Pregnancy Loss: Stress, Investment, and Subsequent Children[1]

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Pregnancy loss, which affects about 1 in 4 pregnancies, is often a traumatic, although unacknowledged, event which may alter prenatal stress and investments in subsequent pregnancies. Using Norwegian registry data, we exploit the random nature of single, early miscarriages to examine the impact of previous pregnancy loss on maternal investment, the birth and educational outcomes of subsequent children, and parental labor market outcomes. Pregnancy loss initially improves subsequent maternal investment and child outcomes, but effects dissipate over time. These findings suggest that long term supports may be required to mitigate negative effects arising from prenatal shocks such as pregnancy loss.

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There is a burgeoning economics literature on shocks and investment during pregnancy and early childhood. Negative prenatal shocks, such as malnutrition, natural disasters, radiation, and parental death, are often associated with poorer cognitive, behavioral, and educational outcomes, with lasting effects into adulthood (see reviews in Currie and Almond (2011) and Almond, Currie, and Duque (2018)). A common, yet under-examined prenatal shock is pregnancy loss;[2] an often traumatic ending to one in four recognized pregnancies, with an estimated 23 million losses occurring annually (Everett 1997; Meaney et al. 2017; Farren et al. 2020; Quenby et al. 2021). The majority of early pregnancy losses arise from random chromosomal abnormalities that affect the viability of the fetus (Larsen et al. 2013).[3] Although employed in the economics literature as an exogenous shock to birth timing and maternal outcomes (Hotz, McElroy, and Sanders 2005; Miller 2011; Buckles and Munnich 2012), pregnancy loss, and the changes in stress and investment that ensues, has not yet been considered as a shock to the outcomes of parents and subsequent children. For the first time, we examine the long-term impact of pregnancy loss through hypothesized changes in psychological and physical investments using Norwegian registry data.

Despite the prevalence of pregnancy loss, little is published in either the medical or social science literature about its long-term consequences. This may be partly attributed to the difficulty in fully identifying causal effects. While most pregnancy losses are random, it is estimated that up to 10 or 15 percent are driven by individual risk factors such as previous pregnancy loss, assisted conception, high parental age, low BMI, substance use, and some disorders and chronic diseases (García-Enguídanos et al. 2002; Maconochie et al. 2007), many of which are socially determined. There are a number of small sample studies examining the impact of pregnancy loss on outcomes such as anxiety, but typically they face validity challenges in sample selection and the absence of a comparison group (Geller, Kerns, and Klier 2004). As calls to speak about and better understand pregnancy loss have increased (Quenby et al. 2021), larger registry-based studies have appeared, however they are generally descriptive or associative, looking for example, at trends in pregnancy losses over time or the role of

[2] Pregnancy loss is alternatively labelled miscarriage or spontaneous abortion. In this paper we use the terms pregnancy loss and miscarriage interchangeably. Miscarriage is defined as an involuntary termination of a non-viable fetus before 24 weeks (Franche and Mikail 1999). While rates vary, it is reported that ~15 percent of clinical recognized pregnancies end in miscarriage. In addition, it is estimated that undetected pregnancy loss occurs at a further rate of 8 to 22 percent. Statistics on recognized miscarriage may be prone to under-reporting where home-managed losses are unobserved, so an estimation of home managed losses are included in our figures (Everett 1997). Only one percent of miscarriages occur after the first 12 weeks of gestation.

[3] A chromosome abnormality is a missing, extra, or irregular portion of chromosomal DNA.

maternal age in pregnancy loss (Bruckner, Mortensen, and Catalano 2016; Linnakaari et al. 2019; Magnus et al. 2019). [4]

In this paper we use the universe of children born in Norway between 1999 and 2018 to investigate the impact of pregnancy loss on maternal investment and subsequent children's birth, health, and educational outcomes, as well as parental health and labor market outcomes. We address potential omitted-variable bias by restricting our sample to women with two children who experienced at most one pregnancy loss between births. In an approach similar to Currie and Schwandt (2013) in their study on the impact of seasonality on birth outcomes, we effectively examine differences in the outcomes of siblings, and thus account for fixed maternal characteristics that could be associated with child outcomes and the risk of pregnancy loss.

There are two interconnected channels through which pregnancy loss may impact parent and subsequent child outcomes – heightened prenatal stress and changes in maternal investment. Fear of recurrent pregnancy loss and persistent mental health issues arising from a previous loss may result in heightened stress in later pregnancies (Geller, Kerns, and Klier 2004; Fertl et al. 2009). It is estimated that 20 percent of women who experience a pregnancy loss develop some form of depression and/or anxiety, with symptoms still evident for up to three years (see review in Nynas et al. (2015)). In addition, 50 to 60 percent of women become pregnant again within 12 months of experiencing a loss (Lamb 2002), and thus are likely to be impacted both by the initial loss, as well as concerns over the viability of the new pregnancy. While expected to dissipate over time (Farren et al. 2020), the impact of pregnancy loss may be particularly potent as research shows that grief is greater when the loss is more personal (Persson and Rossin-Slater 2018; Segal and Bouchard 1993). In addition, compared to other forms of grief, families are less likely to share their experience of pregnancy loss with others and therefore receive fewer supports (Bellhouse, Temple-Smith, and Bilardi 2018). There is also some associative evidence that pregnancy loss can have long-lasting psychological effects even after

[4] In the economics literature, pregnancy loss itself has been used as a random exogenous shock. Delays to motherhood induced by pregnancy loss have been found to increase earnings and work hours (Miller 2011; Li 2012). The random occurrence of pregnancy loss, conditional on controls for known risk factors, is also employed as an instrumental variable (IV) to examine the impact of teen pregnancy (Hotz, Mullin, and Sanders 1997; Hotz, McElroy, and Sanders 2005). Building on this work, Ermisch and Pevalin (2005) use pregnancy loss as an IV when reporting that younger mothers fare worse on the marriage market. Buckles and Munnich (2012) find an improvement for child outcomes with an added year between siblings, citing larger results when the exogenous shock of pregnancy loss is employed over a standard OLS estimation biased by the endogeneity of birth spacing. In addition, Karimi (2014) shows that larger birth spacing due to miscarriage increases the probability of labor market re-entry between births and income after the second birth in Sweden.

the healthy birth of a subsequent child (Hunfeld et al. 1997). Thus, the highly prevalent and acutely stressful impact of a pregnancy loss may be greater than some of the less frequent or less traumatizing prenatal shocks typically studied in the literature, such as exposure to major earthquakes or the Super Bowl (Menclova and Stillman 2020; Duncan, Mansour, and Rees 2017).

A number of studies in economics have attempted to examine the short and long term impact of maternal stress in pregnancy on later child outcomes using novel exogenous shocks such as natural disasters, terrorist attacks, and conflict (examples include Currie and Rossin-Slater 2013; Quintana-Domeque and Ródenas-Serrano 2017; Mansour and Rees 2012). Heightened parental stress may impact the development of children in-utero as it can influence fetal programming (Seckl and Meaney 2004; Nakamura, Sheps, and Clara Arck 2008).[5] A review of the impact of stress and the stress response on pregnancy reports that the structural impact of stress on the child's brain can negatively affect neurodevelopment, cognitive development, temperament, and psychiatric disorders (Van den Bergh et al. 2020). Using a sibling comparison model, Aizer, Stroud, and Buka (2016) examine cortisol from blood samples as a marker for stress to show that children exposed to higher levels of cortisol in utero have worse cognitive, health and educational outcomes. The effects are large and correspond to ~0.4 - 0.5 SD, however there are no significant effects on birth outcomes.[6] A small number of papers have specifically examined the impact of stress during pregnancy induced via a family member's death. Black, Devereux, and Salvanes (2016), using Norwegian registry data, find that the death of a mother's parent during pregnancy leads to a small decrease in birthweight (21 grams) and an increase in caesarean sections (~1 percent), but no effects on educational attainment, earnings, or health in adulthood.[7] Persson and Rossin-Slater (2018), using Swedish administrative data, find that prenatal exposure to a death of a maternal relative increases the use of medication for ADHD and anxiety/depression in adulthood, as well as negatively

[5] This arises because stress is a state of threat to homeostasis, the stable internal system our bodies maintain despite our fluctuating external environment. To restore stability, the body produces a stress response that involves disrupting or inhibiting the nervous, endocrine, and immune systems. This stress response prioritizes survival over less essential functions such as growth and reproduction (Joseph and Whirledge 2017). There can be beneficial physiological and psychological effects of the stress response, however prolonged or repeated disruptions to these systems can have negative consequences for the mother and child. In particular, the nervous and endocrine systems co-regulate the immune system, which is essential for the establishment and maintenance of pregnancy and fetal programming (Parker and Douglas 2010).

[6] The lack of effects on birth outcomes is attributed to selection into the sample during the third trimester.

[7] They compare the outcomes of children who lost a grandparent during pregnancy to children who lost a grandparent just before or after pregnancy, as well as using a fixed effect approach by comparing siblings, one of whom experienced a grandparental death in-utero.

impacting birth outcomes (e.g., 11 gram decrease in birthweight and 3 percent increase in caesarean sections).

In relation to pregnancy loss, heightened stress and concerns about the outcomes of subsequent pregnancies may impact child outcomes through changes in maternal investment (for a review, see Lee, McKenzie-McHarg, and Horsch 2017). For women who experience a previous pregnancy loss, anxiety and stress may be associated with a feeling of personal responsibility for that loss (Nikcevic, Kuczmierczyk, and Nicolaides 1998), and a greater belief that their behavior may impact the subsequent pregnancy (Franche and Mikail 1999), thus potentially increasing prenatal investment. This is important as positive shocks to prenatal investment such as iodine supplementation have large positive effects for child outcomes, particularly for girls (Field, Robles, and Torero 2009).[8]

However, for some women, the subsequent pregnancy may be marked by uncertainty that drives ambivalence and detachment towards the pregnancy and thus lowers or delays investment (Geller, Kerns, and Klier 2004; Christiansen 2017). This research is largely based on small sample studies reporting conflicting directions of association between investment and previous loss, primarily focusing on maternal-fetal attachment[9] (Tsartsara and Johnson 2006; Lee, McKenzie-McHarg, and Horsch 2017; Branjerdporn et al. 2021) and initiation of prenatal care (Ney et al. 1994; Kinsey et al. 2015).

Yet, neither Aizer at al. (2016) nor Persson and Rossin-Slater (2018) find changes in prenatal investment, either positive or negative, because of increased stress in pregnancy. prenatal stress may also impact later child outcomes via changes in parental labor market participation if, for example, mothers change their working hours during pregnancy. If this change in investment persists after pregnancy, through choice or opportunity, the cost for mothers of previous loss

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[8] Other studies have used changes in policy to investigate the impact of prenatal shocks on later outcomes. For example. the introduction of the workplace smoking ban, which reduced the incidence of maternal smoking during pregnancy, improved birth outcomes (e.g., Bharadwaj, Johnsen, and Løken 2014; Hajdu and Hajdu 2018). Studies exploiting changes in prenatal maternity leave policies also find some positive effects on birth and later outcomes, although the effects are more mixed (see review in Ahammer, Halla, and Schneeweis 2020). The impact of prenatal shocks to nutritional investment in pregnancy is examined by Almond and Mazumder (2011) and Almond, Mazumder, and van Ewijk (2015) among others, who find negative effects on birth outcomes, childhood test scores and adult disability for pregnancies that coincided with Ramadan.

[9] Maternal-fetal attachment (MFA) is defined as the thoughts, feelings, and behaviors that characterize affection towards the fetus. It is generally measured with multi-item scales covering behaviors such as eating healthily, speaking to the baby, and learning about child development (Branjerdporn et al. 2021). Thus, higher levels of MFA indicate higher levels of maternal investment in the pregnancy.

could be large. However again, Persson and Rossin-Slater (2018) find no effect of grief-induced stress on wage income in the year during or after conception.

Building on the literature concerning shocks to human capital formation, our paper makes two contributions. First, we examine the impact of pregnancy loss, a very common pregnancy complication, and thus a potentially major, under-examined contributor to human capital formation. By testing for and documenting any short- and long-term consequences of pregnancy loss on health, human capital and labor market outcomes, and the channels through which these consequences arise, we contribute to increased public discourse around pregnancy loss and possible supports which could be put in place to mitigate any negative effects. Given the high prevalence rate of pregnancy loss, the welfare consequences are likely to be large, particularly when compared to less frequent and short-term shocks that are typically examined in this literature. Second, we consider the complex interaction between physical and emotional investment that a shock via pregnancy loss may incur. In particular, we hypothesize that an adverse shock to maternal mental health may be compensated in some cases by increases in physical investment via maternal behaviors during and after pregnancy. Unpicking the drivers of these differential effects is important for identifying groups with higher risk of adverse outcomes after loss and potential intervention streams.

We find that pregnancy loss increases maternal investment in the subsequent pregnancy, through increased supplementation and decreased smoking. We also find that maternal labor market engagement during pregnancy and after the birth declines, and this is not driven by poorer health. At birth, children born after a pregnancy loss have higher weight, and have less GP and ER visits in subsequent years. However, by age ten the impact of pregnancy previous loss on children has dissipated. There are no significant differences for GPA, math, English and reading scores, , and indeed, in most cases the effects are negative. We theorize that this arises from lingering investment decisions by the mother – through choice or opportunity – to decrease labor market engagement even two years after the birth.

The remainder of the paper is organized as follows. In part I we describe the registry data. In part II, we outline our estimation strategy for examining the effects of pregnancy loss on parent and subsequent child outcomes, including strategies for asserting the exogeneity of miscarriage in our identification, our approach to hypothesis setting, and descriptive statistics for our sample. Results are described in part III, covering our main analysis, sub-group analyses based on child gender, maternal education, and paternity. We contextualize these results using the economic and scientific literature. We report on robustness checks in part IV, including the role of maternal physical health, timing, and contamination of the sample with non-random miscarriage, before some concluding remarks in part V.

I. Data

We use Norwegian Registry data, a linked administrative dataset that covers the Norwegian population and provides information about labor market status, educational attainment, demographics, and family relations. We merge this data to the datasets described below using personal identification numbers for parents and children.

A. Birth data

Data on births, pregnancy losses, health and health behavior during pregnancy are obtained from the Medical Birth Registry of Norway, which contains records for all births with a minimum gestation period of 16 weeks since 1967. The records include information on the date of birth, age of the mother and father, variables related to infant health at birth and method of delivery. To examine the impact of pregnancy loss on subsequent children at birth, we examine the baby's weight (in grams), APGAR scores,[10] duration of gestation (in weeks), and whether the delivery was by caesarean section (c-section). Low birthweight babies are well-established to have worse short-run and long-run human capital formation (e.g., Black, Devereux, and Salvanes 2007; Cook and Fletcher 2015) and, together with APGAR scores and gestational length, birthweight is a common metric for child health at birth that is associated with adult outcomes (for a review of studies, see Currie and Almond 2011). We use c-section delivery as a proxy for an unhealthy birth, as non-medically indicated c-sections (e.g. driven by maternal or practitioner preferences) are associated with worse child and maternal outcomes compared to vaginal delivery, and medically indicated c-sections (e.g. excessive bleeding) are determined by poor maternal and/or child health factors at the outset or during labor (Sandall et al. 2018; Mascarello, Horta, and Silveira 2017; Polos and Fletcher 2019; Currie and MacLeod 2016; Witt et al. 2015).

