(0.0142)	(0.0223)	(0.0126)
Observations	11856	11887	11908	11862	11826	11910
Treated	1669	1674	1677	1668	1665	1678
Control	10187	10213	10231	10194	10161	10232
Age 11	0.0206	0.0299**	-0.00311	0.0348**	-0.0235	0.00435
	(0.0169)	(0.0152)	(0.0183)	(0.0166)	(0.0318)	(0.0108)
Observations	11323	11346	11345	11343	11177	11349
Treated	1605	1608	1608	1607	1572	1609
Control	9718	9738	9737	9736	9605	9740

Standard errors in parentheses.
$^{+}$ Ear infections at the age of 3 years, hearing problems at the age of 5, 7, and 11 years.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5 Conclusions

This paper examined the impact of maternal postpartum depression on child's health development. Poor health experienced in childhood has been associated with poorer health, adverse educational and labour market outcomes in adulthood. In our analysis, we used data from the Millennium Cohort Study and we wanted to investigate whether maternal postpartum depression had an impact on early child health development before child enter in primary school and as s/he grows up. In detail, we assessed the effects of maternal postpartum depression on health child's outcomes, and on the number of injuries or accidents occurred at the child, for which s/he was taken to the hospital at ages of 3, 5, 7 and 11 years. Our estimation results show a non-negligible impact of maternal

postpartum depression on those child health issues advanced by a stressful environment, as wheezing and hay fever throughout childhood. At later ages (7 and 11 years), children with a mother who experienced postpartum depression are more likely to suffer from asthma. Moreover, the results indicate a significant strong effect of maternal postpartum depression on the accident rate at the ages of 3 and 5 years (the incidence-rate ratio is of 1.193 and 1.280 respectively). Findings suggest a link between maternal postpartum depression and children's health, where maternal depression may contribute in the transmission of health inequalities through generations. We could successfully test our results on child health outcomes through placebo test. Eventually, findings about child health outcomes and number of accidents hold up using propensity score matching method.

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Appendix A

Table 6: Descriptive Statistics - S2 sample

	mean	sd	p50	min	max	count
Psychological distress (Malaise Inventory)	0.14	0.35	0.00	0	1	12048
Missing values in Mal. Inventory	0.00	0.06	0.00	0	1	12048
Residual maternal distress S2	-0.04	3.41	-0.67	-7	21	12048
Age of CM at S2 (days)	1143.92	72.03	1121.00	969	1651	12048
Male	0.51	0.50	1.00	0	1	12048
Cohort Member Ethnic Group: White	0.90	0.30	1.00	0	1	12048
Cohort Member Ethnic Group: Mixed	0.03	0.16	0.00	0	1	12048
Cohort Member Ethnic Group: Indian	0.02	0.13	0.00	0	1	12048
Cohort Member Ethnic Group: Pakistani and Bangladeshi	0.03	0.17	0.00	0	1	12048
Cohort Member Ethnic Group: Black or Black British	0.02	0.14	0.00	0	1	12048
Cohort Member Ethnic Group: Other (inc Chinese)	0.01	0.08	0.00	0	1	12048
Birth weight	3.39	0.57	3.40	1	7	12048
Born under-weight	0.06	0.23	0.00	0	1	12048
Preterm babies (below 32 weeks)	0.03	0.16	0.00	0	1	12048
Siblings living in HH S1	0.58	0.49	1.00	0	1	12048
Mother with Postpartum depression and more than one child	0.09	0.28	0.00	0	1	12048
Age mother below 30 years at CM's birth	0.51	0.50	1.00	0	1	12048
Age mother left education	17.72	2.48	17.00	9	35	12048
Mother worked during pregnancy	0.70	0.46	1.00	0	1	12048
Ante-natal classes	0.38	0.48	0.00	0	1	12048
Mother smoked during pregnancy	0.22	0.41	0.00	0	1	12048
Mother drank alcohol when pregnant	0.33	0.47	0.00	0	1	12048
Mother had problems during pregnancy	0.39	0.49	0.00	0	1	12048
Mother: longstanding illness, disability or infirmity	0.22	0.41	0.00	0	1	12048
Mother suffers from asthma (S1)	0.17	0.37	0.00	0	1	12048
Breastfeeding less than 6 months	0.42	0.49	0.00	0	1	12048
Breastfeeding more than 6 months	0.23	0.42	0.00	0	1	12048
Delay in breathing at birth or difficulties in first week	0.08	0.26	0.00	0	1	12048
Jaundice requiring hospital treatment in first week	0.07	0.26	0.00	0	1	12048
Infection or suspected infection in first week	0.04	0.19	0.00	0	1	12048
Breech birth - feet first during labour	0.03	0.16	0.00	0	1	12048
Other abnormal lie eg shoulder first during labour	0.03	0.18	0.00	0	1	12048
Very long labour	0.07	0.26	0.00	0	1	12048
Very rapid labour	0.03	0.16	0.00	0	1	12048
Fetal distress during labour	0.16	0.37	0.00	0	1	12048
Caesarian delivery	0.22	0.41	0.00	0	1	12048
S1 Wheezing or asthma at 9 months	0.07	0.25	0.00	0	1	12048
S1 Skin problems at 9 months (incl. eczema)	0.20	0.40	0.00	0	1	12048
S1 Other breathing problems at 9 months	0.01	0.09	0.00	0	1	12048
No one else present at birth	0.04	0.20	0.00	0	1	12048
Natural father present in household (S1)	0.85	0.35	1.00	0	1	12048
Ln of predicted equivalised weekly net family income	5.85	0.72	5.94	3	7	12048
Maternal Grandmother is alive (S1)	0.93	0.25	1.00	0	1	12048
Maternal Grandfather is alive (S1)	0.85	0.36	1.00	0	1	12048
Pollution, environmental problems (S1)	0.21	0.41	0.00	0	1	12048
S2 Whether CM had wheezing/whistling in last 12 months	0.20	0.40	0.00	0	1	12048
S2 Whether CM ever had asthma	0.12	0.33	0.00	0	1	11850
S2 Whether CM ever had hay fever/eczema	0.37	0.48	0.00	0	1	11949
S2 Whether CM had recurring ear infections	0.07	0.25	0.00	0	1	12032
Number of accidents S2 (<= 4)	0.47	0.72	0.00	0	4	12004
S2 England - Advantaged	0.30	0.46	0.00	0	1	12048
S2 England - Disadvantaged	0.24	0.42	0.00	0	1	12048
S2 England - Ethnic	0.07	0.26	0.00	0	1	12048
S2 Wales - Advantaged	0.05	0.22	0.00	0	1	12048
S2 Wales - Disadvantaged	0.11	0.32	0.00	0	1	12048
S2 Scotland - Advantaged	0.07	0.25	0.00	0	1	12048
S2 Scotland - Disadvantaged	0.06	0.24	0.00	0	1	12048
S2 Northern Ireland - Advantaged	0.04	0.20	0.00	0	1	12048
S2 Northern Ireland - Disadvantaged	0.06	0.24	0.00	0	1	12048

Table 7: Descriptive Statistics - S3 sample

	mean	sd	p50	min	max	count
Psychological distress (Malaise Inventory)	0.14	0.35	0.00	0	1	12396
Missing values in Mal. Inventory	0.00	0.06	0.00	0	1	12396
Residual maternal distress S3	-0.04	3.56	-0.64	-6	21	12396
Age of CM at S3 (days)	1904.95	90.63	1902.00	1608	2238	12396
Male	0.51	0.50	1.00	0	1	12396
Cohort Member Ethnic Group: White	0.89	0.31	1.00	0	1	12396
Cohort Member Ethnic Group: Mixed	0.03	0.16	0.00	0	1	12396
Cohort Member Ethnic Group: Indian	0.02	0.14	0.00	0	1	12396
Cohort Member Ethnic Group: Pakistani and Bangladeshi	0.03	0.18	0.00	0	1	12396
Cohort Member Ethnic Group: Black or Black British	0.02	0.15	0.00	0	1	12396
Cohort Member Ethnic Group: Other (inc Chinese)	0.01	0.09	0.00	0	1	12396
Birth weight	3.38	0.57	3.40	1	7	12396
Born under-weight	0.06	0.23	0.00	0	1	12396
Preterm babies (below 32 weeks)	0.03	0.16	0.00	0	1	12396
Siblings living in household (S1)	0.57	0.49	1.00	0	1	12396
Mother with Postpartum depression and more than one child	0.09	0.28	0.00	0	1	12396
Age mother below 30 years at CM's birth	0.52	0.50	1.00	0	1	12396
Age mother left education	17.73	2.49	17.00	1	35	12396
Mother worked during pregnancy	0.69	0.46	1.00	0	1	12396
Ante-natal classes	0.38	0.49	0.00	0	1	12396
Mother smoked during pregnancy	0.22	0.41	0.00	0	1	12396
Mother drank alcohol when pregnant	0.32	0.47	0.00	0	1	12396
Mother had problems during pregnancy	0.39	0.49	0.00	0	1	12396
Mother: longstanding illness, disability or infirmity	0.22	0.41	0.00	0	1	12396
Mother suffers from asthma	0.17	0.37	0.00	0	1	12396
Breastfeeding less than 6 months	0.42	0.49	0.00	0	1	12396
Breastfeeding more than 6 months	0.23	0.42	0.00	0	1	12396
Delay in breathing at birth or difficulties in first week	0.07	0.26	0.00	0	1	12396
Jaundice requiring hospital treatment in first week	0.07	0.26	0.00	0	1	12396
Infection or suspected infection in first week	0.04	0.19	0.00	0	1	12396
Breech birth - feet first during labour	0.02	0.15	0.00	0	1	12396
Other abnormal lie eg shoulder first during labour	0.03	0.18	0.00	0	1	12396
Very long labour	0.07	0.26	0.00	0	1	12396
Very rapid labour	0.03	0.16	0.00	0	1	12396
Fetal distress during labour	0.16	0.36	0.00	0	1	12396
Caesarian delivery	0.21	0.41	0.00	0	1	12396
S1 Wheezing or asthma at 9 months	0.07	0.25	0.00	0	1	12396
S1 Skin problems at 9 months (incl. eczema)	0.20	0.40	0.00	0	1	12396
S1 Other breathing problems at 9 months	0.01	0.08	0.00	0	1	12396
No one else present at birth	0.04	0.20	0.00	0	1	12396
Natural father present in household (S1)	0.85	0.35	1.00	0	1	12396
Ln of predicted equivalised weekly net family income	5.83	0.72	5.93	3	7	12396
Maternal Grandmother is alive (S1)	0.93	0.25	1.00	0	1	12396
Maternal Grandfather is alive (S1)	0.85	0.36	1.00	0	1	12396
Pollution, environmental problems (S1)	0.21	0.41	0.00	0	1	12396
S3 Whether CM had wheezing in last 12 months	0.16	0.37	0.00	0	1	12396
S3 Whether CM ever had asthma	0.15	0.36	0.00	0	1	12351
S3 Whether CM ever had hay fever	0.11	0.31	0.00	0	1	12334
S3 Whether CM ever had eczema	0.35	0.48	0.00	0	1	12389
S3 Whether CM ever had hearing problems	0.13	0.33	0.00	0	1	12381
Number of accidents S3 (<= 4)	0.35	0.63	0.00	0	4	12344
S3 England	0.60	0.49	1.00	0	1	12396
S3 Northern Ireland	0.11	0.31	0.00	0	1	12396
S3 Scotland	0.13	0.34	0.00	0	1	12396
S3 Wales	0.16	0.36	0.00	0	1	12396

Table 8: Descriptive Statistics - S4 sample

	mean	sd	p50	min	max	count
Psychological distress (Malaise Inventory)	0.14	0.35	0.00	0	1	11335
Missing values in Mal. Inventory	0.00	0.06	0.00	0	1	11335
Residual maternal distress S4	-0.03	3.57	-0.58	-6	21	11335
Age of CM at S4 (months)	86.78	3.00	86.70	76	101	11335
Male	0.51	0.50	1.00	0	1	11335
Cohort Member Ethnic Group: White	0.89	0.32	1.00	0	1	11335
Cohort Member Ethnic Group: Mixed	0.02	0.16	0.00	0	1	11335
Cohort Member Ethnic Group: Indian	0.02	0.14	0.00	0	1	11335
Cohort Member Ethnic Group: Pakistani and Bangladeshi	0.04	0.19	0.00	0	1	11335
Cohort Member Ethnic Group: Black or Black British	0.02	0.15	0.00	0	1	11335
Cohort Member Ethnic Group: Other (inc Chinese)	0.01	0.09	0.00	0	1	11335
Birth weight	3.39	0.56	3.40	1	7	11335
Born under-weight	0.06	0.23	0.00	0	1	11335
Preterm babies (below 32 weeks)	0.03	0.16	0.00	0	1	11335
Siblings living in household (S1)	0.57	0.49	1.00	0	1	11335
Mother with Postpartum depression and more than one child	0.09	0.28	0.00	0	1	11335
Age mother below 30 years at CM's birth	0.51	0.50	1.00	0	1	11335
Age mother left education	17.78	2.51	17.00	9	34	11335
Mother worked during pregnancy	0.70	0.46	1.00	0	1	11335
Ante-natal classes	0.38	0.49	0.00	0	1	11335
Mother smoked during pregnancy	0.21	0.41	0.00	0	1	11335
Mother drank alcohol when pregnant	0.32	0.47	0.00	0	1	11335
Mother had problems during pregnancy	0.39	0.49	0.00	0	1	11335
Mother: longstanding illness, disability or infirmity	0.22	0.41	0.00	0	1	11335
Mother suffers from asthma	0.16	0.37	0.00	0	1	11335
Breastfeeding less than 6 months	0.41	0.49	0.00	0	1	11335
Breastfeeding more than 6 months	0.23	0.42	0.00	0	1	11335
Delay in breathing at birth or difficulties in first week	0.07	0.26	0.00	0	1	11335
Jaundice requiring hospital treatment in first week	0.07	0.26	0.00	0	1	11335
Infection or suspected infection in first week	0.04	0.19	0.00	0	1	11335
Breech birth - feet first during labour	0.02	0.15	0.00	0	1	11335
Other abnormal lie eg shoulder first during labour	0.03	0.18	0.00	0	1	11335
Very long labour	0.07	0.26	0.00	0	1	11335
Very rapid labour	0.03	0.16	0.00	0	1	11335
Fetal distress during labour	0.16	0.36	0.00	0	1	11335
Caesarian delivery	0.22	0.41	0.00	0	1	11335
S1 Wheezing or asthma at 9 months	0.06	0.25	0.00	0	1	11335
S1 Skin problems at 9 months (incl. eczema)	0.20	0.40	0.00	0	1	11335
S1 Other breathing problems at 9 months	0.01	0.08	0.00	0	1	11335
No one else present at birth	0.04	0.20	0.00	0	1	11335
Natural father present in household (S1)	0.86	0.35	1.00	0	1	11335
Ln of predicted equivalised weekly net family income	5.85	0.72	5.94	3	7	11335
Maternal Grandmother is alive (S1)	0.93	0.25	1.00	0	1	11335
Maternal Grandfather is alive (S1)	0.84	0.36	1.00	0	1	11335
Pollution, environmental problems (S1)	0.21	0.41	0.00	0	1	11335
S4 Whether CM had wheezing in last 12 months	0.12	0.33	0.00	0	1	11335
S4 Whether CM ever had asthma	0.17	0.37	0.00	0	1	11308
S4 Whether CM ever had hay fever	0.15	0.36	0.00	0	1	11285
S4 Whether CM ever had eczema	0.35	0.48	0.00	0	1	11329
S4 Whether CM ever had hearing problems	0.12	0.33	0.00	0	1	11331
Number of accidents S4 (<= 4)	0.29	0.58	0.00	0	4	11305
S4 England	0.61	0.49	1.00	0	1	11335
S4 Wales	0.16	0.36	0.00	0	1	11335
S4 Scotland	0.13	0.33	0.00	0	1	11335
S4 Northern Ireland	0.11	0.31	0.00	0	1	11335

Table 9: Descriptive Statistics - S5 sample

	mean	sd	p50	min	max	count
Psychological distress (Malaise Inventory)	0.14	0.34	0.00	0	1	10571
Missing values in Mal. Inventory	0.00	0.06	0.00	0	1	10571
Residual maternal distress S5	-0.06	4.12	-1.48	-7	21	10571
Age of CM at S5 (years)	10.92	1.59	11.08	-1	12	10571
Male	0.50	0.50	1.00	0	1	10571
Cohort Member Ethnic Group: White	0.88	0.33	1.00	0	1	10571
Cohort Member Ethnic Group: Mixed	0.03	0.16	0.00	0	1	10571
Cohort Member Ethnic Group: Indian	0.02	0.14	0.00	0	1	10571
Cohort Member Ethnic Group: Pakistani and Bangladeshi	0.04	0.20	0.00	0	1	10571
Cohort Member Ethnic Group: Black or Black British	0.02	0.15	0.00	0	1	10571
Cohort Member Ethnic Group: Other (inc Chinese)	0.01	0.09	0.00	0	1	10571
Birth weight	3.39	0.57	3.40	1	7	10571
Born under-weight	0.06	0.23	0.00	0	1	10571
Preterm babies (below 32 weeks)	0.03	0.16	0.00	0	1	10571
Siblings living in household (S1)	0.57	0.49	1.00	0	1	10571
Mothers with Postpartum depression and more than one child	0.08	0.28	0.00	0	1	10571
Age mother below 30 years at CM's birth	0.51	0.50	1.00	0	1	10571
Age mother left education	17.83	2.53	17.00	8	32	10571
Mother worked during pregnancy	0.70	0.46	1.00	0	1	10571
Ante-natal classes	0.39	0.49	0.00	0	1	10571
Mother smoked during pregnancy	0.20	0.40	0.00	0	1	10571
Mother drank alcohol when pregnant	0.32	0.47	0.00	0	1	10571
Mother had problems during pregnancy	0.39	0.49	0.00	0	1	10571
Mother: longstanding illness, disability or infirmity	0.22	0.41	0.00	0	1	10571
Mother suffers from asthma	0.16	0.37	0.00	0	1	10571
Breastfeeding less than 6 months	0.42	0.49	0.00	0	1	10571
Breastfeeding more than 6 months	0.24	0.43	0.00	0	1	10571
Delay in breathing at birth or difficulties in first week	0.07	0.26	0.00	0	1	10571
Jaundice requiring hospital treatment in first week	0.07	0.25	0.00	0	1	10571
Infection or suspected infection in first week	0.04	0.19	0.00	0	1	10571
Breech birth - feet first during labour	0.02	0.15	0.00	0	1	10571
Other abnormal lie eg shoulder first during labour	0.03	0.18	0.00	0	1	10571
Very long labour	0.07	0.26	0.00	0	1	10571
Very rapid labour	0.03	0.16	0.00	0	1	10571
Fetal distress during labour	0.16	0.36	0.00	0	1	10571
Caesarian delivery	0.22	0.41	0.00	0	1	10571
S1 Wheezing or asthma at 9 months	0.07	0.25	0.00	0	1	10571
S1 Skin problems at 9 months (incl. eczema)	0.20	0.40	0.00	0	1	10571
S1 Other breathing problems at 9 months	0.01	0.08	0.00	0	1	10571
No one else present at birth	0.04	0.20	0.00	0	1	10571
Natural father present in household (S1)	0.86	0.35	1.00	0	1	10571
Ln of predicted equivalised weekly net family income	5.86	0.72	5.95	3	7	10571
Maternal Grandmother is alive (S1)	0.93	0.25	1.00	0	1	10571
Maternal Grandfather is alive (S1)	0.84	0.36	1.00	0	1	10571
Pollution, environmental problems (S1)	0.22	0.41	0.00	0	1	10571
S5 Whether CM had wheezing in last 12 months	0.22	0.41	0.00	0	1	10571
S5 Whether CM ever had asthma	0.18	0.39	0.00	0	1	10567
S5 Whether CM ever had hay fever	0.25	0.44	0.00	0	1	10564
S5 Whether CM ever had eczema	0.32	0.47	0.00	0	1	10567
S5 Whether CM ever had hearing problems	0.08	0.27	0.00	0	1	10570
Number of accidents S5 (<= 4)	0.52	0.80	0.00	0	4	10441
S5 England	0.62	0.49	1.00	0	1	10571
S5 Wales	0.15	0.36	0.00	0	1	10571
S5 Scotland	0.12	0.33	0.00	0	1	10571
S5 Northern Ireland	0.11	0.31	0.00	0	1	10571

Appendix B

Table 10: Marginal effects on wheezing (age 3)

	Wheezing
Postpartum depression	0.0597***
	(0.0215)
Missing values in Mal. inventory	0.143
	(0.0898)
Male	0.0357***
	(0.00836)
Age of CM at S2 (days)	-0.0000443
	(0.0000615)
Mixed ethnic group	0.0314
	(0.0282)
Indian ethnic group	-0.0000415
	(0.0380)
Pakistani and Bangladeshi ethnic group	0.0263
	(0.0294)
Black or Black British ethnic group	-0.0142
	(0.0295)
Other ethnic group (inc Chinese)	-0.135***
	(0.0216)
Birth weight	-0.0131
	(0.00843)
Preterm babies (below 32 weeks)	0.0179
	(0.0284)
Siblings living in household (S1)	0.0363***
	(0.0117)
Interaction Postpartum depression and siblings	-0.0622***
	(0.0178)
Age mother below 30 years	0.00439
	(0.00971)
Age mother left education	0.00195
	(0.00199)
Mother worked during pregnancy	-0.00412
	(0.0102)

Attended ante-natal classes	0.00402
	(0.0108)
Mother smoked during pregnancy	0.00307
	(0.0110)
Mother drank alcohol when pregnant	-0.00429
	(0.00895)
Mother had problems during pregnancy	0.0280***
	(0.00866)
Mother: longstanding illness, disability or infirmity	0.0248**
	(0.0107)
Mother suffers from asthma	0.0990***
	(0.0130)
Breastfeeding less than 6 months	-0.0215**
	(0.00976)
Breastfeeding more than 6 months	-0.0456***
	(0.0116)
Delay in breathing at birth or difficulties in first week	0.0555***
	(0.0173)
Jaundice requiring hospital treatment in first week	0.0418**
	(0.0173)
Infection or suspected infection in first week	-0.00619
	(0.0198)
Breech birth - feet first during labour	-0.0293
	(0.0240)
Other abnormal lie eg shoulder first during labour	0.00902
	(0.0232)
Very long labour	0.0278
	(0.0176)
Very rapid labour	0.00614
	(0.0245)
Fetal distress during labour	0.0260**
	(0.0120)
Caesarian delivery	0.0304***
	(0.0110)
Wheezing or asthma at 9 months	0.171***
	(0.0208)
Skin problems at 9 months	0.0266**
	(0.0108)