[10] APGAR scores are determined for newborns at one and five minutes after birth as a means of quickly summarizing the child's health. The quick test assesses color, heart rate, reflexes, muscle tone, and respiration. Higher scores, between 7 and 10, are considered reassuring (Simon, Hashmi, and Bragg 2021).

The birth registry also contains information about mothers' health behaviors, which we explore as mechanisms. This includes whether the mother supplemented folic acid and multivitamins before and during pregnancy, whether the mother smoked at the start of and during pregnancy, and whether she attended an ultrasound. Interventions to increase investment such as supplementation, smoking cessation, and pre-natal care have been successful in improving maternal and child outcomes (Lassi et al. 2014) and are recommended by the WHO (World Health Organization 2016).

The data also contains information on a set of health conditions experienced by the mothers prior to and during pregnancy, such as hypertension, gestational diabetes, eclampsia, preeclampsia, and early preeclampsia. Most importantly, the birth registry contains information about the number of previous pregnancy losses which occurred before week 12, as well as late miscarriages for children born in 1999 or later.

B. School data

Educational choice and attainment are directly reported by schools to Statistics Norway, thereby minimizing any measurement error from misreporting. For each student born between 1999 and 2008 er, we observe test scores from the national exam at age 10. These nationwide exams are externally graded. Here we examine average GPA, math, English and Norwegian reading scores as medium-term outcomes that provide insight into the trajectory of the impact of in-utero shocks (Almond, Currie, and Duque 2018). Health at birth is linked to childhood academic achievement (Chatterji, Kim, and Lahiri 2014), which is in turn associated with adult labor market outcomes (Flouri and Buchanan 2002). Test scores are standardized to have mean zero and standard deviation one.

C. Health Data

In Norway, health services are publicly financed and universally accessible for all Norwegian citizens. The services are organized in two levels: primary care and specialist care. Primary health care is the responsibility of the municipalities and includes general practitioners, emergency rooms, infant and child health care centres, school health services, and elderly care. Specialist care is the responsibility of the four health regions in Norway and it includes somatic specialist care, psychiatric health services, and private referral specialists.

General practitioners (hereafter GPs) and local emergency rooms (hereafter ERs) are the basis of the primary care services. The vast majority of Norwegian citizens belong to a specific GP's list, and GPs are responsible for providing primary health care services to the patients on their list. GPs diagnose their patients, certify sick leave, prescribe treatments, and refer their patients to specialist care when needed. They also follow up on their patient after they have received care in the specialist system. In general, the GPs serve as gatekeepers to the specialist care system and health-related welfare benefits. Most specialist care is provided through public hospitals and outpatient care clinics, but contracted private specialists can also provide specialist care. Most importantly, the first contact with specialist care takes place via the referral of the patient by the GP or the ER because it is not possible for a patient to proceed directly to specialist care within the public health care system. Hence, GPs and ERs are crucial gatekeepers in the Norwegian public health care system for all types of diagnosis and treatment including mental health problems.

Information on visits to GPs and ERs is obtained from the Control and Payment of Health Refunds database (acronym KUHR in Norwegian) and is available between 2006 and 2020. GPs and ERs are obliged to report all consultations and relevant International Classification of Primary Care (ICPC-2) codes to this claims database to receive payment. ICPC codes convey information about the GPs' assessment of the patient's health problems and the type of care provided. Specifically, each ICPC code is made of one letter, indicating where the symptoms or diseases are located in the body, and two numbers indicating whether the GPs assessed health symptoms and diseases. This allows us to assess the health issues detected during each visit. We analyse primary care use and diagnosis for both mothers and children.

D. Employment data

Annual parental earnings data are obtained from the tax registry and include labor earnings, taxable sick pay, unemployment benefits, and parental leave payments. They are not top-coded. We use parents' earnings as a control variable and the log of mothers' and fathers' earnings two years after birth as outcome variables.

Sick leave is reported by the Social Security Administration. It contains start and end dates for all certified illness-related work absences exceeding the first 16 days, which is paid by the employer. We only consider absences taken for the employee's own health (i.e., absence due to illness of other family members is ignored). The data also includes a variable indicating total sick leave payments during a period of absence. We consider both the number of days and the total payments for long-term sick leave that start after the conception of the child up to two years after the birth.

We examine parental labor market outcomes as a mechanism through which pregnancy loss may affect child outcomes. During pregnancy, maternal and practitioner perception of risk may be skewed and a "better safe than sorry" approach may be adopted for those who experienced a previous loss (Lyerly et al. 2009). Thus, after asserting that women with a history of pregnancy loss are less likely to be diagnoses with pregnancy-related health concerns and controlling, we examine sick leave as an indicator of potentially anxiety-driven investment. Finally, we examine whether the impact of pregnancy loss will endure post-pregnancy beyond the offspring by considering parental later labor market participation.

II. Estimation Strategy

Our goal is to examine the impact of exposure to miscarriage on the birth, health and educational outcomes of subsequent children. Given its largely random nature, we do not expect most single, early pregnancy losses to be determined by fertility or physical health issues that will affect subsequent children. We hypothesize that exposure to miscarriage increases stress which, in turn, affects investment during subsequent pregnancies by the mother and potentially others, such as fathers and doctors. While we do not observe maternal mental health, we can examine the impact of exposure to miscarriage on maternal investment.

We use a natural experiment induced by the near-random nature of single, early pregnancy losses to identify effects. There are three major considerations that must be factored into our identification framework. First, we must account for known non-random components of exposure to miscarriage and recognition of miscarriage. We do this through careful restrictions to our sample, including controls for factors associated with miscarriage, and a series of robustness tests. Second, we must consider potential endogeneity arising from unobserved factors such as genetics. To counteract bias arising from unobserved time-invariant factors we employ maternal fixed effects. Finally, we must consider time-variant factors such as paternity and maternal health and behavior. Here, we further employ control variables and sub-group analyses.

A. Factors in observed miscarriage

An important identifying assumption is the randomness of pregnancy loss, or in other words, that the factors correlated with pregnancy loss are unrelated to parent and subsequent child outcomes. Larsen et al (2013) summarize the biological evidence on the occurrence and mechanisms behind sporadic (one or two) and recurrent (three or more) miscarriages. There is strong evidence that about 85 percent of early pregnancy losses are caused by random fetal chromosomal abnormalities,[11] with a further 5 percent showing some chromosomal abnormality. Chromosomal abnormalities are less common in late and recurrent losses than sporadic early losses (Larsen et al. 2013), which occur in about one percent of women (Regan and Rai 2000). Loss after the first trimester is associated with further loss and pregnancy complications in subsequent pregnancies (Linehan et al. 2019). Thus, while there is a strong argument that most single, early pregnancy losses are random, this is not the case for the rarer events of recurrent and late miscarriage. For this reason, we restrict the sample of women with a history of pregnancy loss to those with a single, early pregnancy loss.

Studies on teen motherhood provide evidence that the randomness of pregnancy loss from a biological perspective is curtailed by socio-economic factors. Miscarriage is more likely to occur in lower-SES women, potentially driven by health gradients or access to healthcare including abortion (Hotz, McElroy, and Sanders 2005; Hotz, Mullin, and Sanders 1997; Li 2012; Miller 2011). We exclude assisted conceptions and control for maternal and family characteristics such as household income that are associated with increased risk of loss and non-random miscarriage. In sub-group analysis, we consider differential effects arising from child gender, maternal education, smoking status and paternity.

In further work on teen pregnancy, termination (abortion) is shown to censor miscarriage (Ashcraft, Fernández-Val, and Lang 2013; Ashcraft and Lang 2006; Fletcher and Wolfe 2009). While we do not observe abortion history in the data, in Norway in 2020, 85 percent of terminations took place within nine weeks of conception (Løkeland et al. 2021),[12] thus it is

[11] In fetal development, chromosomes act as blocks of DNA that contain instructions on development such as how cells are formed and eye color. At conception, the fetus can receive too many or too few chromosomes. The reasons for this are viewed as a random developmental occurrence, but it means the fetus will not be able to develop normally, resulting in a miscarriage. It is very unlikely to recur. www.nhs.uk/conditions/miscarriage/causes

[12] Birth and abortion rates have declined over time in Norway. In 2006, approximately 5.6% of women aged 15 to 49 gave birth. By 2020 this had dropped to approximately 4.4%. Annual abortion rates fell from approximately 1.3% of people aged 15 to 49, to 0.9% between 2006 and 2020 (Løkeland et al. 2021).

reasonable to expect that some miscarriages were prevented by termination. In particular, we must consider how termination may censor recurrent miscarriage. Where three or more miscarriages take place, the cause is no longer considered to be largely random, therefore there may be a proportion of women who undergo multiple terminations and, for some of these people, repeat terminations may censor multiple miscarriages. However, given the relative rarity of multiple abortions (0.16 to 0.48 percent of women[13]) and multiple miscarriages (1 to 2 percent of women), we do not anticipate that this will significantly bias our results. Furthermore, we exclude women with two miscarriages (despite indications that most pregnancy loss in this group would also be random) as some people in this group may have had an abortion, which would censor a third loss.

Finally, while we correct for the non-random causes of pregnancy loss, it is the *recognition* of miscarriage and the timing of the recognition that we are interested in using as a natural experiment. This may bias our sample towards women who recognize early pregnancy, for example, those trying to conceive or those who have struggled with conception, as it is reasonable to assume this group would engage in cycle tracking and early pregnancy detection. In the US, increasing miscarriage rates over time are likely a feature of increased recognition of pregnancy with increases in reported miscarriage strongest in the first seven weeks and absent after 12 weeks, and increasing more in white and better educated individuals (Lang and Nuevo-Chiquero 2012). In Norway, pregnant women have free access to healthcare, most miscarriages and abortions are registered, and there are high levels of education and awareness on the early signs of pregnancy (Magnus et al. 2019). However, to increase the robustness of our estimates, we exclude observations where there is a history of assisted conception. We also control for socioeconomic factors, and we consider higher educated mothers as a sub-sample. Finally, we include a control that covers the birth spacing between the study child and their older sibling.

Thus, we adopt a number of strategies to adjust for observable, non-random aspects of miscarriage. Mothers with a history of multiple or late pregnancy losses, stillbirths, and IVF

[13] For terminations between 2007 and 2011 in Norway, 37% were repeat terminations. In 12% of cases, two or more terminations had preceded the study observation. (Justad-Berg, Eskild, and Strøm-Roum 2015). Using the 2006 figures for terminations rates, this indicates that 0.48% of women will undergo their second termination annually and 0.16% of women will undergo their 3rd, or more, termination. Furthermore, one quarter of repeat terminations were for women with one previous live birth, the group we restrict our sample to.

are excluded from the sample.[14] We include controls for parental age, socioeconomic status (maternal civil status, and education and earnings of both parents) and maternal health (asthma, chronic hypertension, kidney disease, rheumatism, epilepsy and diabetes) that are explanatory factors for both pregnancy loss and the recognition of loss. In subsample analysis, we consider higher educated and lower educated mothers separately. As changing partners is a possible predictor of miscarriage (Maconochie et al. 2007), we re-analyze our results when the sample is restricted to children with the same father.

B. Unobserved factors

Our main sample includes mothers who gave birth between 1999 and 2018. Further to the sample restrictions based on pregnancy loss and conception history, we only consider mothers with two single births and at most one early pregnancy loss which occurred between births. This allows us to control for maternal fixed effects that are constant across children, that is we can leverage within-family between-sibling differences in exposure to pregnancy loss. This helps us account for unobservable genetic or anatomic factors that may influence miscarriage and child outcomes. Using a fixed effects strategy, identification derives from differences between the pre-natal periods for siblings, thus we control for fixed unobservable differences between mothers that may bias our results. Child gender is also included as a control. There are some disadvantages to this approach. It requires the exclusion of groups where stress may be higher, those without children and those who have experienced repeated pregnancy loss. We therefore expect our results will be a lower bound of the impact of miscarriage for the general population.

While the employment of fixed effects allows us to control for time-invariant maternal factors, we must also consider time-variant factors. To this end, we include control variables that vary across siblings. Fertility decisions will be affected by pregnancy loss. Birth spacing between siblings is a determinant of child outcomes and increases with miscarriage (Buckles and Munnich 2012), thus we control for this by including the ages of both parents at the birth of both siblings. Parental earnings and education, and maternal health are also allowed to vary over time in the model. In sub-group analyses we restrict the sample to siblings with the same

[14] 1% of the sample are pregnancies that end in late miscarriage, 0.2% are still births or do not survive the first year, and 2% are IVF births. The categories are not mutually exclusive, thus less than 3% of pregnancies are excluded from the sample due to these issues.

father, in order to address differences that arise from paternal factors. We also consider non-smokers as a separate group given the strong association between smoking and miscarriage (Pineles, Park, and Samet 2014).

C. Model

To estimate the effects of pregnancy loss on the outcomes of subsequent children, we restrict the population of Norwegian children born between 1999 and 2018 to two-sibling families, where mothers have a history of at most one early pregnancy loss that occurred between births and no history of assisted conception. For a mother, i, we consider the difference in outcomes for her second child compared to her first child, ΔY. Thus, we have the following model for our main specification:

$$\Delta Y_i = \alpha_0 + \alpha_1 P_i + \beta_1 \boldsymbol{D}_i + \beta_2 \boldsymbol{H}_i + \varepsilon$$

Our independent variable of interest is P, a binary indicator of previous pregnancy loss. Controls include $\boldsymbol{D}$, a vector of demographics including the gender of each child, mother's civil status, and parents' age, education in years and income at the time of each birth. $\boldsymbol{H}$ is a vector of maternal health characteristics at the time of each birth.

D. Descriptive statistics

Table 1 shows demographic and health information for women with two children who gave birth between 1999 and 2018.[15] Despite restrictions to remove women with a known risk of pregnancy loss (e.g., those with a history of assisted conception), there are some differences between the women with no history of pregnancy loss and women who experienced a single loss between their first and second child. As suggested by the literature (Maconochie et al. 2007; Turkeltaub et al. 2019), mothers who miscarry are on average older, their partners are older, they are less educated, more likely to be single at birth, and more likely to suffer from asthma. We control for these factors in our model.

E. Hypothesis

We want to examine the impact of pregnancy loss on the birth, health and educational outcomes of subsequent children. However, to hypothesize the impact of pregnancy loss on these

[15] Data on school outcomes is available for a subset of this group, births up to 2009. Differences between the groups are similar.

outcomes, we must first consider the impact of pregnancy loss on maternal stress and investment.

The intuition behind the impact of miscarriage is nuanced and under-studied. We expect miscarriage to have a negative impact on maternal mental health, as it often involves profound, stigmatized grief compounded by insufficient social and psychological supports (Bellhouse, Temple-Smith, and Bilardi 2018; Bute, Brann, and Hernandez 2019; Renner et al. 2000). Other studies in this area show the negative impact of exogenous shocks to maternal mental health during pregnancy (examples include Black, Devereux, and Salvanes 2016; Duncan, Mansour, and Rees 2017; Currie and Rossin-Slater 2013). However, we are interested in the interaction between previous loss and the recognition of subsequent pregnancy. In the early stages of subsequent pregnancy, particularly before the week of gestation when the pregnancy loss occurred, maternal stress may be heightened (Geller, Kerns, and Klier 2004). However, this may decline as pregnancy continues and viability of the fetus becomes more likely (Wilcox et al. 1988).

Miscarriage induced stress may also have heterogenous effects on investment. Maternal investment in pregnancy, such as supplement, alcohol and drug use, diet and lifestyle factors, are important determinants of child outcomes (reviews include Bell et al. 2018; Borge et al. 2017; Easey et al. 2019; Iglesias Vázquez, Canals, and Arija 2019; Yeoh et al. 2019). Typically, there is an increase in investment before and during pregnancy through activities such as attending pre-natal classes (Fabian, Rådestad, and Waldenström 2004). For some, pregnancy loss increases the sense of personal responsibility for the subsequent pregnancy (Franche and Mikail 1999), which could further increase investment. However, poor mental health, fear of childbirth and fear of miscarriage are also associated with decreased investment (Hassanzadeh et al. 2020). For some people with a history of pregnancy loss, they rest less and are less motivated to exercise in early pregnancy (Devlin, Huberty, and Downs 2016; McCarthy et al. 2015). This arises from uncertainty and ambivalence associated with the outcome of pregnancy. Indeed, there is some evidence that maternal-fetal attachment is lower in pregnancies after loss, particularly before the week of gestation at which the previous loss occurred (Christiansen 2017; Franche and Mikail 1999). There is also some suggestive evidence that parents delay announcing and seeking medical care for the subsequent pregnancy (Ney et al. 1994) and feel less emotional attachment (Robertson and Kavanaugh 1998), although these are all based on small sample studies. Such behavior may serve as a protective or coping mechanism.

Therefore, to form hypotheses we need to consider the impact of miscarriage on mental health and maternal investment. The detailed data on visits to primary and specialist health services allows us to study the impacts on mothers' mental (and physical) health during and after pregnancies. We examine investment through maternal behaviors regarding folic acid and multivitamin use and smoking, both before and during pregnancy, and attendance at ultrasound. If the impact of stress is detachment from the fetus, we expect to see no effects or a negative effect on investment. That is, a decrease in supplement use and ultrasounds, and an increase in smoking. Together with evidence on the impact of stress, we then expect a negative effect on child outcomes. Where a previous loss increases investment, effects will be determined by the countervailing impact of increased stress, which is expected to harm child outcomes, and increased investment, which is expected to improve outcomes. We further consider investment through parental labor force engagement, during pregnancy and two years after birth.

The birth outcomes we examine include weight, APGAR scores at one and five seconds, delivery by c-section, and gestation in weeks. High maternal stress and low investment are associated with worse outcomes across these measures (Abu-Saad and Fraser 2010; Ingrid Goh et al. 2006; Navaratne, Foo, and Kumar 2016). Stress and investment during pregnancy are also formative for educational outcomes (Kingston and Tough 2014), though the evidence is more mixed and these outcomes are less studied than outcomes earlier in childhood (Almond, Currie, and Duque 2018). Thus we include GPA, math, English and Norwegian reading scores at age ten. Our sample includes all women who meet our inclusion criteria between 1999 and 2018, thus test scores at age ten are available for a sub-group only. As a robustness check, we re-run all estimations restricted to this sample. We also consider this 'older' sub-group as a comparison group where acknowledgement of miscarriages may have been less and knowledge about maternal investment poorer.[16]

In sub-group analyses, we examine boys and girls separately. This is motivated by mixed evidence on heterogenous gender effects for parental preferences for investment and the impact of prenatal shocks and investment. For example, depending on the setting, parents invest more in girls or boys, with knock-on effects for child outcomes (Baker and Milligan 2016; Bharadwaj and Lakdawala 2013). There is also some evidence that boys are more susceptible to a poor prenatal environment, such as through exposure to alcohol (Nilsson 2017). However, gender

[16] For example, Norwegian nutrition authorities first recommended folic acid supplementation as a preventative measure against neural tube defects in 1998. Maternal knowledge of the importance of folic acid supplementation increased after this recommendation was made (Daltveit et al. 2004).

differences are not consistently found, for example Quintana-Domeque and Ródenas-Serrano (2017) find no gender effects regarding the impact of terror attacks on birth outcomes.

We also examine lower and higher educated mothers separately. Maternal education affects child health through the uptake of prenatal care, smoking status, marriage, and fertility decisions (Currie and Moretti 2003). Employing fixed effects controls for time invariant aspects of this effect, however it is reasonable to anticipate that mothers with higher and lower education levels may make different fertility and investment decisions before and after pregnancy loss. We expect higher educated mothers to recognize pregnancy and pregnancy loss earlier in gestation (Lang and Nuevo-Chiquero 2012). Thus, this could increase stress for a longer proportion of the pregnancy and may also have investment effects. The literature is ambiguous regarding the most impactful timing of prenatal stress, with evidence that stress impacts brain programming in both early and late gestation although through different mechanisms (Van den Bergh et al. 2020; Weinstock 2008). There is some evidence that early maternal investment has larger positive effects for the children of more educated mothers (Del Bono et al. 2016). For lower educated women, there is evidence that many will have a higher endowment level of stress, which is controlled for through our fixed effects specification, but also that stress in this group is more variable and will have greater impact on their children (Aizer, Stroud, and Buka 2016).

Table 1 shows evidence that early pregnancy loss is random conditional on maternal SES and time invariant characteristics.

III. Results

A. Maternal investment

To facilitate hypothesis setting on child outcomes, we first consider the impact of previous pregnancy loss on maternal investment during the subsequent pregnancy. Table 2 shows effects for maternal folic acid use, multivitamin use and smoking status before and during pregnancy, and whether the mother opted to have an ultrasound during her pregnancy. Given our specification, coefficients indicate the difference in maternal investment between siblings, conditional on a previous pregnancy loss. Table 2 shows that for a baseline difference of zero between siblings with no miscarriage history, younger siblings who were exposed to the after-effects of miscarriage were more likely to be exposed to folic acid supplementation and multivitamin use both before and during pregnancy compared to their older siblings. They were also exposed to significantly less smoking before and during pregnancy. The effect sizes range from 2.3 percentage points for smoking during pregnancy to 9.6 percentage points for folic acid before pregnancy.

The results are largely consistent in the main sample and across sub-groups, however there is no impact on smoking for less educated mothers. The effect sizes are also consistent for boys and girls, while there are somewhat larger effect sizes for high educated mothers. These results largely align with one branch of the literature which argues that following a loss, women increase investment in subsequent pregnancies. This could be driven by an increased sense of personal responsibility for the subsequent pregnancy. This highlights an important difference in maternity-induced stress and generalized stress, such as that examined by Aizer, Stroud, and Buka (2016) and Persson and Rossin-Slater (2018) – they showed no significant differences in investment based on prenatal cortisol levels and prenatal grief respectively. It is not surprising that an effect on smoking cessation is only evident in the higher educated group, as lower SES women have less knowledge of the importance of smoking cessation during pregnancy and, more so, are less likely to respond to this knowledge with smoking cessation (Meara 2001). Based on this evidence and the available literature on dual shocks and the persistence of shocks (Gunnsteinsson et al. 2019; Almond, Currie, and Duque 2018), we hypothesize that there will be a small, positive effect on birth outcomes and small positive or no effects on childhood test scores. Finally, we will facilitate later discussion of the results by considering another form of investment: parental labor market engagement.

B. Child Birth & Health outcomes

The evidence on how prenatal stress affects birth is mixed. Aizer, Stroud, and Buka (2016) show no impact of cortisol levels on birthweight or gestation, and Currie and Rossin-Slater (2013) show that exposure to hurricanes increases the probability of birth complications by 30 percent and abnormalities by 60 percent, however low birthweight and gestation are not affected. Persson and Rossin-Slater (2018) show evidence of a negative effect of maternal grief across birth outcomes: birthweight decreases by 18 grams, and low birth weight and pre-term births increase when exposed to grief. Where shocks improve investment, there is evidence of positive birth effects. For example, Bharadwaj, Johnsen, and Løken (2014) show an increase in birthweight of 175 grams after the introduction of a smoking ban in Norway. In a two-stage study that examines the countervailing impact of positive and negative prenatal shocks, Gunnsteinsson et al. (2019) consider the interaction of a tornado in Bangladesh with a pregnancy nutrition trial. While exposure to the tornado decreased birth size and post-natal growth and increased the incidence of fevers, supplementation with vitamin A protected against these factors. The negative and protective shocks are entirely driven by boys.

Thus based on the literature we do not expect miscarriage to have a negative effect on birth outcomes, given evidence of small or nil effects on birthweight in previous studies and some indication that mitigating shocks can offset negative health effects. Expectation on null or positive effects is unclear, though we expect larger shocks for boys. Table 3 shows the impact of previous loss on the birth outcomes of the subsequent child. We examine weight in grams, APGAR scores (where a higher score indicates better health), if delivery was by c-section, and the length of gestation in weeks. There is evidence of effects on birthweight, – an increase of 19 grams from older to younger siblings. Larger effect sizes are found for boys and low educated mothers. The size of the effect falls to 10 grams for the sample where siblings have the same father. Given the association between paternal weight and the birthweight of offspring (Klebanoff et al. 1998), this may indicate that paternal variables in the main specification are not sufficiently controlling for paternal effects. The effect size in the main sample is similar in scale to those found in studies of prenatal grief by Black, Devereux, and Salvanes (2016) and Persson and Rossin-Slater (2018), however they report a *decrease* in birthweight of 18 to 19 grams.

There is no impact on gestation length, or any other birth outcome, in any estimation sample, indicating that the birthweight effects are not driven by pregnancy length.

Table 4 examines the impact of pregnancy loss on subsequent child health. Siblings born following a pregnancy loss are less likely to have GP and ER visits than older siblings. In all cases the coefficients are negative, and in several cases, significantly so, particularly for visits later in childhood (between four and nine years). The effects are stronger for girls and children of higher educated mothers. Thus, it is possible that the beneficial effects of increased birthweight translates into improved health later in childhood.

C. Child Test Scores

In the literature on shocks to and investment in child development, effects in early childhood often fade by middle childhood – even when evidence of treatment effects re-emerge in adulthood (Almond, Currie, and Duque 2018). Thus, hypothesis on the impact of miscarriage on subsequent test scores is difficult. In similar work examining prenatal grief, Black, Devereux, and Salvanes (2016) find small negative effects on birth outcomes but no effects on school completion and cognitive test scores later in childhood and adulthood. However, Persson and Rossin-Slater (2018) show that exposure to prenatal grief increases the use of ADHD medications at age ten. In this cohort, we see evidence of positive effects on birthweight. Thus in line with the literature, we expect a fade-out of effects at school age. As shown in Table 5, this is largely the case. There are no significant effects on GPA, math, English, and Norwegian reading scores in the main sample or any sub-sample, and the coefficients are all negative. Thus from a positive impact on birth outcomes, pregnancy loss has no effect, or perhaps even a negative effect, on younger siblings by mid childhood. Given we expect investment to have driven positive effects at birth, we consider longer term parental investment as a potential mechanism behind this change in the direction of effects by age ten.

D. Parental labor market engagement

Data is available on maternal and paternal labor market engagement during and after pregnancy, which we consider as a mode of investment. During pregnancy, we consider sick days and sick pay – which we expect to increase where there is a history of pregnancy loss. There are two potential mechanisms at play here. Women with a history of pregnancy loss may have worse health overall, this could drive miscarriage, child outcomes, and sick leave in subsequent pregnancies. However, given the restrictions we imposed on our sample we think this unlikely. However, we consider this possibility in robustness testing, where we see few differences in maternal health dependent on pregnancy loss history and, in fact, women with a history of loss are less likely to experience hypertension in the subsequent pregnancy. Alternatively, we consider sick leave taken as a precaution by the mother and/or her doctor following a previous pregnancy loss. As such, it can also proxy increased pregnancy-related stress. Thus, while no more physically unwell, women with a history of loss may take more leave. We also consider parental labor market engagement, measured via maternal and paternal income, 2 years after birth.

The first two columns of Table 6 show the effects of previous pregnancy loss on sick leave and sick pay during the subsequent pregnancy. Across all samples we see a significant increase in sick leave and sick pay, an increase of three to four days between siblings for women with a history of loss. As Norway has broad social security, children are protected from a possible income shock arising from this increased sick leave. In columns 3 and 4, we examine whether this change to labor force engagement persists two years after birth. Maternal income is negatively affected by pregnancy loss two years after the birth of the subsequent child. This holds across all sub-samples. For fathers, there are no effects on labor market engagement Thus, it appears that mothers reduce their workloads in response to stress and/or an increase in time investments into their children, while fathers, perhaps due to household budget constraints do not change their workload.

In work examining the impact of taking leave from employment during pregnancy, Del Bono, Ermisch, and Francesconi (2012) find positive effects on birthweight. Further, they show that parental investment choices are influenced by the endowments of their existing children. Thus, we theorize that parental investment persists for the younger sibling, despite their relatively good health at birth, as investment decisions are based not only on the child's health but the outcomes of previous pregnancy, including the previous loss. Here we see a decrease in maternal pay in the two years after the birth of their younger child, which we assume is driven by choice or opportunity, compared to women with no history of pregnancy loss. For the impact on child outcomes, we consider it as a time investment similar to taking additional leave. Evidence is mixed on how leave from work after the birth of a child affects that child's outcomes. A Norwegian change to maternity leave in 1977 from 12 weeks of unpaid leave to 4 months of paid leave and 12 months of unpaid leave had significant positive impacts on high school completion and wages, driven by large effects for the children whose mothers could not take much leave under the previous rules (Carneiro, Løken, and Salvanes 2015). However, work examining the impact of extensions to paid leave in later periods after birth show no effects or negative effects on child outcomes, with some evidence of heterogenous effects (Baker and Milligan 2016; Danzer and Lavy 2018). Thus, while maternal time investment in their children persists after birth, our results indicating few and possible negative effects on grades aligns with some of the literature – potentially showing the importance of financial security over further time investment. Alternatively, declines in child outcomes and maternal labor engagement could arise from the persistence of mental health issues, for which there is some evidence in the literature (Hunfeld et al. 1997). Regardless of the interpretation with respect to child outcomes, it is clear that pregnancy loss is a costly experience for women's human capital even two years after the birth of subsequent children.