Other breathing problems at 9 months	-0.0319
	(0.0397)
No one else present at birth	0.0189
	(0.0210)
Natural father resident in household (S1)	-0.00340
	(0.0140)
Ln of predicted equivalised weekly net family income	-0.0293***
	(0.00819)
Maternal Grandmother is alive (S1)	0.00930
	(0.0164)
Maternal Granfather is alive (S1)	0.0133
	(0.0115)
Pollution, environmental problems (S1)	0.00959
	(0.0102)
K6S2 residuals	0.00469***
	(0.00117)
Observations	12048

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 11: Marginal effects on wheezing (age 5)

	Wheezing
Postpartum depression	0.0440**
	(0.0187)
Missing values in Mal. inventory	0.0438
	(0.0661)
Male	0.0400***
	(0.00749)
Age of CM at S3 (days)	-0.000101**
	(0.0000410)
Mixed ethnic group	0.0195
	(0.0236)
Indian ethnic group	0.0514
	(0.0324)
Pakistani and Bangladeshi ethnic group	0.0336
	(0.0241)
Black or Black British ethnic group	-0.0272
	(0.0237)
Other ethnic group (inc Chinese)	-0.0420
	(0.0374)
Birth_weight	-0.0107
	(0.00765)
Preterm babies (below 32 weeks)	0.0181
	(0.0250)
Siblings living in household (S1)	0.00787
	(0.0107)
Interaction Postpartum depression and siblings	-0.0195
	(0.0184)
Age mother below 30 years	-0.00849
	(0.00863)
Age mother left education	-0.00125
	(0.00178)
Mother worked during pregnancy	0.0108
	(0.00884)
Attended ante-natal classes	-0.00949
	(0.00947)

Mother smoked during pregnancy	0.00873
	(0.0100)
Mother drank alcohol when pregnant	-0.0104
	(0.00802)
Mother had problems during pregnancy	0.0169**
	(0.00778)
Mother: longstanding illness, disability or infirmity	0.0349***
	(0.00986)
Mother suffers from asthma	0.0665***
	(0.0114)
Breastfeeding less than 6 months	-0.00287
	(0.00893)
Breastfeeding more than 6 months	-0.0164
	(0.0108)
Delay in breathing at birth or difficulties in first week	0.0547***
	(0.0162)
Jaundice requiring hospital treatment in first week	0.0126
	(0.0143)
Infection or suspected infection in first week	0.0234
	(0.0193)
Breech birth - feet first during labour	0.0307
	(0.0274)
Other abnormal lie eg shoulder first during labour	-0.0181
	(0.0196)
Very long labour	0.0209
	(0.0156)
Very rapid labour	0.00762
	(0.0222)
Fetal distress during labour	-0.000318
	(0.0105)
Caesarian delivery	0.0209**
	(0.0101)
Wheezing or asthma at 9 months	0.0787***
	(0.0168)
Skin problems at 9 months	0.0458***
	(0.0102)
Other breathing problems at 9 months	-0.0225
	(0.0366)

No one else present at birth	-0.00777
	(0.0172)
Natural father resident in household (S1)	-0.0336**
	(0.0142)
Ln of predicted equivalised weekly net family income	-0.0156**
	(0.00736)
Maternal Grandmother is alive (S1)	0.0190
	(0.0138)
Maternal Granfather is alive (S1)	-0.00154
	(0.0105)
Pollution, environmental problems (S1)	0.0215**
	(0.00928)
K6S3 residuals	0.00276***
	(0.000984)
Observations	12396

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 12: Marginal effects on wheezing (age 7)

	Wheezing
Postpartum depression	0.0285*
	(0.0168)
Missing values in Mal. inventory	0.0518
	(0.0591)
Male	0.0329***
	(0.00685)
Age of CM at S4	0.00115
	(0.00113)
Mixed ethnic group	0.0271
	(0.0231)
Indian ethnic group	0.0551*
	(0.0324)
Pakistani and Bangladeshi ethnic group	0.0189
	(0.0204)
Black or Black British ethnic group	-0.0107
	(0.0220)
Other ethnic group (inc Chinese)	-0.0157
	(0.0375)
Birth weight	-0.00490
	(0.00677)
Preterm babies (below 32 weeks)	0.00623
	(0.0224)
Siblings living in household (S1)	0.00569
	(0.00996)
Interaction Postpartum depression and siblings	-0.0173
	(0.0163)
Age mother below 30 years	-0.0182**
	(0.00772)
Age mother left education	-0.000378
	(0.00159)
Mother worked during pregnancy	-0.00635
	(0.00871)
Attended ante-natal classes	0.000786
	(0.00892)

Mother smoked during pregnancy	0.00717
	(0.00920)
Mother drank alcohol when pregnant	-0.00990
	(0.00723)
Mother had problems during pregnancy	0.00432
	(0.00695)
Mother: longstanding illness, disability or infirmity	0.0296***
	(0.00894)
Mother suffers from asthma	0.0685***
	(0.0111)
Breastfeeding less than 6 months	-0.00937
	(0.00815)
Breastfeeding more than 6 months	-0.0160*
	(0.00959)
Delay in breathing at birth or difficulties in first week	0.0331**
	(0.0145)
Jaundice requiring hospital treatment in first week	0.0222
	(0.0136)
Infection or suspected infection in first week	0.0170
	(0.0178)
Breech birth - feet first during labour	-0.0132
	(0.0214)
Other abnormal lie eg shoulder first during labour	-0.00784
	(0.0186)
Very long labour	-0.00341
	(0.0129)
Very rapid labour	-0.0274
	(0.0173)
Fetal distress during labour	0.0197*
	(0.0103)
Caesarian delivery	0.0164*
	(0.00926)
Wheezing or asthma at 9 months	0.0601***
	(0.0163)
Skin problems at 9 months	0.0577***
	(0.00976)
Other breathing problems at 9 months	-0.0251
	(0.0301)

No one else present at birth	0.00380
	(0.0170)
Natural father resident in household (S1)	-0.0196
	(0.0131)
Ln of predicted equivalised weekly net family income	-0.00160
	(0.00689)
Maternal Grandmother is alive (S1)	0.0248**
	(0.0118)
Maternal Granfather is alive (S1)	0.0110
	(0.00902)
Pollution, environmental problems (S1)	0.00389
	(0.00834)
K6S4 residuals	0.00242***
	(0.000893)
Observations	11335

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 13: Marginal effects on wheezing (age 11)

	Wheezing
Postpartum depression	0.0590**
	(0.0239)
Missing values in Mal. inventory	0.0702
	(0.0849)
Male	0.0565***
	(0.00966)
Age of CM at S5	-0.00667**
	(0.00294)
Mixed ethnic group	0.0260
	(0.0305)
Indian ethnic group	-0.0145
	(0.0438)
Pakistani and Bangladeshi ethnic group	-0.0175
	(0.0234)
Black or Black British ethnic group	-0.0398
	(0.0321)
Other ethnic group (inc Chinese)	-0.0987**
	(0.0416)
Birth weight	0.00000811
	(0.00979)
Preterm babies (below 32 weeks)	0.0370
	(0.0337)
Siblings living in the household (S1)	0.00862
	(0.0137)
Interaction Postpartum depression and siblings	-0.0287
	(0.0250)
Age mother below 30 years	-0.0174
	(0.0113)
Age mother left education	0.00306
	(0.00215)
Mother worked during pregnancy	-0.00758
	(0.0121)
Attended ante-natal classes	0.0111
	(0.0123)

Mother smoked during pregnancy	0.0117
	(0.0133)
Mother drank alcohol when pregnant	-0.00187
	(0.0104)
Mother had problems during pregnancy	0.0224**
	(0.0101)
Mother: longstanding illness, disability or infirmity	0.0330***
	(0.0125)
Mother suffers from asthma	0.112***
	(0.0150)
Breastfeeding less than 6 months	-0.00344
	(0.0118)
Breastfeeding more than 6 months	-0.0111
	(0.0139)
Delay in breathing at birth or difficulties in first week	0.0883***
	(0.0206)
Jaundice requiring hospital treatment in first week	0.00177
	(0.0192)
Infection or suspected infection in first week	0.0176
	(0.0249)
Breech birth - feet first during labour	-0.0411
	(0.0290)
Other abnormal lie eg shoulder first during labour	-0.00527
	(0.0279)
Very long labour	0.0159
	(0.0196)
Very rapid labour	0.0166
	(0.0304)
Fetal distress during labour	0.00196
	(0.0136)
Caesarian delivery	0.0206
	(0.0128)
Wheezing or asthma at 9 months	0.120***
	(0.0231)
Skin problems at 9 months	0.0670***
	(0.0130)
Other breathing problems at 9 months	-0.0164
	(0.0479)

No one else present at birth	0.0478*
	(0.0264)
Natural father resident in household (S1)	0.00143
	(0.0175)
Ln of predicted equivalised weekly net family income	-0.00858
	(0.00960)
Maternal Grandmother is alive (S1)	0.0246
	(0.0189)
Maternal Granfather is alive (S1)	0.0159
	(0.0135)
Pollution, environmental problems (S1)	0.0139
	(0.0121)
Residuals	0.00322***
	(0.00118)
Observations	10571

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 14: Table: Marginal effects on asthma (age 3)

	Asthma
Postpartum depression	0.0118
	(0.0146)
Missing values in Mal. inventory	0.0588
	(0.0725)
Male	0.0277***
	(0.00596)
Age of CM at S2 (days)	0.0000712*
	(0.0000385)
Mixed ethnic group	0.0385*
	(0.0209)
Indian ethnic group	0.0232
	(0.0270)
Pakistani and Bangladeshi ethnic group	-0.0147
	(0.0161)
Black or Black British ethnic group	0.00783
	(0.0243)
Other ethnic group (inc Chinese)	-0.0725***
	(0.0102)
Birth weight	-0.00441
	(0.00582)
Preterm babies (below 32 weeks)	0.0267
	(0.0216)
Siblings living in household (S1)	0.0145*
	(0.00809)
Interaction Postpartum depression and siblings	-0.0106
	(0.0150)
Age mother below 30 years	0.0194***
	(0.00681)
Age mother left education	-0.00156
	(0.00145)
Mother worked during pregnancy	-0.00966
	(0.00733)
Attended ante-natal classes	-0.00320
	(0.00756)