Overall, impact of previous pregnancy loss on the outcomes of subsequent children is mixed. There is a consistent positive impact on most facets of maternal investment before and during pregnancy. Birthweight is positively affected across samples, with fewer effects on other birth outcomes. By age ten, there are no positive effects. We hypothesize that this could be attributable to lingering investment decisions and stress that affect household characteristics after birth.

IV. Robustness Tests

A. Maternal physical health

We make a number of assumptions about maternal physical health. In our hypothesis on how pregnancy loss affects subsequent child outcomes, we assume that changes to stress and investment induced by the miscarriage drive any effects. Secondly, we argue that sick leave during pregnancy arises from investment decisions and stress, rather than poorer physical health in mothers with a history of pregnancy loss. To test the robustness of these underlying assumptions, we must consider the impact of a previous pregnancy loss on maternal health. In our model specification, we control for indicators of maternal health – typically chronic disease – that can change over time and are associated with increased risk of miscarriage. This includes asthma, hypertension, kidney disease, rheumatism, epilepsy, and diabetes. Now we also consider whether pregnancy loss can cause worse health in subsequent pregnancy.

Table 7 shows the impact of exposure to pregnancy loss on five pregnancy conditions: gestational diabetes, hypertension, eclampsia, pre-eclampsia, and early pre-eclampsia. Given the higher rate of sick leave in women with a history of miscarriage, reporting may be biased upward for this group. That is, we expect those who engage with health services more likely to be diagnosed with conditions than those who have a condition but do not attend health services for diagnosis. To check the impact of health services access on diagnoses, we consider eclampsia in three stages. If access to health services drives some of our outcomes, we would expect women with a history of pregnancy loss to have higher rates of early preeclampsia, and women without a history of miscarriage to have higher rates of eclampsia – where earlier stages of the disease went undiagnosed and unmanaged.

As shown in Table 7, there is no evidence that women with a previous pregnancy loss have poorer health outcomes in subsequent pregnancies, indeed women with a history of miscarriage are less likely to be diagnosed with hypertension. This improved health could arise from increased investment, which we see through increased supplementation across the cohort and decreased smoking. Contrary to the other markers of maternal health, the coefficients on gestational diabetes are positive, although not significant. In sum, these results suggest that women who experienced a previous miscarriage do not enter the next pregnancy with poorer health outcomes.

The health information discussed above comes from the birth registers. We complement this information with medical visits undertaken during and immediately after the pregnancy in Tables 8-13. After a pregnancy loss there is an increase in the total number of primary health care visits attended during the subsequent pregnancy. Table 8 shows that mothers who experienced a previous loss have an increased number of GP visits, consultations, ultrasounds, and lab tests, however there are no differences in the number of ER visits. This might be driven by increased contacts with the health care system and an abundance of caution by either the pregnant woman or the health professionals. In Norway, pregnant women follow a check-up schedule and can opt to go to the GP or the midwife for these free check-ups. Additional pregnancy related visits are also free of charge. The midwives are, however, employed by the municipality and are therefore not billing free for service requests. Hence, we do not see how many times mothers visit the midwife in the administrative data. Table 9 shows that these increases in primary health care visits are primarily driven by pregnancy related issues and concerns and not by health conditions such as diabetes and hypertension. Importantly, these visits are not related to psychological symptoms which suggests that the mechanism underlying increased investment during pregnancy is not driven by stress .

In Table 10 we present the impacts on the number of primary care visits in the 7 years following the subsequent pregnancy. In the years immediately following the birth (years 1-4), mothers who previously experienced a loss, have significantly less health visits. In addition, for the visits that do take place, Tables 11-13 show that there are almost no differences in the diagnoses arising from these visits. Mothers with a pregnancy loss are less likely to attend a primary health care visit due to pregnancy and contraception issues in years one, two, and three, and there are no significant differences regarding other conditions including issues related to blood, immune system, digestive, eye/ear, cardiovascular, musculoskeletal, neurological, respiratory, skin, endocrine, urological, and genital. In addition, following a pregnancy loss, mothers are not attending primary health care visits due to psychological related issues.

Based on these results, it is possible that higher levels of investment in pregnancy, in terms of supplementation and increased preventative care, may translate into improved health after birth.

Overall, there is no indication that pregnancy loss affects subsequent children through negative changes to maternal health either during or after birth. Furthermore, high use of sick leave during pregnancy and reduced income after pregnancy does not appear to be motivated by physical health conditions.

B. Timing

The period in which a woman experiences loss and subsequent pregnancy is also of interest. We argue that the traditionally social and medical taboo nature of pregnancy loss is likely to contribute to the traumatizing impact of the loss. However, recent decades have seen an increase in research and literature on the impact of miscarriage, alongside changes to treatment, post-loss care, and increases in public discourse on pregnancy loss. Throughout our analysis we examine a sub-sample of pregnancies that took place between 1999 and 2008 (i.e., excluding the last 10 years), which we call the 'school sample' where data on test scores at age ten is available. This sample allows us to also consider the impact of the lessening of the taboo and decreases the risk of including women with unobserved repeat miscarriage. For example, if a woman has a child in 2006, a miscarriage in 2007, and a child in 2008 with no other pregnancy history, she is included in our main specification. However, we cannot observe whether she goes on to have multiple subsequent losses.[17] By examining children for whom we have ten years of data, we can also exclude many women with observed repeat miscarriage after the birth of the study child.

[17] We also do not observe silent miscarriage, pregnancy loss that a woman is unaware of, usually occurring in very early pregnancy. 15 to 25% of pregnancies are estimated to end in silent miscarriage (Linnakaari et al. 2019; Wang et al. 2003). Silent miscarriage can be identified after the fact through changes to urine samples or ultrasound, or may go unrecognized. While early pregnancy loss is associated with higher conception rates in subsequent cycles, shorter time-to-conceive, subsequent silent miscarriage, and clinical pregnancy, silent miscarriage is not associated with subsequent recognized pregnancy loss or subsequent birth outcomes (Wang et al. 2003). Thus we do not expect silent miscarriage rates to vary between women with and without recognized pregnancy loss, or to bias reporting on child outcomes.

In panel G of Tables 2 to 6, results are shown for the school sample, except Table 4 where the main sample is the school sample. In Table 2, which examines investment decisions, we find consistent significant effects regardless of the sample's timespan. For the school sample, investment is positively affected, with slightly smaller coefficients on folic acid and smoking. This could, in part, arise from knowledge as the Norwegian nutrition authorities first recommended folic acid supplementation just before and during early pregnancy in March 1998 which corresponds to the start of our sample period. In 1998, 33 percent of Norwegian women of reproductive age knew about the role of folate in pregnancy, yet this increased to 46 percent by 2000 (Daltveit et al. 2004).

In Table 3, we find that there is a consistent increase in birthweight across all sub-samples except for the school sample. There is a positive coefficient on weight, but no significant difference. However, APGAR scores at one minute also saw a significant improvement post-miscarriage. We theorize that fewer birth effects are seen for this sub-sample due to the relative lack of support provided during this period when miscarriages were more taboo.

The results for the main sample and sub-sample are the same when we examine test scores in Table 4, where we find a negative effect on overall GPA. We theorized that, based on the main sample, this may arise from the temporary erosion of effects in middle childhood that may re-appear in adulthood, or that reduced maternal income after birth may have detrimental effects on school performance. However, given the reduced effects in the sub-sample at birth and our theory of increased stress, this may also be explained by the enduring effects of poor maternal mental health.

A further consideration on timing is birth spacing and fertility decisions that arise from pregnancy loss. Three out of five women who experience miscarriage become pregnant within the next two years (Smith, Ewings, and Quinlan 2009). By nine months after miscarriage, there is evidence that women can maintain clinically important levels of stress (Farren et al. 2020), however for women who conceive within six months of miscarriage, there is associative evidence that pregnancy and birth outcomes tend to be better than for women with longer pregnancy intervals (Love et al. 2010). Conversely, intervals of up to six months between pregnancies that result in live births are associated with worse outcomes compared to 18-month intervals, particularly in older women (Schummers et al. 2018). By including the age of mothers at the births of the children before and after the miscarriage, we inherently control for the impact of birth spacing. However, we do not observe the timing of pregnancy loss between these two births, therefore we cannot consider the impact of recognizing a subsequent pregnancy while experiencing acute distress from a recent loss.

In our specification, we consider women with two children where any loss occurs between births. This allows us to compare the younger sibling to the older sibling who had no exposure to loss-related shocks. However, it is reasonable to expect that the stress response to loss for nulliparous women may be greater – though evidence on this is mixed. For example, Tseng et al. (2017) report that couples with no living children experience more intense grief that couples with living children, while Woods-Giscombé, Lobel, and Crandell (2010) report that parity does not buffer the impact of anxiety after loss. Further, the probability of experiencing a miscarriage is 30 percent lower for women with one previous live birth, compared to women with no previous births (Maconochie et al. 2007). Thus, while women with a history of loss before any live births may experience a more stressful reaction to miscarriage, it is more difficult to assert the exogeneity of miscarriage itself. We consider a sample of women with two children, where at most one pregnancy loss occurred before the birth of the two living children (when the woman was nulliparous). In appendix A1, measures of maternal physical health indicate worse prenatal health, including an increased risk of hypertension and preeclampsia, for the women in the sample who experienced a loss before their first birth compared to the women with no loss, Thus, we cannot reasonably assert the exogenous occurrence of pregnancy loss in this group. As such, the results of this study cannot be considered representative of the universe of women who experience pregnancy loss.

C. Sample Selection

In our main analysis we control for socioeconomic risk factors associated with miscarriage, acknowledging that 10 to 15 percent of pregnancy losses are not attributed to random chromosomal abnormalities (Larsen et al. 2013). In effect, this means that for a proportion of our sample the loss was not random.

First, we consider a restriction on the data to reduce any bias this introduces. Smoking while pregnant is a strong predictor of miscarriage. There is a 1 percent increase in the relative risk of miscarriage per cigarette smoked per day; smoking cessation at conception or early in pregnancy reduces the risk of miscarriage by 25 percent compared to people who smoke further into pregnancy, while non-smokers and former smokers have a similar risk of miscarriage (Pineles, Park, and Samet 2014). Thus we consider smoking status as a selection criteria into non-random miscarriage, and re-estimate our results for only non-smokers. As a consequence, this could restrict our sample to higher SES mothers, however, in our main sample 35 percent are classified as having low education and 31 percent of the non-smoker sample have low educational attainment.

Results are available in appendix two. For investment (Table A2a), the results are similar in significance and magnitude to the main results. However, among non-smokers, those with a history of pregnancy loss are significantly less likely to attend an ultrasound - however the effect is small at 0.3 percent. At birth (Table A2b), the positive effects on weight are maintained. However, sporadic effects on other outcomes depending on the sub-sample are no longer evident, potentially indicating that bias from non-random loss may explain some of the inconsistency in sub-sample results. By school age (Table A2c), there is no significant impact on grades, in contrast to the negative significant effects on GPA in the main sample, however the coefficients remain negative. Results for parental labor market engagement (Table A2d) are consistent with the main results, there is an increase in sick leave and pay during pregnancy that cedes to lower maternal pay two years after birth. For maternal physical health (Table A2e), the results are largely consistent with the main sample for hypertension, where there is a decrease for women with a history of pregnancy loss. However, any effects on eclampsia – where there were sporadic improvements based on miscarriage – are no longer evident.

In work on teen pregnancy, Hotz et al. (1997; 2005), bound treatment effects based on population estimates of the randomness of pregnancy loss and the prevalence of pregnancy termination. We do not observe abortion, and thus these bounds would be too broad to be meaningful (Goodman, Kaplan, and Walker 2004). In this paper we calculate the adjustment for point estimates as Hotz et al. describe, based on epidemiological estimates of the proportions of births and random miscarriages in the population. Based on the literature, we estimate a probability of 70 to 80 percent that a pregnancy will end in birth (P_B), a maximum rate of 5 percent for abortions, and that, for the miscarriages that do occur, 10 to 15 percent will be random. This is based on estimations of when chromosomal abnormalities cause (85 percent) and are detected in (a further 5 percent) miscarriages and are thus random. Hotz et al. (1997) adjust point estimates by a factor of $1/P_B(1 - P_{NR})$, and so in this case we estimate that the point estimates may be under-reported by a factor of 1.28 to 1.48. Where we report a 19.8 gram difference in birth weight in our sample of siblings with the same father, the true effect may be closer to 12.5 to 14.4 grams. These adjustments contain only rudimentary consideration of abortion and do not account for the heterogeneity introduced into the sample from the contamination of the randomness of miscarriage (Goodman, Kaplan, and Walker 2004). However, in contrast to many other studies examining miscarriage, we employ maternal fixed effects alongside the natural experiment to correct for unobserved time-invariant factors that may determine the nature of miscarriage, alongside various restrictions on the sample to exclude women with a high chance of non-random loss. Thus, we expect our original point estimates to be generally robust to the inclusion of non-random losses in the sample.

Overall, we see robust evidence that when accounting for non-random assignment, a history of miscarriage increases investment through supplementation. While mental health effects may be evident in the lower uptake of ultrasound, we caution that the significant difference in uptake masks a small effect size. In turn, there is a positive impact of previous miscarriage on birth weight, but this benefit fades by school age, potentially as a result of lingering changes to maternal investment. Other, sporadic effects that we see in our main specification (e.g. APGAR scores) may be noise arising from the presence of non-random loss in the sample, however, our model specification is generally successful at controlling for the impact of such non-randomness.

V. Conclusion

There is growing evidence on the impact of shocks to investment and stress during pregnancy on child outcomes (Almond, Currie, and Duque 2018), and while the destigmatization of pregnancy loss is increasing, little is known about the impact of this common, largely random, and traumatizing experience on subsequent child outcomes (Quenby et al. 2021). In this study, we show that the impact of pregnancy loss on maternal investment in subsequent pregnancies may offset the negative consequences of stress and, instead improve the birth and health outcomes of subsequent children. However, over time, child outcomes disimprove, as maternal investment results in decreased human capital accumulation by the mother.

Using Norwegian registry data, we examine the impact of pregnancy loss on parental investment and subsequent child outcomes. Using careful sample selection and model specification, we assert that single, early pregnancy losses that occur between a woman's first and second live births are an exogenous shock to subsequent investment decisions and child outcomes. The medical, psychological, and epidemiological literature indicates increased anxiety, depression, and stress for people who experience miscarriage (Geller, Kerns, and Klier 2004), and the economic literature demonstrates the harmful impact of exposure to stress and grief in utero (Aizer, Stroud, and Buka 2016; Black, Devereux, and Salvanes 2016; Persson and Rossin-Slater 2018). Hypothesis setting on the impact of previous loss on parental investment was less clear, therefore we provide evidence that a history of miscarriage increases investment, through improved nutrition and decreased smoking. In addition, we argue that investment is evident of a more cautious approach to the subsequent pregnancy, through increased use of sick leave despite evidence that the physical health of women who experience a miscarriage is similar or slightly better than women who do not. Therefore, after experiencing a loss, we assume women undergo increased stress, but we also show that there is a countervailing force through an increase in investment. The investment is effective, with higher birthweight and better health outcomes for children where mothers have experienced a miscarriage. By middle childhood however, few effects are evident on school outcomes. This is consistent with the broad literature on early childhood investment (Almond, Currie, and Duque 2018).