Mother smoked during pregnancy	0.00302
	(0.00739)
Mother drank alcohol when pregnant	-0.0152**
	(0.00627)
Mother had problems during pregnancy	0.0168***
	(0.00618)
Mother: longstanding illness, disability or infirmity	0.0107
	(0.00726)
Mother suffers from asthma	0.0915***
	(0.0108)
Breastfeeding less than 6 months	-0.0115*
	(0.00678)
Breastfeeding more than 6 months	-0.0349***
	(0.00776)
Delay in breathing at birth or difficulties in first week	0.0333**
	(0.0133)
Jaundice requiring hospital treatment in first week	0.0217*
	(0.0128)
Infection or suspected infection in first week	0.00383
	(0.0140)
Breech birth - feet first during labour	-0.00964
	(0.0179)
Other abnormal lie eg shoulder first during labour	-0.00852
	(0.0152)
Very long labour	0.00864
	(0.0116)
Very rapid labour	-0.00521
	(0.0162)
Fetal distress during labour	0.0199**
	(0.00895)
Caesarian delivery	0.0150*
	(0.00805)
Wheezing or asthma at 9 months	0.284***
	(0.0215)
Skin problems at 9 months	0.0274***
	(0.00808)
Other breathing problems at 9 months	-0.0274
	(0.0240)

No one else present at birth	-0.0116
	(0.0127)
Natural father resident in household (S1)	-0.0298***
	(0.0113)
Ln of predicted equivalised weekly net family income	-0.0102*
	(0.00585)
Maternal Grandmother is alive (S1)	0.00499
	(0.0113)
Maternal Granfather is alive (S1)	-0.0159*
	(0.00905)
Pollution, environmental problems (S1)	0.000681
	(0.00710)
K6S2 residuals	0.0000753
	(0.000795)
Observations	11850

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 15: Marginal effects on asthma (age 5)

	Asthma
Postpartum depression	0.0101
	(0.0160)
Missing values in Mal. inventory	0.107
	(0.0808)
Male	0.0404***
	(0.00687)
Age of CM at S3 (days)	-0.00000797
	(0.0000371)
Mixed ethnic group	0.0372
	(0.0234)
Indian ethnic group	-0.0100
	(0.0244)
Pakistani and Bangladeshi ethnic group	0.0106
	(0.0204)
Black or Black British ethnic group	0.00922
	(0.0246)
Other ethnic group (inc Chinese)	-0.0420
	(0.0320)
Birth_weight	-0.0197***
	(0.00673)
Preterm babies (below 32 weeks)	0.0285
	(0.0247)
Siblings living in household (S1)	0.00255
	(0.00961)
Interaction Postpartum depression and siblings	-0.00655
	(0.0184)
Age mother below 30 years	0.00662
	(0.00791)
Age mother left education	-0.00192
	(0.00168)
Mother worked during pregnancy	-0.00445
	(0.00844)
Attended ante-natal classes	-0.00308
	(0.00865)

Mother smoked during pregnancy	0.00595
	(0.00876)
Mother drank alcohol when pregnant	-0.0208***
	(0.00726)
Mother had problems during pregnancy	0.0126*
	(0.00713)
Mother: longstanding illness, disability or infirmity	0.0228**
	(0.00890)
Mother suffers from asthma	0.0900***
	(0.0115)
Breastfeeding less than 6 months	-0.0145*
	(0.00792)
Breastfeeding more than 6 months	-0.0386***
	(0.00915)
Delay in breathing at birth or difficulties in first week	0.0449***
	(0.0149)
Jaundice requiring hospital treatment in first week	0.0123
	(0.0137)
Infection or suspected infection in first week	0.00500
	(0.0159)
Breech birth - feet first during labour	-0.00759
	(0.0229)
Other abnormal lie eg shoulder first during labour	-0.00839
	(0.0186)
Very long labour	0.0312**
	(0.0152)
Very rapid labour	-0.0201
	(0.0183)
Fetal distress during labour	0.00663
	(0.00983)
Caesarian delivery	0.0130
	(0.00915)
Wheezing or asthma at 9 months	0.203***
	(0.0201)
Skin problems at 9 months	0.0422***
	(0.00949)
Other breathing problems at 9 months	-0.0203
	(0.0350)

No one else present at birth	-0.000457
	(0.0155)
Natural father resident in household (S1)	-0.0117
	(0.0119)
Ln of predicted equivalised weekly net family income	-0.0197***
	(0.00685)
Maternal Grandmother is alive (S1)	0.0213*
	(0.0124)
Maternal Granfather is alive (S1)	0.00187
	(0.00971)
Pollution, environmental problems (S1)	0.0157*
	(0.00866)
K6S3 residuals	0.00179**
	(0.000907)
Observations	12353

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 16: Marginal effects on asthma (age 7)

	Asthma
Postpartum depression	0.0310*
	(0.0183)
Missing values in Mal. inventory	0.123
	(0.0814)
Male	0.0407***
	(0.00755)
Age of CM at S4	0.000873
	(0.00123)
Mixed ethnic group	0.0509**
	(0.0256)
Indian ethnic group	0.0341
	(0.0319)
Pakistani and Bangladeshi ethnic group	-0.00197
	(0.0216)
Black or Black British ethnic group	-0.0278
	(0.0210)
Other ethnic group (inc Chinese)	-0.0271
	(0.0399)
Birth weight	-0.00996
	(0.00737)
Preterm babies (below 32 weeks)	0.0191
	(0.0265)
Siblings living in household (S1)	-0.00460
	(0.0106)
Interaction Postpartum depression and siblings	-0.0207
	(0.0184)
Age mother below 30 years	0.00435
	(0.00863)
Age mother left education	0.000235
	(0.00175)
Mother worked during pregnancy	-0.00286
	(0.00939)
Attended ante-natal classes	-0.00931
	(0.00951)

Mother smoked during pregnancy	0.00998
	(0.00998)
Mother drank alcohol when pregnant	-0.0194**
	(0.00801)
Mother had problems during pregnancy	0.0253***
	(0.00785)
Mother: longstanding illness, disability or infirmity	0.0260***
	(0.00972)
Mother suffers from asthma	0.105***
	(0.0129)
Breastfeeding less than 6 months	-0.0116
	(0.00885)
Breastfeeding more than 6 months	-0.0396***
	(0.0102)
Delay in breathing at birth or difficulties in first week	0.0278*
	(0.0156)
Jaundice requiring hospital treatment in first week	0.0172
	(0.0150)
Infection or suspected infection in first week	0.0211
	(0.0187)
Breech birth - feet first during labour	-0.0224
	(0.0243)
Other abnormal lie eg shoulder first during labour	0.00738
	(0.0214)
Very long labour	0.0126
	(0.0154)
Very rapid labour	-0.0126
	(0.0216)
Fetal distress during labour	0.00477
	(0.0108)
Caesarian delivery	0.0202**
	(0.0103)
Wheezing or asthma at 9 months	0.221***
	(0.0221)
Skin problems at 9 months	0.0591***
	(0.0106)
Other breathing problems at 9 months	-0.00675
	(0.0384)

No one else present at birth	0.00340
	(0.0182)
Natural father resident in household (S1)	-0.0328**
	(0.0143)
Ln of predicted equivalised weekly net family income	-0.0166**
	(0.00743)
Maternal Grandmother is alive (S1)	0.0178
	(0.0142)
Maternal Granfather is alive (S1)	0.00405
	(0.0104)
Pollution, environmental problems (S1)	0.0236**
	(0.00966)
K6S4 residuals	0.0000888
	(0.00104)
Observations	11309

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 17: Marginal effects on asthma (age 11)

	Asthma
Postpartum depression	0.0505**
	(0.0220)
Missing values in Mal. inventory	0.0911
	(0.0872)
Male	0.0377***
	(0.00894)
Age of CM at S5	-0.00231
	(0.00287)
Mixed ethnic group	0.0708**
	(0.0304)
Indian ethnic group	0.0528
	(0.0396)
Pakistani and Bangladeshi ethnic group	0.00765
	(0.0229)
Black or Black British ethnic group	-0.0474*
	(0.0271)
Other ethnic group (inc Chinese)	-0.0285
	(0.0481)
Birth weight	-0.000992
	(0.00935)
Preterm babies (below 32 weeks)	0.0860**
	(0.0361)
Siblings living in the household (S1)	0.00597
	(0.0121)
Interaction Postpartum depression and siblings	-0.0207
	(0.0225)
Age mother below 30 years	-0.0112
	(0.0103)
Age mother left education	0.000419
	(0.00196)
Mother worked during pregnancy	-0.00233
	(0.0110)
Attended ante-natal classes	0.0104
	(0.0110)

Mother smoked during pregnancy	-0.00447
	(0.0120)
Mother drank alcohol when pregnant	-0.00621
	(0.00948)
Mother had problems during pregnancy	0.0152*
	(0.00919)
Mother: longstanding illness, disability or infirmity	0.0381***
	(0.0117)
Mother suffers from asthma	0.107***
	(0.0143)
Breastfeeding less than 6 months	-0.00718
	(0.0105)
Breastfeeding more than 6 months	-0.0327***
	(0.0120)
Delay in breathing at birth or difficulties in first week	0.0429**
	(0.0183)
Jaundice requiring hospital treatment in first week	-0.0276*
	(0.0152)
Infection or suspected infection in first week	0.0408
	(0.0253)
Breech birth - feet first during labour	-0.0200
	(0.0277)
Other abnormal lie eg shoulder first during labour	0.0182
	(0.0270)
Very long labour	0.0161
	(0.0181)
Very rapid labour	-0.0270
	(0.0240)
Fetal distress during labour	0.0141
	(0.0125)
Caesarian delivery	0.0173
	(0.0117)
Wheezing or asthma at 9 months	0.153***
	(0.0220)
Skin problems at 9 months	0.0723***
	(0.0122)
Other breathing problems at 9 months	-0.00615
	(0.0472)

No one else present at birth	0.0587**
	(0.0247)
Natural father resident in household (S1)	-0.0178
	(0.0166)
Ln of predicted equivalised weekly net family income	-0.0154*
	(0.00886)
Maternal Grandmother is alive (S1)	0.0203
	(0.0165)
Maternal Granfather is alive (S1)	0.0114
	(0.0121)
Pollution, environmental problems (S1)	0.0121
	(0.0112)
Residuals	0.00120
	(0.00107)
Observations	10588

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 18: Marginal effects on hay fever or eczema (age 3)

	Hay fever/eczema
Postpartum depression	0.0616**
	(0.0272)
Missing values in Mal. inventory	0.100
	(0.0985)
Male	0.00749
	(0.0111)
Age of CM at S2 (days)	-0.000187**
	(0.0000779)
Mixed ethnic group	0.00126
	(0.0333)
Indian ethnic group	-0.0132
	(0.0450)
Pakistani and Bangladeshi ethnic group	-0.116***
	(0.0309)
Black or Black British ethnic group	0.0135
	(0.0408)
Other ethnic group (inc Chinese)	0.0531
	(0.0650)
Birth weight	0.0366***
	(0.0111)
Preterm babies (below 32 weeks)	0.0118
	(0.0397)
Siblings living in household (S1)	0.000696
	(0.0155)
Interaction Postpartum depression and siblings	-0.0342
	(0.0321)
Age mother below 30 years	0.0270**
	(0.0126)
Age mother left education	0.000871
	(0.00251)
Mother worked during pregnancy	-0.00646
	(0.0137)
Attended ante-natal classes	0.0172
	(0.0142)

Mother smoked during pregnancy	-0.0225
	(0.0149)
Mother drank alcohol when pregnant	-0.0181
	(0.0118)
Mother had problems during pregnancy	0.0105
	(0.0115)
Mother: longstanding illness, disability or infirmity	0.0392***
	(0.0143)
Mother suffers from asthma	0.0652***
	(0.0156)
Breastfeeding less than 6 months	-0.0108
	(0.0135)
Breastfeeding more than 6 months	-0.000668
	(0.0162)
Delay in breathing at birth or difficulties in first week	0.0209
	(0.0216)
Jaundice requiring hospital treatment in first week	0.00647
	(0.0220)
Infection or suspected infection in first week	0.0224
	(0.0282)
Breech birth - feet first during labour	0.00963
	(0.0364)
Other abnormal lie eg shoulder first during labour	-0.0128
	(0.0294)
Very long labour	0.0230
	(0.0221)
Very rapid labour	0.0462
	(0.0353)
Fetal distress during labour	0.00450
	(0.0156)
Caesarian delivery	0.0126
	(0.0144)
Wheezing or asthma at 9 months	0.0646***
	(0.0224)
Skin problems at 9 months	0.293***
	(0.0132)
Other breathing problems at 9 months	0.0215
	(0.0651)

No one else present at birth	-0.0172
	(0.0286)
Natural father resident in household (S1)	0.00755
	(0.0199)
Ln of predicted equivalised weekly net family income	0.00185
	(0.0110)
Maternal Grandmother is alive (S1)	0.00593
	(0.0219)
Maternal Granfather is alive (S1)	-0.00365
	(0.0156)
Pollution, environmental problems (S1)	0.00861
	(0.0136)
K6S2 residuals	0.00320*
	(0.00166)
Observations	11949

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 19: Marginal effects on Hay fever (age 5)

	Hay fever
Postpartum depression	0.0367**
	(0.0156)
Missing values in Mal. inventory	0.0707
	(0.0591)
Male	0.0219***
	(0.00605)
Age of CM at S3 (days)	0.0000618*
	(0.0000336)
Mixed ethnic group	0.0625***
	(0.0237)
Indian ethnic group	0.0714**
	(0.0318)
Pakistani and Bangladeshi ethnic group	0.00155
	(0.0174)
Black or Black British ethnic group	0.0841***
	(0.0319)
Other ethnic group (inc Chinese)	0.0965*
	(0.0503)
Birth_weight	0.0000816
	(0.00590)
Preterm babies (below 32 weeks)	0.0175
	(0.0213)
Siblings living in household (S1)	-0.0243***
	(0.00869)
Interaction Postpartum depression and siblings	-0.0247*
	(0.0132)
Age mother below 30 years	0.00696
	(0.00714)
Age mother left education	-0.00200
	(0.00141)
Mother worked during pregnancy	-0.0112
	(0.00798)
Attended ante-natal classes	-0.000349
	(0.00758)

Mother smoked during pregnancy	-0.0241***
	(0.00746)
Mother drank alcohol when pregnant	-0.0122*
	(0.00648)
Mother had problems during pregnancy	0.0108*
	(0.00644)
Mother: longstanding illness, disability or infirmity	0.0132*
	(0.00801)
Mother suffers from asthma	0.0559***
	(0.0101)
Breastfeeding less than 6 months	-0.00480
	(0.00727)
Breastfeeding more than 6 months	-0.0130
	(0.00867)
Delay in breathing at birth or difficulties in first week	0.00916
	(0.0117)
Jaundice requiring hospital treatment in first week	0.00198
	(0.0113)
Infection or suspected infection in first week	0.0112
	(0.0159)
Breech birth - feet first during labour	-0.0218
	(0.0167)
Other abnormal lie eg shoulder first during labour	-0.00983
	(0.0158)
Very long labour	0.00525
	(0.0121)
Very rapid labour	0.0209
	(0.0210)
Fetal distress during labour	0.00452
	(0.00853)
Caesarian delivery	0.0147*
	(0.00821)
Wheezing or asthma at 9 months	0.0184
	(0.0128)
Skin problems at 9 months	0.0393***
	(0.00840)
Other breathing problems at 9 months	0.0603
	(0.0421)

No one else present at birth	0.0327*
	(0.0186)
Natural father resident in household (S1)	-0.0267**
	(0.0129)
Ln of predicted equivalised weekly net family income	0.0101
	(0.00621)
Maternal Grandmother is alive (S1)	0.0259**
	(0.0108)
Maternal Granfather is alive (S1)	0.00516
	(0.00849)
Pollution, environmental problems (S1)	0.0168**
	(0.00780)
K6S3 residuals	0.0000368
	(0.000836)
Observations	12336

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 20: Marginal effects on Hay fever (age 7)

	Hay fever
Postpartum depression	0.0335*
	(0.0193)
Missing values in Mal. inventory	0.0447
	(0.0699)
Male	0.0531***
	(0.00799)
Age of CM at S4	0.00431***
	(0.00131)
Mixed ethnic group	0.123***
	(0.0317)
Indian ethnic group	0.0508
	(0.0336)
Pakistani and Bangladeshi ethnic group	-0.00815
	(0.0215)
Black or Black British ethnic group	0.136***
	(0.0370)
Other ethnic group (inc Chinese)	0.0220
	(0.0480)
Birth weight	-0.0174**
	(0.00787)
Preterm babies (below 32 weeks)	-0.00935
	(0.0250)
Siblings living in household (S1)	-0.0172
	(0.0111)
Interaction Postpartum depression and siblings	-0.0263
	(0.0199)
Age mother below 30 years	-0.000593
	(0.00930)
Age mother left education	-0.000124
	(0.00183)
Mother worked during pregnancy	-0.00694
	(0.0103)
Attended ante-natal classes	0.0182*
	(0.0100)

Mother smoked during pregnancy	-0.0211**
	(0.0105)
Mother drank alcohol when pregnant	-0.00688
	(0.00863)
Mother had problems during pregnancy	0.0114
	(0.00841)
Mother: longstanding illness, disability or infirmity	0.0000154
	(0.0101)
Mother suffers from asthma	0.0591***
	(0.0124)
Breastfeeding less than 6 months	-0.0000614
	(0.00975)
Breastfeeding more than 6 months	-0.0175
	(0.0115)
Delay in breathing at birth or difficulties in first week	0.00560
	(0.0155)
Jaundice requiring hospital treatment in first week	0.00927
	(0.0151)
Infection or suspected infection in first week	0.0280
	(0.0212)
Breech birth - feet first during labour	-0.0187
	(0.0242)
Other abnormal lie eg shoulder first during labour	0.000176
	(0.0225)
Very long labour	0.00759
	(0.0158)
Very rapid labour	0.0113
	(0.0260)
Fetal distress during labour	0.0158
	(0.0114)
Caesarian delivery	0.0141
	(0.0106)
Wheezing or asthma at 9 months	0.0183
	(0.0173)
Skin problems at 9 months	0.0569***
	(0.0107)
Other breathing problems at 9 months	0.0287
	(0.0477)

No one else present at birth	0.0328
	(0.0230)
Natural father resident in household (S1)	-0.0248
	(0.0160)
Ln of predicted equivalised weekly net family income	0.0157*
	(0.00827)
Maternal Grandmother is alive (S1)	0.0289**
	(0.0145)
Maternal Granfather is alive (S1)	-0.00723
	(0.0116)
Pollution, environmental problems (S1)	0.0215**
	(0.0102)
K6S4 residuals	0.000998
	(0.00106)
Observations	11286

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 21: Marginal effects on Hay fever (age 11)

	Hay fever
Postpartum depression	0.0432*
	(0.0251)
Missing values in Mal. inventory	0.0285
	(0.0811)
Male	0.0528***
	(0.0105)
Age of CM at S5	0.000220
	(0.00327)
Mixed ethnic group	0.179***
	(0.0376)
Indian ethnic group	0.136***
	(0.0491)
Pakistani and Bangladeshi ethnic group	0.0366
	(0.0296)
Black or Black British ethnic group	0.140***
	(0.0398)
Other ethnic group (inc Chinese)	-0.0355
	(0.0475)
Birth weight	-0.00724
	(0.0112)
Preterm babies (below 32 weeks)	-0.0132
	(0.0344)
Siblings living in the household (S1)	-0.0113
	(0.0144)
Interaction Postpartum depression and siblings	-0.0357
	(0.0277)
Age mother below 30 years	-0.00841
	(0.0121)
Age mother left education	-0.000414
	(0.00232)
Mother worked during pregnancy	-0.0108
	(0.0135)
Attended ante-natal classes	0.0301**
	(0.0132)

Mother smoked during pregnancy	-0.0326**
	(0.0147)
Mother drank alcohol when pregnant	-0.0112
	(0.0114)
Mother had problems during pregnancy	0.0277**
	(0.0109)
Mother: longstanding illness, disability or infirmity	0.000946
	(0.0134)
Mother suffers from asthma	0.0932***
	(0.0157)
Breastfeeding less than 6 months	-0.0164
	(0.0127)
Breastfeeding more than 6 months	-0.0337**
	(0.0146)
Delay in breathing at birth or difficulties in first week	0.0443**
	(0.0213)
Jaundice requiring hospital treatment in first week	0.00991
	(0.0228)
Infection or suspected infection in first week	0.0209
	(0.0276)
Breech birth - feet first during labour	-0.0125
	(0.0327)
Other abnormal lie eg shoulder first during labour	-0.0340
	(0.0274)
Very long labour	-0.00583
	(0.0199)
Very rapid labour	0.00600
	(0.0307)
Fetal distress during labour	0.0135
	(0.0150)
Caesarian delivery	0.0277**
	(0.0139)
Wheezing or asthma at 9 months	0.00959
	(0.0212)
Skin problems at 9 months	0.0887***
	(0.0141)
Other breathing problems at 9 months	0.0766
	(0.0671)

No one else present at birth	0.0111
	(0.0271)
Natural father resident in household (S1)	0.00235
	(0.0194)
Ln of predicted equivalised weekly net family income	0.0203*
	(0.0105)
Maternal Grandmother is alive (S1)	0.0293
	(0.0200)
Maternal Granfather is alive (S1)	0.00666
	(0.0144)
Pollution, environmental problems (S1)	0.0331**
	(0.0130)
Residuals	0.00324**
	(0.00135)
Observations	10585

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 22: Marginal effects on Eczema (age 5)

	Eczema
Postpartum depression	0.0100
	(0.0257)
Missing values in Mal. inventory	0.105
	(0.0887)
Male	0.0224**
	(0.0108)
Age of CM at S3 (days)	0.0000396
	(0.0000591)
Mixed ethnic group	-0.0248
	(0.0312)
Indian ethnic group	-0.0377
	(0.0399)
Pakistani and Bangladeshi ethnic group	-0.102***
	(0.0288)
Black or Black British ethnic group	0.0475
	(0.0393)
Other ethnic group (inc Chinese)	-0.0430
	(0.0547)
Birth_weight	0.0174
	(0.0109)
Preterm babies (below 32 weeks)	0.0232
	(0.0384)
Siblings living in household (S1)	0.0127
	(0.0149)
Interaction Postpartum depression and siblings	-0.0279
	(0.0316)
Age mother below 30 years	0.0253**
	(0.0123)
Age mother left education	0.00161
	(0.00242)
Mother worked during pregnancy	0.000574
	(0.0134)
Attended ante-natal classes	0.0215
	(0.0138)