We examined sub-groups based on gender, maternal education, paternity, time and maternal smoking status. We found no evidence that the impact of previous miscarriage has heterogenous effects on investment or outcomes based on child gender. Results are largely consistent when we examine results by maternal education. The effects on prenatal investment and school outcomes are similar in both groups, and while birthweight is positively impacted in both groups, the effect is twice as large for the children of lower educated mothers. This could arise from differential effects of a previous loss on maternal health in the subsequent pregnancy e.g., while higher educated mothers may always be aware of the benefits of supplementation, lower educated mothers may become more cognizant of the benefits after a pregnancy loss. When we restrict the sample to children with the same father, the results are consistent in terms of significance, though the scale of the effect on birthweight is decreased. When we examine the sub-sample of births that took place in the earlier half of our sample, we find some reduced effects on birth outcomes which we theorize may result from poorer knowledge of maternal investment and increased stress during a period when miscarriage was more stigmatized. Overall, our subgroup analyses points to the importance of maternal investment in pregnancy for counteracting potentially detrimental factors such as stress, taboo, and household resources.

Our study aligns with work on the impact of birth spacing where, when using miscarriage as an exogenous shock to birth spacing, positive child outcomes are evident (Buckles and Munnich 2012). In the specification used here, we control for birth spacing, but our findings suggest that the larger effects Buckles and Munnich find may be, in part, driven by its effect on maternal investment. Our study stands in contrast to other work on prenatal shocks to mental health, and highlights the importance of the origin of the shock. Aizer at al. (2016) and Persson and Rossin-Slater (2018) do not find evidence of increased investment in response to increased stress. We theorize that strong investment effects arise here because the shock is more directly relatable to pregnancy. This increase in investment may explain the positive effect that miscarriage has on birth outcomes, in contrast to other forms of grief (Black, Devereux, and Salvanes 2016; Persson and Rossin-Slater 2018). However, the negative impact of miscarriage persists for the mother. Persson and Rossin-Slater (2018) find no maternal income effects in the year of conception and the following year following birth, and Karimi (2014) finds a positive impact of birth spacing exogenously affected by pregnancy loss, on maternal labor market engagement. However, we show evidence that a history of miscarriage leads to lower maternal labor market engagement during pregnancy and two years after. While this could be interpreted as an investment in subsequent offspring, it is also a depletion of maternal human capital (and income) that could be costly in the long-run.

A major contribution of this paper is the use of careful identification and specification to examine a phenomenon typically studied in non-economic disciplines using descriptive and associative approaches. We take advantage of the largely random nature of pregnancy loss to examine a shock to maternal stress and investment, however we also add to the economic literature (examples include Buckles and Munnich 2012; Hotz, McElroy, and Sanders 2005; Li 2012; Miller 2011) that has exploited miscarriage as an exogenous shock by incorporating an estimation strategy based on maternal fixed effects that draws from the literature on prenatal shocks (the most closely related to this study include Aizer, Stroud, and Buka 2016; Black, Devereux, and Salvanes 2016; Persson and Rossin-Slater 2018). Together with sample exclusions, controls, and sub-group analyses informed by epidemiological studies on non-random miscarriage (for reviews see Maconochie et al. 2007; Regan and Rai 2000), this study examines the impact of random pregnancy loss with some precision.

However, there are limitations that arise with our estimation strategy. We do not observe termination of pregnancy in our data, which could censor miscarriage (Ashcraft and Lang 2006; Ashcraft, Fernández-Val, and Lang 2013; Fletcher and Wolfe 2009) – that is, we may be including women in the sample who terminated pregnancies that, if not terminated, would have resulted in miscarriages. If a woman terminated a pregnancy between two births in advance of a miscarriage she selected out of the miscarriage group and into the no-miscarriage group. If a woman experienced a loss between births and multiple terminations censoring multiple miscarriages, they will not be caught by our exclusion criteria. The absence of information on abortion also precludes us from calculating bounds on our estimations as outlined by Hotz, Mullin, and Sanders (1997).

A second limitation of this study is that the estimates likely represent a lower bound for the impact of miscarriage via stress on investment and child outcomes. We restrict our sample to maternal fixed effects, thus controlling for maternal time invariant factors that may determine miscarriage, investment, stress, and child outcomes. However, in doing so we exclude groups for whom pregnancy loss may be more traumatic such as those with no living children and those with repeated experience of loss (Huffman, Swanson, and Schwartz 2010). Thus, while we conclude that miscarriage has a protective effect for subsequent children as increased investment counteracts increased stress, this cannot be generalized to the entire population of women who experience pregnancy loss. Finally, while three out of five women give birth within two years of miscarriage and four out of five women give birth within five years, some women – particularly older women and those with more than one miscarriage – may select out of further pregnancy (Smith, Ewings, and Quinlan 2009). While we control for birth spacing as a fertility decision arising from a previous loss, we do not consider the impact of pregnancy loss on selecting out of further pregnancy or other household outcomes such as the breakdown of relationships (Neff and Karney 2004). These are important considerations of the impact of pregnancy loss that should be examined in follow-on work.

Based on the medical and epidemiological literature, we assume an increased stress-load in the aftermath of pregnancy loss and on the recognition of subsequent pregnancy (for a review, see Geller, Kerns, and Klier 2004). However, many studies in this area are based on small samples and/or have methodological issues. Further work should examine measures of miscarriage-induced stress and its effect on subsequent outcomes, employing suitably robust methods as in this study. This would allow for a breakdown of the countervailing influences of stress and investment on maternal and child outcomes. Furthermore, this study considers only parental investment. An interesting finding here concerns maternal sick leave, which increases without a corresponding increase in pregnancy-related illnesses or complications. We interpret this from the perspective of maternal investment, however it may also highlight differences in medical practice that could improve birth outcomes. Thus, examining the impact of previous loss on health service investment would be elucidating from a health policy and practice perspective. Finally, the cost of maternal human capital decline should be further considered in the broader implications of miscarriage.

Pregnancy loss is a common, taboo, and emotionally disruptive event. Arising in part from high short-term economic costs (estimated at £471 million in the UK annually) and estimates of the psychological and physical impacts of miscarriage, there is an increasing demand for robust analyses of the implications of miscarriage and improved supports for those experiencing it (Quenby et al. 2021). A recent review of the evidence on approaches to treating miscarriage, concluded that the pervasive attitude of acceptance undermines and risks dismissing the impact of miscarriage (The Lancet 2021). Thus, this paper is a major contribution to the discourse on miscarriage through employing careful identification and specification to examine the effect that pregnancy loss has on subsequent maternal investment and child outcomes. We find that women with a history of miscarriage between live births significantly increase their investment in the subsequent pregnancy and see improved birth outcomes for their subsequent child. However, by mid childhood the impact of miscarriage has become negative for mothers, indicating the need for long-term supports. As research and understanding on the impact of miscarriage and other prenatal shocks to mental health continues, investment and long-term supports are vital considerations.

References

Abu-Saad, Kathleen, and Drora Fraser. 2010. 'Maternal Nutrition and Birth Outcomes'. *Epidemiologic Reviews* 32 (1): 5–25. https://doi.org/10.1093/epirev/mxq001.

Ahammer, Alexander, Martin Halla, and Nicole Schneeweis. 2020. 'The Effect of Prenatal Maternity Leave on Short and Long-Term Child Outcomes.' *Journal of Health Economics* 70 (March): 102250. https://doi.org/10.1016/j.jhealeco.2019.102250.

Aizer, Anna, Laura Stroud, and Stephen Buka. 2016. 'Maternal Stress and Child Outcomes: Evidence from Siblings'. *The Journal of Human Resources* 51 (3): 523–55. https://doi.org/10.3386/w18422.

Almond, Douglas, Janet Currie, and Valentina Duque. 2018. 'Childhood Circumstances and Adult Outcomes: Act II'. *Journal of Economic Literature* 56 (4): 1360–1446.

Almond, Douglas, and Bhashkar Mazumder. 2011. 'Health Capital and the Prenatal Environment: The Effect of Ramadan Observance during Pregnancy'. *American Economic Journal: Applied Economics* 3 (4): 56–85.

Almond, Douglas, Bhashkar Mazumder, and Reyn van Ewijk. 2015. '"In Utero" Ramadan Exposure and Children's Academic Performace'. *The Economic Journal* 125 (589): 1501–33.

Ashcraft, Adam, Iván Fernández-Val, and Kevin Lang. 2013. 'The Consequences of Teenage Childbearing: Consistent Estimates When Abortion Makes Miscarriage Non-Random'. *The Economic Journal* 123 (571): 875–905.

Ashcraft, Adam, and Kevin Lang. 2006. 'The Consequences of Teenage Childbearing'. 12485. NBER Working Paper. NBER. DOI: 10.3386/w12485.

Aune, Dagfinn, Abhijit Sen, Tore Henriksen, Ola Didrik Saugstad, and Serena Tonstad. 2016. 'Physical Activity and the Risk of Gestational Diabetes Mellitus: A Systematic Review and Dose—Response Meta-Analysis of Epidemiological Studies'. *European Journal of Epidemiology* 31 (10): 967–97.

Baker, Michael, and Kevin Milligan. 2016. 'Boy-Girl Differences in Parental Time Investments: Evidence from Three Countries.' *Journal of Human Capital* 10 (4): 399–441.

Bell, Kerry, Belen Corbacho, Sarah Ronaldson, Gerry Richardson, David Torgerson, Michael Robling, and on behalf of the Building Blocks trial group. 2018. 'The Impact of Pre and Perinatal Lifestyle Factors on Child Long Term Health and Social Outcomes: A Systematic Review'. *Health Economics Review* 8 (1): 2. https://doi.org/10.1186/s13561-018-0186-6.

Bellhouse, Clare, Meredith J. Temple-Smith, and Jade E. Bilardi. 2018. '"It's Just One of Those Things People Don't Seem to Talk about..." Women's Experiences of Social Support Following Miscarriage: A Qualitative Study'. *BMC Women's Health* 18 (1): 176. https://doi.org/10.1186/s12905-018-0672-3.

Bharadwaj, Prashant, Julian V. Johnsen, and Katrine V. Løken. 2014. 'Smoking Bans, Maternal Smoking and Birth Outcomes'. *Journal of Public Economics* 115 (Journal Article): 72–93. https://doi.org/10.1016/j.jpubeco.2014.04.008.

Bharadwaj, Prashant, and Leah K. Lakdawala. 2013. 'Discrimination Begins in the Womb: Evidence of Sex-Selective Prenatal Investments'. *The Journal of Human Resources* 48 (1): 71–113. https://doi.org/10.1353/jhr.2013.0004.

Black, Sandra E., Paul J. Devereux, and Kjell G. Salvanes. 2007. 'From the Cradle to the Labor Market? The Effect of Birth Weight on Adult Outcomes'. *The Quarterly Journal of Economics* 122 (1): 409–39. https://doi.org/10.1162/qjec.122.1.409.

———. 2016. 'Does Grief Transfer across Generations? Bereavements during Pregnancy and Child Outcomes'. *American Economic Journal: Applied Economics* 8 (1): 193–223.

Borge, Tiril Cecilie, Heidi Aase, Anne Lise Brantsæter, and Guido Biele. 2017. 'The Importance of Maternal Diet Quality during Pregnancy on Cognitive and Behavioural Outcomes in Children: A Systematic Review and Meta-Analysis'. *BMJ Open* 7 (9): e016777–e016777. https://doi.org/10.1136/bmjopen-2017-016777.
Branjerdporn, Grace, Pamela Meredith, Trish Wilson, and Jenny Strong. 2021. 'Maternal–Fetal Attachment: Associations with Maternal Sensory Processing, Adult Attachment, Distress and Perinatal Loss'. *Journal of Child and Family Studies* 30 (2): 528–41. https://doi.org/10.1007/s10826-020-01876-1.
Bruckner, Tim A., Laust H. Mortensen, and Ralph A. Catalano. 2016. 'Spontaneous Pregnancy Loss in Denmark Following Economic Downturns'. *American Journal of Epidemiology* 183 (8): 701–8. https://doi.org/10.1093/aje/kww003.
Buckles, Kasey S., and Elizabeth L. Munnich. 2012. 'Birth Spacing and Sibling Outcomes'. *Journal of Human Resources* 47 (3): 613–42.
Bute, Jennifer J., Maria Brann, and Rachael Hernandez. 2019. 'Exploring Societal-Level Privacy Rules for Talking about Miscarriage'. *Journal of Social and Personal Relationships* 36 (2): 379–99. https://doi.org/10.1177/0265407517731828.
Carneiro, Pedro, Katrine V. Løken, and Kjell G. Salvanes. 2015. 'A Flying Start? Maternity Leave Benefits and Long-Run Outcomes of Children'. *The Journal of Political Economy* 123 (2): 365–412. https://doi.org/10.1086/679627.
Chatterji, Pinka, Dohyung Kim, and Kajal Lahiri. 2014. 'Birth Weight and Academic Achievement in Childhood'. *Health Economics* 23 (9): 1013–35.
Christiansen, Dorte M. 2017. 'Posttraumatic Stress Disorder in Parents Following Infant Death: A Systematic Review'. *Clinical Psychology Review* 51 (February): 60–74. https://doi.org/10.1016/j.cpr.2016.10.007.
Cook, Justin C., and Jason M. Fletcher. 2015. 'Understanding Heterogeneity in the Effects of Birth Weight on Adult Cognition and Wages.' *Journal of Health Economics* 41 (May): 107–16. https://doi.org/10.1016/j.jhealeco.2015.01.005.
Currie, Janet, and Douglas Almond. 2011. 'Human Capital Development before Age Five'. In *Handbook of Labor Economics*, edited by David Card and Orley Ashenfelter, 4:1315–1486. Elsevier. https://doi.org/10.1016/S0169-7218(11)02413-0.
Currie, Janet, and W. Bentley MacLeod. 2016. 'Diagnosing Expertise: Human Capital, Decision Making, and Performance among Physicians'. *Journal of Labor Economics* 35 (1): 1–43. https://doi.org/10.1086/687848.
Currie, Janet, and Enrico Moretti. 2003. 'Mother's Education and the Intergenerational Transmission of Human Capital: Evidence from College Openings'. *The Quarterly Journal of Economics* 118 (4): 1495–1532. https://doi.org/10.1162/003355303322552856.
Currie, Janet, and Maya Rossin-Slater. 2013. 'Weathering the Storm: Hurricanes and Birth Outcomes.' *Journal of Health Economics* 32 (3): 487–503. https://doi.org/10.1016/j.jhealeco.2013.01.004.
Currie, Janet, and Hannes Schwandt. 2013. 'Within-Mother Analysis of Seasonal Patterns in Health at Birth'. *Proceedings of the National Academy of Sciences - PNAS* 110 (30): 12265–70. https://doi.org/10.1073/pnas.1307582110.
Daltveit, Anne Kjersti, Stein Emil Vollset, Britt Lande, and Henriette Øien. 2004. 'Changes in Knowledge and Attitudes of Folate, and Use of Dietary Supplements among Women of Reproductive Age in Norway 1998-2000.' *Scandinavian Journal of Public Health* 32 (4): 264–71. https://doi.org/10.1080/14034940310019515.
Danzer, Natalia, and Victor Lavy. 2018. 'Paid Parental Leave and Children's Schooling Outcomes'. *The Economic Journal* 128 (608): 81–117. https://doi.org/10.1111/ecoj.12493.