Mother smoked during pregnancy	-0.0371**
	(0.0144)
Mother drank alcohol when pregnant	-0.00170
	(0.0116)
Mother had problems during pregnancy	0.0232**
	(0.0112)
Mother: longstanding illness, disability or infirmity	0.0260*
	(0.0138)
Mother suffers from asthma	0.0752***
	(0.0152)
Breastfeeding less than 6 months	0.0121
	(0.0131)
Breastfeeding more than 6 months	0.0460***
	(0.0161)
Delay in breathing at birth or difficulties in first week	0.0346*
	(0.0210)
Jaundice requiring hospital treatment in first week	0.0425*
	(0.0218)
Infection or suspected infection in first week	0.0194
	(0.0269)
Breech birth - feet first during labour	-0.00668
	(0.0355)
Other abnormal lie eg shoulder first during labour	-0.0275
	(0.0287)
Very long labour	0.0271
	(0.0214)
Very rapid labour	-0.0324
	(0.0322)
Fetal distress during labour	-0.0302**
	(0.0148)
Caesarian delivery	0.0266*
	(0.0141)
Wheezing or asthma at 9 months	0.0509**
	(0.0215)
Skin problems at 9 months	0.288***
	(0.0131)
Other breathing problems at 9 months	-0.0146
	(0.0638)

No one else present at birth	0.00286
	(0.0281)
Natural father resident in household (S1)	-0.0103
	(0.0196)
Ln of predicted equivalised weekly net family income	0.0188*
	(0.0108)
Maternal Grandmother is alive (S1)	0.0113
	(0.0210)
Maternal Granfather is alive (S1)	-0.0239
	(0.0155)
Pollution, environmental problems (S1)	0.0234*
	(0.0133)
K6S3 residuals	0.00412***
	(0.00155)
Observations	12391

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 23: Marginal effects on Eczema (age 7)

	Eczema
Postpartum depression	0.0119
	(0.0261)
Missing values in Mal. inventory	0.0534
	(0.0876)
Male	-0.000660
	(0.0113)
Age of CM at S4	0.00510***
	(0.00185)
Mixed ethnic group	0.0185
	(0.0350)
Indian ethnic group	0.00547
	(0.0432)
Pakistani and Bangladeshi ethnic group	-0.0873***
	(0.0309)
Black or Black British ethnic group	0.0517
	(0.0399)
Other ethnic group (inc Chinese)	-0.0306
	(0.0605)
Birth weight	0.0231**
	(0.0114)
Preterm babies (below 32 weeks)	0.00836
	(0.0412)
Siblings living in household (S1)	-0.00417
	(0.0156)
Interaction Postpartum depression and siblings	-0.0457
	(0.0320)
Age mother below 30 years	0.00605
	(0.0128)
Age mother left education	-0.00120
	(0.00250)
Mother worked during pregnancy	0.00404
	(0.0141)
Attended ante-natal classes	0.0230
	(0.0144)

Mother smoked during pregnancy	-0.0189
	(0.0154)
Mother drank alcohol when pregnant	-0.000866
	(0.0121)
Mother had problems during pregnancy	0.0146
	(0.0117)
Mother: longstanding illness, disability or infirmity	0.0362**
	(0.0147)
Mother suffers from asthma	0.0625***
	(0.0160)
Breastfeeding less than 6 months	0.0105
	(0.0138)
Breastfeeding more than 6 months	0.0416**
	(0.0166)
Delay in breathing at birth or difficulties in first week	0.0620***
	(0.0227)
Jaundice requiring hospital treatment in first week	0.0251
	(0.0225)
Infection or suspected infection in first week	0.0356
	(0.0301)
Breech birth - feet first during labour	0.00914
	(0.0383)
Other abnormal lie eg shoulder first during labour	0.0586*
	(0.0316)
Very long labour	0.0203
	(0.0221)
Very rapid labour	-0.0519
	(0.0324)
Fetal distress during labour	-0.0208
	(0.0155)
Caesarian delivery	-0.00461
	(0.0146)
Wheezing or asthma at 9 months	0.0499**
	(0.0231)
Skin problems at 9 months	0.272***
	(0.0137)
Other breathing problems at 9 months	-0.0414
	(0.0666)

No one else present at birth	0.0236
	(0.0304)
Natural father resident in household (S1)	-0.00163
	(0.0210)
Ln of predicted equivalised weekly net family income	0.0223**
	(0.0114)
Maternal Grandmother is alive (S1)	0.0103
	(0.0221)
Maternal Granfather is alive (S1)	-0.00356
	(0.0159)
Pollution, environmental problems (S1)	0.0263*
	(0.0141)
K6S4 residuals	0.00350**
	(0.00160)
Observations	11330

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 24: Marginal effects on Eczema (age 11)

	Eczema
Postpartum depression	0.0431
	(0.0278)
Missing values in Mal. inventory	-0.0100
	(0.0884)
Male	0.00214
	(0.0115)
Age of CM at S5	-0.00494
	(0.00362)
Mixed ethnic group	0.0543
	(0.0374)
Indian ethnic group	-0.0420
	(0.0440)
Pakistani and Bangladeshi ethnic group	-0.103***
	(0.0267)
Black or Black British ethnic group	0.0387
	(0.0407)
Other ethnic group (inc Chinese)	-0.0572
	(0.0556)
Birth weight	-0.00330
	(0.0120)
Preterm babies (below 32 weeks)	-0.0340
	(0.0369)
Siblings living in the household (S1)	0.000164
	(0.0162)
Interaction Postpartum depression and siblings	-0.0518*
	(0.0314)
Age mother below 30 years	-0.00285
	(0.0129)
Age mother left education	0.00358
	(0.00251)
Mother worked during pregnancy	-0.0108
	(0.0146)
Attended ante-natal classes	0.0147
	(0.0145)

Mother smoked during pregnancy	-0.0405**
	(0.0158)
Mother drank alcohol when pregnant	-0.00846
	(0.0123)
Mother had problems during pregnancy	-0.000812
	(0.0118)
Mother: longstanding illness, disability or infirmity	0.0234
	(0.0148)
Mother suffers from asthma	0.0602***
	(0.0162)
Breastfeeding less than 6 months	0.000700
	(0.0141)
Breastfeeding more than 6 months	0.0431**
	(0.0169)
Delay in breathing at birth or difficulties in first week	0.0186
	(0.0220)
Jaundice requiring hospital treatment in first week	-0.00402
	(0.0239)
Infection or suspected infection in first week	-0.000682
	(0.0299)
Breech birth - feet first during labour	-0.00501
	(0.0392)
Other abnormal lie eg shoulder first during labour	-0.0250
	(0.0297)
Very long labour	0.0377
	(0.0229)
Very rapid labour	0.0210
	(0.0342)
Fetal distress during labour	-0.00817
	(0.0161)
Caesarian delivery	0.0147
	(0.0149)
Wheezing or asthma at 9 months	0.0361
	(0.0234)
Skin problems at 9 months	0.221***
	(0.0150)
Other breathing problems at 9 months	0.0644
	(0.0752)

No one else present at birth	0.0445
	(0.0312)
Natural father resident in household (S1)	-0.0128
	(0.0216)
Ln of predicted equivalised weekly net family income	0.0121
	(0.0112)
Maternal Grandmother is alive (S1)	0.0357
	(0.0218)
Maternal Granfather is alive (S1)	-0.0137
	(0.0162)
Pollution, environmental problems (S1)	0.0134
	(0.0143)
Residuals	0.00633***
	(0.00144)
Observations	10588

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 25: Incidence rate ratio on the number of accidents (age 3)

	Number of accidents
Postpartum depression	1.193**
	(0.0864)
Missing values in Mal. inventory	1.247
	(0.358)
Male	1.280***
	(0.0431)
Age of CM at S2 (days)	1.001***
	(0.000203)
Mixed ethnic group	0.809*
	(0.0950)
Indian ethnic group	0.553***
	(0.0981)
Pakistani and Bangladeshi ethnic group	0.810*
	(0.0926)
Black or Black British ethnic group	0.718**
	(0.0966)
Other ethnic group (inc Chinese)	0.722
	(0.197)
Birth_weight	1.095***
	(0.0363)
Preterm babies (below 32 weeks)	0.882
	(0.103)
Siblings living in household (S1)	1.014
	(0.0472)
Interaction Postpartum depression and siblings	0.952
	(0.0883)
Age mother below 30 years	1.157***
	(0.0441)
Age mother left education	0.985*
	(0.00764)
Mother worked during pregnancy	1.009
	(0.0410)
Attended ante-natal classes	1.025
	(0.0430)

Mother smoked during pregnancy	1.038
	(0.0466)
Mother drank alcohol when pregnant	0.935*
	(0.0336)
Mother had problems during pregnancy	1.069**
	(0.0359)
Mother: longstanding illness, disability or infirmity	1.053
	(0.0440)
Mother suffers from asthma	1.098**
	(0.0476)
Breastfeeding less than 6 months	1.122***
	(0.0438)
Breastfeeding more than 6 months	1.048
	(0.0513)
Delay in breathing at birth or difficulties in first week	1.053
	(0.0607)
Jaundice requiring hospital treatment in first week	0.972
	(0.0627)
Infection or suspected infection in first week	0.987
	(0.0810)
Breech birth - feet first during labour	1.150
	(0.112)
Other abnormal lie eg shoulder first during labour	1.120
	(0.0946)
Very long labour	1.124*
	(0.0694)
Very rapid labour	1.088
	(0.105)
Fetal distress during labour	0.949
	(0.0438)
Caesarian delivery	1.049
	(0.0435)
Wheezing or asthma at 9 months	1.145**
	(0.0658)
Skin problems at 9 months	0.974
	(0.0398)
Other breathing problems at 9 months	1.179
	(0.202)

No one else present at birth	1.110
	(0.0891)
Natural father resident in household (S1)	0.896**
	(0.0491)
Ln of predicted equivalised weekly net family income	0.918***
	(0.0290)
Maternal Grandmother is alive (S1)	1.037
	(0.0742)
Maternal Granfather is alive (S1)	0.936
	(0.0442)
Pollution, environmental problems (S1)	1.110***
	(0.0432)
K6S2 residuals	1.004
	(0.00456)
Constant	0.232***
	(0.0773)
Observations	12005

Notes: Poisson regression, incidence rate ratio reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 26: Incidence rate ratio on the number of accidents (age 5)

	Number of accidents
Postpartum depression	1.280***
	(0.110)
Missing values in Mal. inventory	1.142
	(0.335)
Male	1.238***
	(0.0485)
Age of CM at S3 (days)	1.000
	(0.000216)
Mixed ethnic group	0.791*
	(0.0999)
Indian ethnic group	0.799
	(0.123)
Pakistani and Bangladeshi ethnic group	0.721**
	(0.101)
Black or Black British ethnic group	0.747**
	(0.107)
Other ethnic group (inc Chinese)	0.982
	(0.272)
Birth weight	1.029
	(0.0382)
Preterm babies (below 32 weeks)	1.016
	(0.147)
Siblings living in household (S1)	1.203***
	(0.0635)
Interaction Postpartum depression and siblings	0.897
	(0.0954)
Age mother below 30 years	1.197***
	(0.0528)
Age mother left education	0.987
	(0.00908)
Mother worked during pregnancy	0.966
	(0.0453)
Attended ante-natal classes	1.026
	(0.0481)