Del Bono, Emilia, John Ermisch, and Marco Francesconi. 2012. 'Intrafamily Resource Allocations: A Dynamic Structural Model of Birth Weight'. *Journal of Labor Economics* 30 (3): 657–706. https://doi.org/10.1086/664831.

Del Bono, Emilia, Marco Francesconi, Yvonne Kelly, and Amanda Sacker. 2016. 'Early Maternal Time Investment and Early Child Outcomes'. *Economic Journal* 126 (596): F96-135.

Devlin, Courtenay A., Jennifer Huberty, and Danielle Symons Downs. 2016. 'Influences of Prior Miscarriage and Weight Status on Perinatal Psychological Well-Being, Exercise Motivation and Behavior'. *Midwifery* 43 (December): 29–36. https://doi.org/10.1016/j.midw.2016.10.010.

Duncan, Brian, Hani Mansour, and Daniel I. Rees. 2017. 'It's Just a Game: The Super Bowl and Low Birth Weight'. *The Journal of Human Resources* 52 (4): 946–78. https://doi.org/10.3368/jhr.52.4.0615-7213R.

Easey, Kayleigh E., Maddy L. Dyer, Nicholas J. Timpson, and Marcus R. Munafò. 2019. 'Prenatal Alcohol Exposure and Offspring Mental Health: A Systematic Review'. *Drug and Alcohol Dependence* 197 (Journal Article): 344–53. https://doi.org/10.1016/j.drugalcdep.2019.01.007.

Ermisch, John, and David J. Pevalin. 2005. 'Early Motherhood and Later Partnerships'. *Journal of Population Economics* 18 (3): 469–89.

Everett, Christopher. 1997. 'Incidence and Outcome of Bleeding before the 20th Week of Pregnancy: Prospective Study from General Practice'. *BMJ* 315 (7099): 32–34. https://doi.org/10.1136/bmj.315.7099.32.

Fabian, Helena M., Ingela J. Rådestad, and Ulla Waldenström. 2004. 'Characteristics of Swedish Women Who Do Not Attend Childbirth and Parenthood Education Classes during Pregnancy.' *Midwifery* 20 (3): 226–35. https://doi.org/10.1016/j.midw.2004.01.003.

Farren, Jessica, Maria Jalmbrant, Nora Falconieri, Nicola Mitchell-Jones, Shabnam Bobdiwala, Maya Al-Memar, Sophie Tapp, et al. 2020. 'Posttraumatic Stress, Anxiety and Depression Following Miscarriage and Ectopic Pregnancy: A Multicenter, Prospective, Cohort Study'. *American Journal of Obstetrics and Gynecology* 222 (4): 367.e1-367.e22. https://doi.org/10.1016/j.ajog.2019.10.102.

Fertl, Kerstin I., Annekathrin Bergner, Reinhard Beyer, Burghard F. Klapp, and Martina Rauchfuss. 2009. 'Levels and Effects of Different Forms of Anxiety during Pregnancy after a Prior Miscarriage.' *European Journal of Obstetrics, Gynecology, and Reproductive Biology* 142 (1): 23–29. https://doi.org/10.1016/j.ejogrb.2008.09.009.

Field, Erica, Omar Robles, and Maximo Torero. 2009. 'Iodine Deficiency and Schooling Attainment in Tanzania'. *American Economic Journal: Applied Economics* 1 (4): 140–69.

Fletcher, Jason M., and Barbara L. Wolfe. 2009. 'Education and Labor Market Consequences of Teenage Childbearing: Evidence Using the Timing of Pregnancy Outcomes and Community Fixed Effects'. *The Journal of Human Resources* 44 (2): 303–25.

Flouri, Eirini, and Ann Buchanan. 2002. 'Childhood Predictors of Labor Force Participation in Adult Life'. *Journal of Family and Economic Issues* 23 (2): 101–20.

Franche, Renée-Louise, and Samuel F. Mikail. 1999. 'The Impact of Perinatal Loss on Adjustment to Subsequent Pregnancy'. *Social Science & Medicine* 48 (11): 1613–23. https://doi.org/10.1016/S0277-9536(98)00438-9.

García-Enguídanos, A, M.E Calle, J Valero, S Luna, and V Domínguez-Rojas. 2002. 'Risk Factors in Miscarriage: A Review'. *European Journal of Obstetrics and Gynecology*

and Reproductive Biology 102 (2): 111–19. https://doi.org/10.1016/S0301-2115(01)00613-3.
Geller, Pamela A, Danielle Kerns, and Claudia M Klier. 2004. 'Anxiety Following Miscarriage and the Subsequent Pregnancy: A Review of the Literature and Future Directions'. *Journal of Psychosomatic Research* 56 (1): 35–45. https://doi.org/10.1016/S0022-3999(03)00042-4.
Goodman, A, G Kaplan, and I Walker. 2004. 'Understanding the Effects of Early Motherhood in Britain: The Effects on Mothers'. *Institute for Fiscal Studies Working Paper* 04 (20).
Gunnsteinsson, Snaebjorn, Achyuta Adhvaryu, Parul Christian, Alain Labrique, Jonathan Sugimoto, Abu Ahmed Shamim, and Keith P. West. 2019. *Protecting Infants from Natural Disasters: The Case of Vitamin A Supplementation and a Tornado in Bangladesh*. NBER Working Paper Series, no. w25969. Cambridge, Mass: National Bureau of Economic Research.
Hajdu, Tamás, and Gábor Hajdu. 2018. 'Smoking Ban and Health at Birth: Evidence from Hungary'. *Economics and Human Biology* 30 (Journal Article): 37–47. https://doi.org/10.1016/j.ehb.2018.05.003.
Hassanzadeh, Robab, Fateme Abbas-Alizadeh, Shahla Meedya, Sakineh Mohammad-Alizadeh-Charandabi, and Mojgan Mirghafourvand. 2020. 'Fear of Childbirth, Anxiety and Depression in Three Groups of Primiparous Pregnant Women Not Attending, Irregularly Attending and Regularly Attending Childbirth Preparation Classes'. *BMC Women's Health* 20 (1): 180–180. https://doi.org/10.1186/s12905-020-01048-9.
Hotz, V. Joseph, Susan Williams McElroy, and Seth G. Sanders. 2005. 'Teenage Childbearing and Its Life Cycle Consequences: Exploiting a Natural Experiment'. *Journal of Human Resources* 40 (3): 683–715.
Hotz, V. Joseph, Charles H. Mullin, and Seth G. Sanders. 1997. 'Bounding Causal Effects Using Data From a Contaminated Natural Experiment: Analysis the Effects of Teenage Childbearing'. *The Review of Economic Studies* 64 (4): 575–603. https://doi.org/10.2307/2971732.
Huffman, C. S., K. M. Swanson, and T. A. Schwartz. 2010. 'Influence of Fertility Status, Living Children, and Prior Loss on the Emotional Impact of Miscarriage'. *Fertility and Sterility* 94 (4): S5–6. https://doi.org/10.1016/j.fertnstert.2010.07.021.
Hunfeld, J. A. M., A. K. G. Taselaar-Kloos, G. Agterberg, J. W. Wladimiroff, and J. Passchier. 1997. 'Trait Anxiety, Negative Emotions, and the Mothers' Adaptation to an Infant Born Subsequent to Late Pregnancy Loss: A Case–Control Study'. *Prenatal Diagnosis* 17 (9): 843–51.
Iglesias Vázquez, Lucía, Josefa Canals, and Victoria Arija. 2019. 'Review and Meta-analysis Found That Prenatal Folic Acid Was Associated with a 58% Reduction in Autism but Had No Effect on Mental and Motor Development'. *Acta Paediatrica* 108 (4): 600–610. https://doi.org/10.1111/apa.14657.
Ingrid Goh, Y., Enkelejd Bollano, Thomas R. Einarson, and Gideon Koren. 2006. 'Prenatal Multivitamin Supplementation and Rates of Congenital Anomalies: A Meta-Analysis'. *Journal of Obstetrics and Gynaecology Canada* 28 (8): 680–89. https://doi.org/10.1016/S1701-2163(16)32227-7.
Joseph, Dana N., and Shannon Whirledge. 2017. 'Stress and the HPA Axis: Balancing Homeostasis and Fertility'. *International Journal of Molecular Sciences* 18 (10): 2224. https://doi.org/10.3390/ijms18102224.
Justad-Berg, Ragnhild T., Anne Eskild, and Ellen M. Strøm-Roum. 2015. 'Characteristics of Women with Repeat Termination of Pregnancy: A Study of All Requests for

Pregnancy Termination in Norway during 2007–2011'. *Acta Obstetricia et Gynecologica Scandinavica* 94 (11): 1175–80. https://doi.org/10.1111/aogs.12714.
Karimi, Arizo. 2014. 'The Spacing of Births and Women's Subsequent Earnings', Institute for Evaluation of Labour Market and Education Policy Working Paper, 2014 (18).
Kingston, Dawn, and Suzanne Tough. 2014. 'Prenatal and Postnatal Maternal Mental Health and School-Age Child Development: A Systematic Review.' *Maternal and Child Health Journal* 18 (7): 1728–41. https://doi.org/10.1007/s10995-013-1418-3.
Kinsey, Cara Bicking, Kesha Baptiste-Roberts, Junjia Zhu, and Kristen H. Kjerulff. 2015. 'Effect of Multiple Previous Miscarriages on Health Behaviors and Health Care Utilization During Subsequent Pregnancy'. *Women's Health Issues* 25 (2): 155–61. https://doi.org/10.1016/j.whi.2014.11.008.
Klebanoff, Mark A., Birgitte R. Mednick, Charlotte Schulsinger, Niels J. Secher, and Patricia H. Shiono. 1998. 'Father's Effect on Infant Birth Weight'. *American Journal of Obstetrics and Gynecology* 178 (5): 1022–26. https://doi.org/10.1016/S0002-9378(98)70542-3.
Lamb, Elizabeth H. 2002. 'The Impact of Previous Perinatal Loss on Subsequent Pregnancy and Parenting'. *The Journal of Perinatal Education* 11 (2): 33–40. https://doi.org/10.1624/105812402X88696.
Lang, Kevin, and Ana Nuevo-Chiquero. 2012. 'Trends in Self-Reported Spontaneous Abortions: 1970—2000'. *Demography* 49 (3): 989–1009. https://doi.org/10.1007/s13524-012-0113-0.
Larsen, Elisabeth Clare, Ole Bjarne Christiansen, Astrid Marie Kolte, and Nick Macklon. 2013. 'New Insights into Mechanisms behind Miscarriage.' *BMC Medicine* 11 (June): 154. https://doi.org/10.1186/1741-7015-11-154.
Lassi, Zohra S., Tarab Mansoor, Rehana A. Salam, Jai K. Das, and Zulfiqar A. Bhutta. 2014. 'Essential Pre-Pregnancy and Pregnancy Interventions for Improved Maternal, Newborn and Child Health'. *Reproductive Health* 11 (1): S2. https://doi.org/10.1186/1742-4755-11-S1-S2.
Lee, Louise, Kirstie McKenzie-McHarg, and Antje Horsch. 2017. 'The Impact of Miscarriage and Stillbirth on Maternal–Fetal Relationships: An Integrative Review.' *Journal of Reproductive & Infant Psychology* 35 (1): 32–52.
Li, Xia. 2012. 'How Children Affect Women's Labor Market Outcomes: Estimates from Using Miscarriage as a Natural Experiment'. *Economics Bulletin* 32 (4): 2908–20.
Linehan, Laura A., Aoife G. Morris, Sarah Meaney, and Keelin O'Donoghue. 2019. 'Subsequent Pregnancy Outcomes Following Second Trimester Miscarriage—A Prospective Cohort Study'. *European Journal of Obstetrics & Gynecology and Reproductive Biology* 237 (June): 198–203. https://doi.org/10.1016/j.ejogrb.2019.04.006.
Linnakaari, R, N Helle, M Mentula, A Bloigu, M Gissler, O Heikinheimo, and M Niinimäki. 2019. 'Trends in the Incidence, Rate and Treatment of Miscarriage—Nationwide Register-Study in Finland, 1998–2016'. *Human Reproduction* 34 (11): 2120–28. https://doi.org/10.1093/humrep/dez211.
Løkeland, Mette, Rannveig Heiberg-Andersen, Rupali Akerkar, Øystein Aalstad Jonasson, Olaug Margrete Askeland, Mona Tornensis Hornæs, Guri Sundgot Halvorsen, Linda Askvik Faugstad, and Petur Benedikt Juliusson. 2021. 'Abortregisteret: Rapport Om Svangerskapsavbrot 2020 [Report on Termination of Pregnancies for 2020]'. [1]-2021,0. Bergen: Folkehelseinstituttet (Norwegian Institute of Public Health). https://www.fhi.no/globalassets/dokumenterfiler/rapporter/2021/rapport-om-svangerskapsavbrot-2020-rapport-2021.pdf.

Love, Eleanor R., Siladitya Bhattacharya, Norman C. Smith, and Sohinee Bhattacharya. 2010. 'Effect of Interpregnancy Interval on Outcomes of Pregnancy after Miscarriage: Retrospective Analysis of Hospital Episode Statistics in Scotland.' *BMJ (Clinical Research Ed.)* 341 (August): c3967. https://doi.org/10.1136/bmj.c3967.

Lyerly, Anne Drapkin, Lisa M. Mitchell, Elizabeth Mitchell Armstrong, Lisa H. Harris, Rebecca Kukla, Miriam Kuppermann, and Margaret Olivia Little. 2009. 'Risk and the Pregnant Body.' *The Hastings Center Report* 39 (6): 34–42. https://doi.org/10.1353/hcr.0.0211.

Maconochie, N, P Doyle, S Prior, and R Simmons. 2007. 'Risk Factors for First Trimester Miscarriage—Results from a UK-Population-Based Case–Control Study'. *BJOG: An International Journal of Obstetrics & Gynaecology* 114 (2): 170–86. https://doi.org/10.1111/j.1471-0528.2006.01193.x.

Magnus, Maria C, Allen J Wilcox, Nils-Halvdan Morken, Clarice R Weinberg, and Siri E Håberg. 2019. 'Role of Maternal Age and Pregnancy History in Risk of Miscarriage: Prospective Register Based Study'. *BMJ* 364 (March): l869. https://doi.org/10.1136/bmj.l869.