Mother smoked during pregnancy	1.073
	(0.0534)
Mother drank alcohol when pregnant	1.098**
	(0.0448)
Mother had problems during pregnancy	1.072*
	(0.0422)
Mother: longstanding illness, disability or infirmity	1.123**
	(0.0528)
Mother suffers from asthma	1.066
	(0.0543)
Breastfeeding less than 6 months	1.008
	(0.0455)
Breastfeeding more than 6 months	0.980
	(0.0552)
Delay in breathing at birth or difficulties in first week	1.061
	(0.0765)
Jaundice requiring hospital treatment in first week	0.924
	(0.0709)
Infection or suspected infection in first week	1.101
	(0.104)
Breech birth - feet first during labour	1.083
	(0.129)
Other abnormal lie eg shoulder first during labour	0.986
	(0.102)
Very long labour	0.984
	(0.0766)
Very rapid labour	1.098
	(0.125)
Fetal distress during labour	0.999
	(0.0546)
Caesarian delivery	1.050
	(0.0529)
Wheezing or asthma at 9 months	0.961
	(0.0708)
Skin problems at 9 months	0.964
	(0.0462)
Other breathing problems at 9 months	0.979
	(0.258)

No one else present at birth	0.917
	(0.104)
Natural father resident in household (S1)	0.877**
	(0.0560)
Ln of predicted equivalised weekly net family income	0.963
	(0.0375)
Maternal Grandmother is alive (S1)	0.958
	(0.0802)
Maternal Granfather is alive (S1)	1.041
	(0.0569)
Pollution, environmental problems (S1)	0.942
	(0.0450)
K6S3 residuals	1.018***
	(0.00518)
Constant	0.227***
	(0.114)
Observations	12346

Notes: Poisson regression, incidence rate ratio reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 27: Incidence rate ratio on the number of accidents (age 7)

	Number of accidents
Postpartum depression	1.120
	(0.109)
Missing values in Mal. inventory	0.569
	(0.245)
Male	1.170***
	(0.0526)
Age of CM at S4	1.014*
	(0.00768)
Mixed ethnic group	0.719**
	(0.102)
Indian ethnic group	0.764
	(0.150)
Pakistani and Bangladeshi ethnic group	0.823
	(0.122)
Black or Black British ethnic group	0.716**
	(0.115)
Other ethnic group (inc Chinese)	0.732
	(0.188)
Birth weight	1.045
	(0.0461)
Preterm babies (below 32 weeks)	1.031
	(0.156)
Siblings living in household (S1)	1.119*
	(0.0695)
Interaction Postpartum depression and siblings	0.982
	(0.123)
Age mother below 30 years	1.081
	(0.0569)
Age mother left education	0.998
	(0.0103)
Mother worked during pregnancy	0.946
	(0.0508)
Attended ante-natal classes	0.912*
	(0.0509)

Mother smoked during pregnancy	1.163**
	(0.0729)
Mother drank alcohol when pregnant	0.992
	(0.0479)
Mother had problems during pregnancy	1.185***
	(0.0535)
Mother: longstanding illness, disability or infirmity	1.075
	(0.0597)
Mother suffers from asthma	1.192***
	(0.0695)
Breastfeeding less than 6 months	1.049
	(0.0557)
Breastfeeding more than 6 months	1.006
	(0.0643)
Delay in breathing at birth or difficulties in first week	0.884
	(0.0757)
Jaundice requiring hospital treatment in first week	1.109
	(0.0960)
Infection or suspected infection in first week	1.078
	(0.112)
Breech birth - feet first during labour	0.850
	(0.132)
Other abnormal lie eg shoulder first during labour	1.352***
	(0.149)
Very long labour	1.011
	(0.0870)
Very rapid labour	1.091
	(0.163)
Fetal distress during labour	1.016
	(0.0626)
Caesarian delivery	1.102*
	(0.0621)
Wheezing or asthma at 9 months	1.156*
	(0.102)
Skin problems at 9 months	1.060
	(0.0572)
Other breathing problems at 9 months	1.601**
	(0.359)

No one else present at birth	0.897
	(0.105)
Natural father resident in household (S1)	0.870*
	(0.0679)
Ln of predicted equivalised weekly net family income	0.945
	(0.0442)
Maternal Grandmother is alive (S1)	0.887
	(0.0786)
Maternal Granfather is alive (S1)	0.997
	(0.0619)
Pollution, environmental problems (S1)	1.012
	(0.0554)
K6S4 residuals	1.017***
	(0.00620)
Constant	0.0950***
	(0.0710)
Observations	11306

Notes: Poisson regression, incidence rate ratio reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 28: Incidence rate ratio on the number of accidents (age 11)

	Number of accidents
Postpartum depression	1.082
	(0.0853)
Missing values in Mal. inventory	1.188
	(0.260)
Male	1.148***
	(0.0454)
Age of CM at S5	1.028**
	(0.0136)
Mixed ethnic group	0.967
	(0.106)
Indian ethnic group	0.716
	(0.243)
Pakistani and Bangladeshi ethnic group	0.528***
	(0.0638)
Black or Black British ethnic group	0.804
	(0.132)
Other ethnic group (inc Chinese)	0.546**
	(0.136)
Birth weight	1.101**
	(0.0493)
Preterm babies (below 32 weeks)	1.003
	(0.122)
Siblings living in household (S1)	1.030
	(0.0545)
Interaction Postpartum depression and siblings	0.941
	(0.106)
Age mother below 30 years	1.071
	(0.0457)
Age mother left education	1.011
	(0.00830)
Mother worked during pregnancy	1.002
	(0.0482)
Attended ante-natal classes	0.998
	(0.0464)

Mother smoked during pregnancy	1.147**
	(0.0624)
Mother drank alcohol when pregnant	0.964
	(0.0390)
Mother had problems during pregnancy	1.117***
	(0.0440)
Mother: longstanding illness, disability or infirmity	1.009
	(0.0500)
Mother suffers from asthma	1.076
	(0.0574)
Breastfeeding less than 6 months	0.935
	(0.0431)
Breastfeeding more than 6 months	0.924
	(0.0512)
Delay in breathing at birth or difficulties in first week	1.049
	(0.0684)
Jaundice requiring hospital treatment in first week	0.973
	(0.0805)
Infection or suspected infection in first week	1.130
	(0.0983)
Breech birth - feet first during labour	0.890
	(0.106)
Other abnormal lie eg shoulder first during labour	1.176*
	(0.114)
Very long labour	1.003
	(0.0710)
Very rapid labour	1.008
	(0.112)
Fetal distress during labour	1.027
	(0.0505)
Caesarian delivery	1.021
	(0.0447)
Wheezing or asthma at 9 months	0.989
	(0.0793)
Skin problems at 9 months	1.052
	(0.0510)
Other breathing problems at 9 months	1.414**
	(0.216)

No one else present at birth	0.895
	(0.0773)
Natural father resident in household (S1)	0.942
	(0.0694)
Ln of predicted equivalised weekly net family income	0.975
	(0.0368)
Maternal Grandmother is alive (S1)	1.106
	(0.0810)
Maternal Granfather is alive (S1)	1.020
	(0.0534)
Pollution, environmental problems (S1)	1.000
	(0.0471)
K6S5 residuals	1.007
	(0.00507)
Constant	0.221***
	(0.0651)
Observations	10441

Notes: Poisson regression, incidence rate ratio reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix C

Table 29: Marginal effects on recurring Ear infections (age 3)

	Ear infections
Postpartum depression	0.00745
	(0.0125)
Missing values in Mal. inventory	0.0883
	(0.0590)
Male	0.0217***
	(0.00513)
Age of CM at S2 (days)	0.0000385
	(0.0000330)
Mixed ethnic group	-0.0419***
	(0.00910)
Indian ethnic group	-0.0243
	(0.0152)
Pakistani and Bangladeshi ethnic group	-0.0133
	(0.0142)
Black or Black British ethnic group	-0.0364***
	(0.0114)
Other ethnic group (inc Chinese)	-0.0476***
	(0.0120)
Birth weight	-0.00108
	(0.00501)
Preterm babies (below 32 weeks)	0.0157
	(0.0196)
Siblings living in household (S1)	0.00358
	(0.00710)
Interaction Postpartum depression and siblings	-0.00515
	(0.0136)
Age mother below 30 years	0.00554
	(0.00618)
Age mother left education	0.00148
	(0.00121)
Mother worked during pregnancy	-0.00247
	(0.00634)

Attended ante-natal classes	-0.00319
	(0.00654)
Mother smoked during pregnancy	0.0153**
	(0.00751)
Mother drank alcohol when pregnant	-0.0104*
	(0.00538)
Mother had problems during pregnancy	0.0113**
	(0.00550)
Mother: longstanding illness, disability or infirmity	0.0150**
	(0.00707)
Mother suffers from asthma	0.00732
	(0.00716)
Breastfeeding less than 6 months	0.0140**
	(0.00628)
Breastfeeding more than 6 months	-0.000876
	(0.00789)
Delay in breathing at birth or difficulties in first week	0.00299
	(0.00973)
Jaundice requiring hospital treatment in first week	-0.000501
	(0.00952)
Infection or suspected infection in first week	-0.00968
	(0.0110)
Breech birth - feet first during labour	0.0163
	(0.0192)
Other abnormal lie eg shoulder first during labour	0.00338
	(0.0144)
Very long labour	0.0170
	(0.0115)
Very rapid labour	0.00838
	(0.0169)
Fetal distress during labour	0.00219
	(0.00705)
Caesarian delivery	0.00849
	(0.00688)
Wheezing or asthma at 9 months	-0.0107
	(0.00864)
Skin problems at 9 months	-0.00814
	(0.00614)

Other breathing problems at 9 months	-0.0351**
	(0.0142)
No one else present at birth	-0.00884
	(0.0120)
Natural father resident in household (S1)	-0.00987
	(0.00980)
Ln of predicted equivalised weekly net family income	-0.00191
	(0.00544)
Maternal Grandmother is alive (S1)	-0.00519
	(0.0108)
Maternal Granfather is alive (S1)	0.00171
	(0.00714)
Pollution, environmental problems (S1)	0.0110*
	(0.00662)
K6S2 residuals	0.00112
	(0.000713)
Observations	12032

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 30: Marginal effects on Hearing problems (age 5)

	Hearing problems
Postpartum depression	-0.0230
	(0.0154)
Missing values in Mal. inventory	-0.0180
	(0.0480)
Male	0.0203***
	(0.00715)
Age of CM at S3 (days)	-0.00000280
	(0.0000405)
Mixed ethnic group	-0.0431**
	(0.0183)
Indian ethnic group	-0.0512**
	(0.0221)
Pakistani and Bangladeshi ethnic group	-0.0425**
	(0.0191)
Black or Black British ethnic group	-0.0898***
	(0.0123)
Other ethnic group (inc Chinese)	-0.106***
	(0.0156)
Birth_weight	-0.00260
	(0.00712)
Preterm babies (below 32 weeks)	0.00332
	(0.0235)
Siblings living in household (S1)	-0.0145
	(0.0103)
Interaction Postpartum depression and siblings	0.0186
	(0.0241)
Age mother below 30 years	-0.00760
	(0.00835)
Age mother left education	0.000210
	(0.00166)
Mother worked during pregnancy	-0.00488
	(0.00915)
Attended ante-natal classes	-0.00113
	(0.00932)

Mother smoked during pregnancy	0.0119
	(0.0100)
Mother drank alcohol when pregnant	0.000158
	(0.00773)
Mother had problems during pregnancy	0.0359***
	(0.00773)
Mother: longstanding illness, disability or infirmity	0.0151
	(0.00938)
Mother suffers from asthma	0.0311***
	(0.0105)
Breastfeeding less than 6 months	0.0157*
	(0.00890)
Breastfeeding more than 6 months	0.0140
	(0.0112)
Delay in breathing at birth or difficulties in first week	-0.000358
	(0.0136)
Jaundice requiring hospital treatment in first week	-0.000848
	(0.0137)
Infection or suspected infection in first week	-0.0140
	(0.0167)
Breech birth - feet first during labour	0.0336
	(0.0266)
Other abnormal lie eg shoulder first during labour	-0.0175
	(0.0186)
Very long labour	0.0108
	(0.0149)
Very rapid labour	-0.0181
	(0.0203)
Fetal distress during labour	0.00370
	(0.00992)
Caesarian delivery	0.00517
	(0.00943)
Wheezing or asthma at 9 months	-0.00244
	(0.0138)
Skin problems at 9 months	-0.0237***
	(0.00837)
Other breathing problems at 9 months	0.0595
	(0.0461)

No one else present at birth	0.00101
	(0.0190)
Natural father resident in household (S1)	-0.0110
	(0.0136)
Ln of predicted equivalised weekly net family income	0.00272
	(0.00750)
Maternal Grandmother is alive (S1)	-0.000969
	(0.0147)
Maternal Granfather is alive (S1)	0.00458
	(0.0101)
Pollution, environmental problems (S1)	-0.00187
	(0.00876)
K6S3 residuals	0.00117
	(0.00103)
Observations	12383

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 31: Marginal effects on Hearing problems (age 7)

	Hearing problems
Postpartum depression	-0.0201
	(0.0162)
Missing values in Mal. inventory	-0.0983***
	(0.0174)
Male	0.0164**
	(0.00749)
Age of CM at S4	-0.0000219
	(0.00123)
Mixed ethnic group	-0.0251
	(0.0219)
Indian ethnic group	-0.0240
	(0.0271)
Pakistani and Bangladeshi ethnic group	-0.0430**
	(0.0188)
Black or Black British ethnic group	-0.0916***
	(0.0144)
Other ethnic group (inc Chinese)	-0.113***
	(0.0113)
Birth weight	-0.00438
	(0.00786)
Preterm babies (below 32 weeks)	-0.0387*
	(0.0203)
Siblings living in household (S1)	-0.00293
	(0.0105)
Interaction Postpartum depression and siblings	0.0148
	(0.0243)
Age mother below 30 years	0.00240
	(0.00859)
Age mother left education	0.000220
	(0.00173)
Mother worked during pregnancy	-0.00575
	(0.00946)
Attended ante-natal classes	0.00229
	(0.00959)

Mother smoked during pregnancy	0.0217**
	(0.0108)
Mother drank alcohol when pregnant	-0.000325
	(0.00798)
Mother had problems during pregnancy	0.0251***
	(0.00793)
Mother: longstanding illness, disability or infirmity	0.0236**
	(0.00996)
Mother suffers from asthma	0.0132
	(0.0106)
Breastfeeding less than 6 months	0.0108
	(0.00932)
Breastfeeding more than 6 months	0.0160
	(0.0116)
Delay in breathing at birth or difficulties in first week	0.00651
	(0.0145)
Jaundice requiring hospital treatment in first week	-0.0208
	(0.0136)
Infection or suspected infection in first week	0.00169
	(0.0193)
Breech birth - feet first during labour	0.0221
	(0.0278)
Other abnormal lie eg shoulder first during labour	-0.000212
	(0.0214)
Very long labour	-0.00228
	(0.0151)
Very rapid labour	0.0105
	(0.0238)
Fetal distress during labour	0.00728
	(0.0105)
Caesarian delivery	0.0144
	(0.0101)
Wheezing or asthma at 9 months	0.0172
	(0.0159)
Skin problems at 9 months	-0.0326***
	(0.00849)
Other breathing problems at 9 months	0.00384
	(0.0388)

No one else present at birth	-0.00909
	(0.0187)
Natural father resident in household (S1)	0.00333
	(0.0132)
Ln of predicted equivalised weekly net family income	-0.00662
	(0.00734)
Maternal Grandmother is alive (S1)	0.0214
	(0.0143)
Maternal Granfather is alive (S1)	-0.00539
	(0.0109)
Pollution, environmental problems (S1)	-0.000942
	(0.00918)
K6S4 residuals	0.00228**
	(0.00102)
Observations	11332

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 32: Marginal effects on Hearing problems (age 11)

	Hearing problems
Postpartum depression	-0.00930
	(0.0137)
Missing values in Mal. inventory	-0.0250
	(0.0377)
Male	0.00358
	(0.00647)
Age of CM at S5	-0.00396**
	(0.00169)
Mixed ethnic group	-0.0380**
	(0.0160)
Indian ethnic group	-0.0212
	(0.0259)
Pakistani and Bangladeshi ethnic group	-0.00831
	(0.0164)
Black or Black British ethnic group	-0.0524***
	(0.0138)
Other ethnic group (inc Chinese)	-0.0706***
	(0.0103)
Birth weight	-0.00496
	(0.00642)
Preterm babies (below 32 weeks)	0.0160
	(0.0243)
Siblings living in the household (S1)	0.00290
	(0.00930)
Interaction Postpartum depression and siblings	0.0115
	(0.0209)
Age mother below 30 years	-0.000926
	(0.00749)
Age mother left education	0.000777
	(0.00143)
Mother worked during pregnancy	-0.000280
	(0.00799)
Attended ante-natal classes	-0.00715
	(0.00848)

Mother smoked during pregnancy	0.00363
	(0.00862)
Mother drank alcohol when pregnant	-0.00286
	(0.00705)
Mother had problems during pregnancy	0.0164**
	(0.00690)
Mother: longstanding illness, disability or infirmity	0.0107
	(0.00886)
Mother suffers from asthma	0.00906
	(0.00931)
Breastfeeding less than 6 months	0.0264***
	(0.00871)
Breastfeeding more than 6 months	0.0125
	(0.0107)
Delay in breathing at birth or difficulties in first week	0.00280
	(0.0123)
Jaundice requiring hospital treatment in first week	-0.00603
	(0.0122)
Infection or suspected infection in first week	-0.00219
	(0.0157)
Breech birth - feet first during labour	0.0167
	(0.0227)
Other abnormal lie eg shoulder first during labour	-0.0138
	(0.0164)
Very long labour	0.0218
	(0.0148)
Very rapid labour	0.0121
	(0.0216)
Fetal distress during labour	0.000602
	(0.00870)
Caesarian delivery	0.00342
	(0.00824)
Wheezing or asthma at 9 months	0.0126
	(0.0142)
Skin problems at 9 months	0.00288
	(0.00824)
Other breathing problems at 9 months	0.0147
	(0.0378)

No one else present at birth	0.0203
	(0.0175)
Natural father resident in household (S1)	-0.0239*
	(0.0140)
Ln of predicted equivalised weekly net family income	0.00516
	(0.00667)
Maternal Grandmother is alive (S1)	-0.000746
	(0.0130)
Maternal Granfather is alive (S1)	0.0168*
	(0.00888)
Pollution, environmental problems (S1)	0.00315
	(0.00804)
Residuals	0.00230***
	(0.000738)
Observations	10591

Notes: Logistic regression, marginal effects at means reported. Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix D

Table 33: Covariate balance - Sweep 2 sample

	Raw std difference	Matched std difference	Raw ratio	Matched ratio
Male	.0453765	.0097207	.9971244	.9989396
White ethnic group	-.139184	.0223988	1.313456	.9635916
Mixed ethnic group	.0439633	-.0177229	1.281032	.9135047
Indian ethnic group	.0565732	-.0062475	1.409026	.9665924
Pakistani and Bangladeshi ethnic group	.1329855	-.0179905	1.650272	.9453672
Black or Black British ethnic group	.0365034	0	1.232576	1
Age of CM S2 (days)	.0511537	-.0269086	1.117976	.9128722
Preterm babies (below 32 weeks)	.01448	-.0094931	1.087063	.94895
Age mother below 30	.1962681	-.0121276	.9597924	1.005164
Mother: longstanding illness, disability or infirmity	.4158057	.0033384	1.505746	1.0017
Mother: problems during pregnancy	.2520132	-.0043141	1.073206	.9999069
Age mother left educ	-.2470811	.0138834	.8123159	1.108552
Mother worked during pregnancy	-.2499221	.0315163	1.144695	.992251
Ante-natal classes	-.1632637	.0343394	.8955761	1.031615
Mother drank alcohol when pregnant	-.0080994	.0140372	.9938743	1.011866
Breastfeeding less than 6 months	-.0242655	-.0087913	.9913806	.9965648
Breastfeeding more than 6 months	-.1337504	.0254681	.824712	1.044222
Mother suffers from asthma	.1471286	.0185237	1.271544	1.026688
Caesarian delivery	.0145244	-.0154459	1.020207	.9800699
Delay in breathing at birth or difficulties in first week	.094069	.0354598	1.329435	1.105465
Jaundice requiring hospital treatment in first week	.0652872	-.0057206	1.229558	.98345
Infection or suspected infection in first week	.0330036	.0053075	1.16742	1.024161
Breech birth - feet first during labour	.0229753	.0268952	1.145116	1.172569
Other abnormal lie eg shoulder first during labour	.014192	.077719	1.076536	1.564379
Very long labour	.0481168	.0059596	1.169604	1.018615
Very rapid labour	.0585911	-.0086991	1.385423	.957488
Foetal distress during labour	.0315299	.0355825	1.061535	1.069473
Ln of predicted equivalised weekly net family income	-.3616572	-.0187245	1.045748	1.073956
Siblings living in HH S1	.1175621	-.0201602	.9528751	1.01136
No one else present at birth	.0719994	-.0240631	1.332542	.9185084
Maternal grandparents are both alive S1	-.0387529	.0169285	1.057728	.9773433
Pollution, environmental problems S1	.1952245	-.0294463	1.255652	.9744768
Born under-weight	.0477166	-.0352253	1.188958	.8907123
Mother smoked during pregnancy	.2848047	-.0057691	1.376375	.9956207
Natural father resident in HH S1	-.2231243	-.0130622	1.466313	1.018018
Maternal Grandmother is alive S1	-.0481537	.0039792	1.172225	.9877345
Maternal Grandfather is alive S1	-.0168359	.0187261	1.031854	.9673716
England - Advantaged	-.167345	-.015538	.8290975	.9795577
England - Disadvantaged	.0584273	-.0244912	1.072196	.9739963
England - Ethnic	.1106025	-.0176543	1.32224	.9618195
Wales - Advantaged	-.0711883	-.0140972	.726761	.934122
Wales - Disadvantaged	.1133072	.0219928	1.302901	1.047709
Scotland - Advantaged	-.1091286	-.0052454	.6524584	.9770057
Scotland - Disadvantaged	.0481641	.0649973	1.188927	1.268672
Northern Ireland - Advantaged	-.0784729	.0097524	.6750711	1.057062