Mansour, Hani, and Daniel I. Rees. 2012. 'Armed Conflict and Birth Weight: Evidence from the Al-Aqsa Intifada'. *Journal of Development Economics* 99 (1): 190–99.

Mascarello, Keila Cristina, Bernardo Lessa Horta, and Mariângela Freitas Silveira. 2017. 'Maternal complications and cesarean section without indication: systematic review and meta-analysis.' *Revista de saude publica* 51: 105. https://doi.org/10.11606/S1518-8787.2017051000389.

McCarthy, FP, R Moss-Morris, AS Khashan, RA North, PN Baker, G Dekker, L Poston, et al. 2015. 'Previous Pregnancy Loss Has an Adverse Impact on Distress and Behaviour in Subsequent Pregnancy'. *BJOG: An International Journal of Obstetrics & Gynaecology* 122 (13): 1757–64. https://doi.org/10.1111/1471-0528.13233.

Meaney, S, P Corcoran, N Spillane, and K O'Donoghue. 2017. 'Experience of Miscarriage: An Interpretative Phenomenological Analysis'. *BMJ Open* 7 (3): e011382. https://doi.org/10.1136/bmjopen-2016-011382.

Meara, Ellen. 2001. 'Why Is Health Related to Socioeconomic Status?', NBER Working Paper, , no. w8231 (April). https://ssrn.com/abstract=266756.

Menclova, Andrea Kutinova, and Steven Stillman. 2020. 'Maternal Stress and Birth Outcomes: Evidence from an Unexpected Earthquake Swarm.' *Health Economics* 29 (12): 1705–20. https://doi.org/10.1002/hec.4162.

Miller, Amalia R. 2011. 'The Effects of Motherhood Timing on Career Path'. *Journal of Population Economics* 24 (3): 1071–1100.

Nakamura, Katrina, Sam Sheps, and Petra Clara Arck. 2008. 'Stress and Reproductive Failure: Past Notions, Present Insights and Future Directions'. *Journal of Assisted Reproduction and Genetics* 25 (2): 47–62. https://doi.org/10.1007/s10815-008-9206-5.

Navaratne, Pathmila, Xin Y Foo, and Sailesh Kumar. 2016. 'Impact of a High Edinburgh Postnatal Depression Scale Score on Obstetric and Perinatal Outcomes'. *Scientific Reports* 6 (1): 33544. https://doi.org/10.1038/srep33544.

Neff, Lisa A., and Benjamin R. Karney. 2004. 'How Does Context Affect Intimate Relationships? Linking External Stress and Cognitive Processes within Marriage'. *Personality & Social Psychology Bulletin* 30 (2): 134–48. https://doi.org/10.1177/0146167203255984.

Ney, Philip G., Tak Fung, Adele Rose Wickett, and Carol Beaman-Dodd. 1994. 'The Effects of Pregnancy Loss on Women's Health'. *Social Science & Medicine* 38 (9): 1193–1200. https://doi.org/10.1016/0277-9536(94)90184-8.

Nikcevic, A. V., A. R. Kuczmierczyk, and K. H. Nicolaides. 1998. 'Personal Coping Resources, Responsibility, Anxiety and Depression after Early Pregnancy Loss.' *Journal of Psychosomatic Obstetrics and Gynaecology* 19 (3): 145–54. https://doi.org/10.3109/01674829809025692.

Nilsson, J. Peter. 2017. 'Alcohol Availability, Prenatal Conditions, and Long-Term Economic Outcomes'. *Journal of Political Economy* 125 (4): 1149–1207.

Nynas, Johnna, Puneet Narang, Murali K. Kolikonda, and Steven Lippmann. 2015. 'Depression and Anxiety Following Early Pregnancy Loss: Recommendations for Primary Care Providers.' *The Primary Care Companion for CNS Disorders* 17 (1). https://doi.org/10.4088/PCC.14r01721.

Parker, Victoria J., and Alison J. Douglas. 2010. 'Stress in Early Pregnancy: Maternal Neuro-Endocrine-Immune Responses and Effects'. *7th European Congress on Reproductive Immunology* 85 (1): 86–92. https://doi.org/10.1016/j.jri.2009.10.011.

Persson, Petra, and Maya Rossin-Slater. 2018. 'Family Ruptures, Stress, and the Mental Health of the Next Generation'. *American Economic Review* 108 (4–5): 1214–52. https://doi.org/10.1257/aer.20141406.

Pineles, Beth L., Edward Park, and Jonathan M. Samet. 2014. 'Systematic Review and Meta-Analysis of Miscarriage and Maternal Exposure to Tobacco Smoke During Pregnancy'. *American Journal of Epidemiology* 179 (7): 807–23. https://doi.org/10.1093/aje/kwt334.

Polos, Jessica, and Jason Fletcher. 2019. 'Caesarean Section and Children's Health: A Quasi-Experimental Design'. *Population Studies* 73 (3): 353–68. https://doi.org/10.1080/00324728.2019.1624810.

Quenby, Siobhan, Ioannis D. Gallos, Rima K. Dhillon-Smith, Marcelina Podesek, Mary D. Stephenson, Joanne Fisher, Jan J. Brosens, et al. 2021. 'Miscarriage Matters: The Epidemiological, Physical, Psychological, and Economic Costs of Early Pregnancy Loss.' *Lancet (London, England)* 397 (10285): 1658–67. https://doi.org/10.1016/S0140-6736(21)00682-6.

Quintana-Domeque, Climent, and Pedro Ródenas-Serrano. 2017. 'The Hidden Costs of Terrorism: The Effects on Health at Birth'. *Journal of Health Economics* 56 (Journal Article): 47–60. https://doi.org/10.1016/j.jhealeco.2017.08.006.

Regan, Lesley, and Raj Rai. 2000. 'Epidemiology and the Medical Causes of Miscarriage'. *Best Practice & Research Clinical Obstetrics & Gynaecology* 14 (5): 839–54. https://doi.org/10.1053/beog.2000.0123.

Renner, Catherine Hackett, Sophia Verdekal, Sigal Brier, and Gina Fallucca. 2000. 'The Meaning of Miscarriage to Others: Is It an Unrecognized Loss?' *Journal of Personal and Interpersonal Loss* 5 (1): 65–76. https://doi.org/10.1080/10811440008407847.

Robertson, P.A., and K. Kavanaugh. 1998. 'Supporting Parents during and after a Pregnancy Subsequent to a Perinatal Loss'. *Journal of Perinatal and Neonatal Nursing* 12 (2): 63–71.

Sandall, Jane, Rachel M. Tribe, Lisa Avery, Glen Mola, Gerard Ha Visser, Caroline Se Homer, Deena Gibbons, et al. 2018. 'Short-Term and Long-Term Effects of Caesarean Section on the Health of Women and Children.' *Lancet (London, England)* 392 (10155): 1349–57. https://doi.org/10.1016/S0140-6736(18)31930-5.

Schummers, Laura, Jennifer A. Hutcheon, Sonia Hernandez-Diaz, Paige L. Williams, Michele R. Hacker, Tyler J. VanderWeele, and Wendy V. Norman. 2018. 'Association of Short Interpregnancy Interval With Pregnancy Outcomes According to Maternal Age.' *JAMA Internal Medicine* 178 (12): 1661–70. https://doi.org/10.1001/jamainternmed.2018.4696.

Seckl, Jonathan R, and Michael J Meaney. 2004. 'Glucocorticoid Programming'. *Annals of the New York Academy of Sciences* 1032 (1): 63–84. https://doi.org/10.1196/annals.1314.006.
Segal, N. L., and T. J. Jr Bouchard. 1993. 'Grief Intensity Following the Loss of a Twin and Other Relatives: Test of Kinship Genetic Hypotheses.' *Human Biology* 65 (1): 87–105.
Simon, Leslie V., Muhammad F. Hashmi, and Bradley N. Bragg. 2021. 'APGAR Score.' In *StatPearls*. Treasure Island (FL): StatPearls Publishing.
Smith, Lindsay F P, Paul D Ewings, and Catherine Quinlan. 2009. 'Incidence of Pregnancy after Expectant, Medical, or Surgical Management of Spontaneous First Trimester Miscarriage: Long Term Follow-up of Miscarriage Treatment (MIST) Randomised Controlled Trial'. *BMJ* 339. https://doi.org/10.1136/bmj.b3827.
The Lancet. 2021. 'Miscarriage: Worldwide Reform of Care Is Needed'. *The Lancet* 397 (10285): 1597. https://doi.org/10.1016/S0140-6736(21)00954-5.
Tsartsara, Eirini, and Martin P. Johnson. 2006. 'The Impact of Miscarriage on Women's Pregnancy-Specific Anxiety and Feelings of Prenatal Maternal–Fetal Attachment during the Course of a Subsequent Pregnancy: An Exploratory Follow-up Study'. *Journal of Psychosomatic Obstetrics & Gynecology* 27 (3): 173–82. https://doi.org/10.1080/01674820600646198.
Tseng, Ying-Fen, Hsiu-Rong Cheng, Yu-Ping Chen, Shu-Fei Yang, and Pi-Tzu Cheng. 2017. 'Grief Reactions of Couples to Perinatal Loss: A One-Year Prospective Follow-Up'. *Journal of Clinical Nursing* 26 (23–24): 5133–42. https://doi.org/10.1111/jocn.14059.
Turkeltaub, Paul C., Richard F. Lockey, Katie Holmes, and Erika Friedmann. 2019. 'Asthma and/or Hay Fever as Predictors of Fertility/Impaired Fecundity in U.S. Women: National Survey of Family Growth'. *Scientific Reports* 9 (1): 18711. https://doi.org/10.1038/s41598-019-55259-8.
Van den Bergh, Bea R. H., Marion I. van den Heuvel, Marius Lahti, Marijke Braeken, Susanne R. de Rooij, Sonja Entringer, Dirk Hoyer, et al. 2020. 'Prenatal Developmental Origins of Behavior and Mental Health: The Influence of Maternal Stress in Pregnancy'. *Neuroscience & Biobehavioral Reviews* 117: 26–64. https://doi.org/10.1016/j.neubiorev.2017.07.003.
Wang, Xiaobin, Changzhong Chen, Lihua Wang, Dafang Chen, Wenwei Guang, and Jonathan French. 2003. 'Conception, Early Pregnancy Loss, and Time to Clinical Pregnancy: A Population-Based Prospective Study'. *Fertility and Sterility* 79 (3): 577–84. https://doi.org/10.1016/S0015-0282(02)04694-0.
Weinstock, Marta. 2008. 'The Long-Term Behavioural Consequences of Prenatal Stress'. *Neuroscience and Biobehavioral Reviews* 32 (6): 1073–86. https://doi.org/10.1016/j.neubiorev.2008.03.002.
Wilcox, A. J., C. R. Weinberg, J. F. O'Connor, D. D. Baird, J. P. Schlatterer, R. E. Canfield, E. G. Armstrong, and B. C. Nisula. 1988. 'Incidence of Early Loss of Pregnancy.' *The New England Journal of Medicine* 319 (4): 189–94. https://doi.org/10.1056/NEJM198807283190401.
Witt, Whitney P., Lauren E. Wisk, Erika R. Cheng, Kara Mandell, Debanjana Chatterjee, Fathima Wakeel, Amy L. Godecker, and Dakota Zarak. 2015. 'Determinants of Cesarean Delivery in the US: A Lifecourse Approach'. *Maternal and Child Health Journal* 19 (1): 84–93. https://doi.org/10.1007/s10995-014-1498-8.
Woods-Giscombé, Cheryl L., Marci Lobel, and Jamie L. Crandell. 2010. 'The Impact of Miscarriage and Parity on Patterns of Maternal Distress in Pregnancy'. *Research in Nursing & Health* 33 (4): 316–28. https://doi.org/10.1002/nur.20389.

World Health Organization. 2016. *WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience.* https://apps.who.int/iris/bitstream/handle/10665/250796/9789241549912-eng.pdf;jsessionid=E9C2506FD5EE3730B2ABFEAAC7B68853?sequence=1.

Yeoh, Su Lynn, John Eastwood, Ian M. Wright, Rachael Morton, Edward Melhuish, Meredith Ward, and Ju Lee Oei. 2019. 'Cognitive and Motor Outcomes of Children With Prenatal Opioid Exposure: A Systematic Review and Meta-Analysis'. *JAMA Network Open* 2 (7): e197025–e197025. https://doi.org/10.1001/jamanetworkopen.2019.7025.

Tables and Figures

Table 1 Effect of a previous pregnancy loss on pre-determined variables (income 2 years before pregnancy)

	(1) Prebirth Income
Miscarriage	-2403.418
	1577.639
Observations	392310

Table 2 Effect of a previous pregnancy loss on maternal investment in the subsequent pregnancy

	(1) Folic acid before	(2) Folic acid during	(3) Multivitamins before	(4) Multivitamins during	(5) Smoking start	(6) Smoking during	(7) Ultrasound
Panel A: All							
Miscarriage	0.096^{***}	0.052^{***}	0.028^{***}	0.028^{***}	-0.026^{***}	-0.023^{***}	-0.002
	(0.006)	(0.006)	(0.005)	(0.007)	(0.006)	(0.006)	(0.002)
Mean	.259	.651	.154	.382	.227	.197	.984
N	368825	368825	368825	368825	365262	352402	368825
Panel B: Boys							
Miscarriage	0.096^{***}	0.054^{***}	0.021^{***}	0.022^{**}	-0.021^{***}	-0.022^{***}	-0.002
	(0.009)	(0.009)	(0.007)	(0.010)	(0.008)	(0.008)	(0.003)
Mean	.260	.652	.155	.383	.225	.196	.984
N	190072	190072	190072	190072	188231	181664	190072
Panel C: Girls							
Miscarriage	0.097^{***}	0.051^{***}	0.037^{***}	0.037^{***}	-0.030^{***}	-0.024^{***}	-0.002
	(0.009)	(0.009)	(0.007)	(0.010)	(0.008)	(0.008)	(0.003)
Mean	.259	.649	.153	.382	.228	.197	.984
N	178753	178753	178753	178753	177031	170738	178753
Panel D: High educated mother							
Miscarriage	0.105^{***}	0.055^{***}	0.030^{***}	0.035^{***}	-0.036^{***}	-0.033^{***}	-0.002
	(0.008)	(0.008)	(0.007)	(0.008)	(0.007)	(0.007)	(0.002)
Mean	.298	.685	.164	.394	.193	.175	.985
N	240803	240803	240803	240803	238453	229987	240803
Panel E: Low educated mother							
Miscarriage	0.077^{***}	0.046^{***}	0.027^{***}	0.018	-0.007	-0.004	-0.001
	(0.010)	(0.011)	(0.009)	(0.012)	(0.010)	(0.010)	(0.003)
Mean	.186	.586	.134	.360	.291	.238	.983
N	128022	128022	128022	128022	126809	122415	128022
Panel F: Same father							
Miscarriage	0.096^{***}	0.055^{***}	0.029^{***}	0.030^{***}	-0.026^{***}	-0.024^{***}	-0.003
	(0.007)	(0.006)	(0.005)	(0.007)	(0.006)	(0.006)	(0.002)
Mean	.267	.656	.155	.383	.217	.190	.984
N	343165	343165	343165	343165	339872	327952	343165
Panel G: School sample							

Miscarriage	0.080***	0.061***	0.030***	0.027**	-0.018	-0.016	-0.003
	(0.011)	(0.012)	(0.009)	(0.012)	(0.011)	(0.012)	(0.004)
Mean	.204	.521	.137	.326	.284	.240	.979
N	179211	179211	179211	179211	176898	170866	179211

Coefficients and standard errors are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings. Standard errors clustered at mother level in parentheses.

Table 3 Effect of a previous pregnancy loss on birth outcomes in the subsequent pregnancy

		(1) Weight	(2) Apgar 1	(3) Apgar 5	(4) C-section	(5) Pregnancy length
Panel A: All						
	Miscarriage	19.419***	0.023	0.014	-0.002	-0.014
		(6.210)	(0.017)	(0.012)	(0.005)	(0.158)
	Mean	3561	8.74	9.49	.137	279
N		368665	368474	368489	368825	367884
Panel B: Boys						
	Miscarriage	17.824**	0.011	0.012	-0.002	0.003
		(8.921)	(0.025)	(0.017)	(0.007)	(0.230)
	Mean	3594	8.72	9.48	.139	280
N		189991	189882	189894	190072	189599
Panel C: Girls						
	Miscarriage	14.112	0.024	0.010	0.001	-0.015
		(8.582)	(0.024)	(0.017)	(0.007)	(0.217)
	Mean	3526	8.76	9.51	.135	279
N		178674	178592	178595	178753	178285
Panel D: High educated mother						
	Miscarriage	12.733*	0.023	0.017	0.005	-0.142
		(7.408)	(0.021)	(0.015)	(0.006)	(0.188)
	Mean	3571	8.75	9.5	.133	280
N		240703	240596	240608	240803	240280
Panel E: Low educated mother						
	Miscarriage	29.140***	0.016	0.004	-0.012	0.245
		(11.256)	(0.031)	(0.022)	(0.008)	(0.290)
	Mean	3544	8.71	9.48	.145	279
N		127962	127878	127881	128022	127604
Panel F: Same father						
	Miscarriage	9.757	0.006	0.008	0.001	0.010
		(6.336)	(0.018)	(0.013)	(0.005)	(0.162)
	Mean	3563	8.74	9.49	.137	280
N		343019	342839	342853	343165	342319
Panel G: School sample						
	Miscarriage	6.672	0.035	0.021	0.008	-0.081
		(11.774)	(0.032)	(0.022)	(0.010)	(0.305)
	Mean	3565	8.67	9.42	.141	280
N		179070	178973	178968	179211	178517

Coefficients and standard errors are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings, and maternal health (asthma, hypertension, kidney disease, rheumatism, epilepsy, and diabetes).

Table 4 Health of children: number of GP and ER visits in the years after birth

	(1) Total 1-3	(2) GP 1-3	(3) ER 1-3	(4) Total 4-6	(5) GP 4-6	(6) ER 4-6	(7) Total 7-9	(8) GP 7-9	(9) ER 7-9
Panel A: All									
Miscarriage	-0.175	-0.161	-0.014	-0.161*	-0.121	-0.040	-0.205**	-0.162*	-0.043*
	(0.119)	(0.098)	(0.042)	(0.088)	(0.078)	(0.025)	(0.101)	(0.093)	(0.024)
Mean	9.94	7.66	2.28	5.85	4.76	1.09	4.98	4.21	.77
N	347172	347172	347172	354711	354711	354711	295362	295362	295362
Panel B: Boys									
Miscarriage	-0.035	-0.051	0.015	-0.104	-0.093	-0.011	-0.123	-0.066	-0.057*
	(0.171)	(0.141)	(0.060)	(0.124)	(0.109)	(0.036)	(0.138)	(0.126)	(0.034)
Mean	10.2	7.8	2.35	5.87	4.76	1.1	4.96	4.19	.773
N	178944	178944	178944	182705	182705	182705	152034	152034	152034
Panel C: Girls									
Miscarriage	-0.256	-0.225*	-0.031	-0.184	-0.122	-0.063*	-0.259*	-0.233*	-0.026
	(0.164)	(0.136)	(0.058)	(0.126)	(0.111)	(0.036)	(0.148)	(0.136)	(0.034)
Mean	9.72	7.51	2.2	5.83	4.76	1.07	5	4.24	.767
N	168228	168228	168228	172006	172006	172006	143328	143328	143328
Panel D: High educated mother									
Miscarriage	-0.102	-0.145	0.043	-0.215**	-0.159*	-0.057*	-0.248**	-0.190*	-0.057**
	(0.139)	(0.117)	(0.047)	(0.106)	(0.094)	(0.029)	(0.124)	(0.114)	(0.029)
Mean	9.29	7.27	2.02	5.41	4.44	.965	4.58	3.89	.695
N	212827	212827	212827	215868	215868	215868	178320	178320	178320
Panel E: Low educated mother									
Miscarriage	-0.266	-0.150	-0.116	-0.074	-0.055	-0.019	-0.138	-0.115	-0.023
	(0.217)	(0.175)	(0.080)	(0.155)	(0.135)	(0.047)	(0.172)	(0.156)	(0.043)
Mean	11	8.28	2.69	6.54	5.27	1.28	5.6	4.71	.885
N	134345	134345	134345	138843	138843	138843	117042	117042	117042
Panel F: Same father									
Miscarriage	-0.048	-0.057	0.009	-0.111	-0.078	-0.033	-0.189*	-0.146	-0.043*
	(0.119)	(0.099)	(0.042)	(0.090)	(0.079)	(0.026)	(0.103)	(0.094)	(0.024)
Mean	9.82	7.6	2.22	5.78	4.71	1.06	4.89	4.14	.751

N	323087	323087	323087	330303	330303	330303	274616	274616	274616
Panel G: School sample									
Miscarriage	0.017	-0.006	0.023	-0.071	-0.044	-0.028	-0.205	-0.161	-0.044
	(0.344)	(0.288)	(0.112)	(0.154)	(0.135)	(0.046)	(0.144)	(0.133)	(0.035)
Mean	9.4	7.3	2.1	6.07	4.99	1.08	5.39	4.63	.758
N	123866	123866	123866	156185	156185	156185	159875	159875	159875

Coefficients and standard errors clustered at mothered level are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings

Table 5 Effect of a previous pregnancy loss on the subsequent child's test scores at age 10

	(1) All	(2) Math	(3) English	(4) Reading
Panel A: All				
Miscarriage	-0.023	-0.012	-0.016	-0.021
	(0.023)	(0.024)	(0.028)	(0.025)
Mean	.0169	.0222	.000683	.0216
N	179209	176474	164218	174830
Panel B: Boys				
Miscarriage	-0.022	-0.006	-0.010	-0.023
	(0.034)	(0.034)	(0.041)	(0.035)
Mean	.0253	.0529	.0145	-.00436
N	91840	90469	83937	89429
Panel C: Girls				
Miscarriage	-0.022	-0.020	-0.021	-0.017
	(0.032)	(0.033)	(0.039)	(0.034)
Mean	.00805	-.01	-.0137	.0488
N	87369	86005	80281	85401
Panel D: High educated mothers				
Miscarriage	-0.023	-0.011	-0.011	-0.001
	(0.029)	(0.029)	(0.035)	(0.031)
Mean	.184	.185	.105	.184
N	115634	114275	106540	113343
Panel E: Low educated mothers				
Miscarriage	-0.024	-0.014	-0.029	-0.055
	(0.040)	(0.042)	(0.049)	(0.042)
Mean	-.286	-.278	-.192	-.278
N	63575	62199	57678	61487
Panel F: Same father				
Miscarriage	-0.027	-0.017	-0.023	-0.021
	(0.023)	(0.024)	(0.028)	(0.025)
Mean	.0374	.0462	.00958	.0395
N	166933	164551	153107	162984

Coefficients and standard errors are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings, and maternal health (asthma, hypertension, kidney disease, rheumatism, epilepsy, and diabetes).

Table 6 Effect of pregnancy loss on parental labor market engagement

	(1) Sickness days	(2) Sickness pay	(3) Income mother 2 years	(4) Income father 2 years
Panel A: All				
Miscarriage	3.767***	2480.529***	-0.040***	0.003
	(0.876)	(582.563)	(0.010)	(0.007)
Mean	58.5	31104	12.5	13.0
N	368825	368825	327478	339297
Panel B: Boys				
Miscarriage	3.634***	2715.751***	-0.034**	0.007
	(1.201)	(790.506)	(0.014)	(0.010)
Mean	58.0	30733	12.5	13.0
N	190072	190072	168631	174761
Panel C: Girls				
Miscarriage	3.434***	1916.897**	-0.040***	-0.001
	(1.250)	(840.454)	(0.014)	(0.009)
Mean	59.2	31498	12.5	13.0
N	178753	178753	158847	164536
Panel D: High educated mother				
Miscarriage	3.404***	2502.945***	-0.044***	-0.005
	(1.027)	(713.620)	(0.012)	(0.008)
Mean	55.4	30455	12.6	13.1
N	240803	240803	216729	222174
Panel E: Low educated mother				
Miscarriage	4.460***	2518.479***	-0.030*	0.018
	(1.568)	(957.309)	(0.018)	(0.013)
Mean	64.5	32324	12.2	12.9
N	128022	128022	110749	117123
Panel F: Same father				
Miscarriage	2.984***	2036.351***	-0.032***	-0.001
	(0.891)	(595.040)	(0.010)	(0.007)
Mean	58.5	31113	12.5	13.0
N	343165	343165	306576	316940
Panel G: School sample				
Miscarriage	2.981***	1998.630***	-0.032***	-0.002
	(0.902)	(604.099)	(0.010)	(0.007)
Mean	58.4	31124	12.5	13.0
N	339400	339400	303205	313272

Coefficients and standard errors are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings, and maternal health (asthma, hypertension, kidney disease, rheumatism, epilepsy, and diabetes).

Table 7 Effect of pregnancy loss on maternal health during the subsequent pregnancy

	(1) Pregnancy diabetes	(2) Hypertension during	(3) Eclampsia	(4) Preeclampsia	(5) Early preeclampsia
Panel A: All					
Miscarriage	0.001	-0.004*	0.000	-0.003	-0.000
	(0.002)	(0.002)	(0.000)	(0.003)	(0.001)
Mean	.0157	.0193	.000453	.032	.0032
N	368825	368825	368825	368825	368825
Panel B: Boys					
Miscarriage	-0.000	-0.004	0.000	-0.001	-0.001
	(0.002)	(0.003)	(0.000)	(0.004)	(0.001)
Mean	.0158	.0194	.000484	.0316	.00328
N	190072	190072	190072	190072	190072
Panel C: Girls					
Miscarriage	0.002	-0.003	0.000	-0.005	-0.000
	(0.002)	(0.003)	(0.000)	(0.004)	(0.001)
Mean	.0155	.0191	.00042	.0324	.00313
N	178753	178753	178753	178753	178753
Panel D: High educated mothers					
Miscarriage	0.002	-0.004	0.000	-0.002	0.000
	(0.002)	(0.003)	(0.000)	(0.003)	(0.001)
Mean	.0142	.0202	.00044	.0302	.00306
N	240803	240803	240803	240803	240803
Panel E: Low educated mothers					
Miscarriage	-0.002	-0.004	-0.000	-0.004	-0.002
	(0.003)	(0.003)	(0.001)	(0.005)	(0.002)
Mean	.0184	.0176	.000476	.0355	.00347
N	128022	128022	128022	128022	128022
Panel F: Same father					
Miscarriage	-0.000	-0.005**	0.000	-0.001	-0.000
	(0.002)	(0.002)	(0.000)	(0.003)	(0.001)
Mean	.0154	.0196	.00046	.0319	.00317
N	343165	343165	343165	343165	343165
Panel G: School sample					
Miscarriage	0.002	-0.003	-0.000	-0.006	-0.001
	(0.002)	(0.004)	(0.001)	(0.005)	(0.002)
Mean	.00716	.0209	.000547	.0392	.00347
N	179211	179211	179211	179211	179211

Coefficients and standard errors are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings, and maternal health (asthma, hypertension, kidney disease, rheumatism, epilepsy, and diabetes).

Table 8 Effect of pregnancy loss on maternal health during pregnancy: primary health care

	(1) Total	(2) GP	(3) ER	(4) Simple Contacts	(5) Consultations	(6) Ultra Sound	(7) Lab Tests
Panel A: All							
Miscarriage	0.404***	0.385***	0.018	0.189***	0.189***	0.023**	0.159***
	(0.110)	(0.107)	(0.021)	(0.065)	(0.069)	(0.009)	(0.058)
Mean	11.5	11.1	.418	3.48	7.57	.0819	4.5
N	280553	280553	280553	280553	280553	280553	280553
Panel B: Boys							
Miscarriage	0.376**	0.343**	0.032	0.180**	0.188*	0.024*	0.137*
	(0.154)	(0.149)	(0.028)	(0.090)	(0.097)	(0.013)	(0.082)
Mean	11.5	11.1	.416	3.46	7.55	.0819	4.49
N	144556	144556	144556	144556	144556	144556	144556
Panel C: Girls							
Miscarriage	0.431***	0.428***	0.003	0.204**	0.186*	0.023*	0.184**
	(0.158)	(0.152)	(0.031)	(0.094)	(0.099)	(0.013)	(0.083)
Mean	11.6	11.1	.42	3.49	7.6	.0818	4.51
N	135997	135997	135997	135997	135997	135997	135997
Panel D: High educated mother							
Miscarriage	0.369***	0.351***	0.018	0.182**	0.162**	0.020*	0.141**
	(0.126)	(0.123)	(0.024)	(0.075)	(0.081)	(0.011)	(0.065)
Mean	11	10.6	.318	3.32	7.22	.0771	4.31
N	173804	173804	173804	173804	173804	173804	173804
Panel E: Low educated mother							
Miscarriage	0.480**	0.460**	0.021	0.211*	0.244*	0.029*	0.198*
	(0.211)	(0.202)	(0.039)	(0.124)	(0.129)	(0.017)	(0.114)
Mean	12.4	11.8	.581	3.73	8.14	.0896	4.82
N	106749	106749	106749	106749	106749	106749	106749
Panel F: Same father							
Miscarriage	0.377***	0.355***	0.022	0.173***	0.174**	0.023**	0.137**
	(0.108)	(0.105)	(0.021)	(0.063)	(0.069)	(0.009)	(0.056)
Mean	11.4	11	.39	3.41	7.5	.08	4.45
N	260723	260723	260723	260723	260723	260723	260723
Panel G: School sample							
Miscarriage	1.000	0.946	0.054	0.594	0.471	0.019	0.459
	(1.566)	(1.519)	(0.207)	(0.828)	(1.066)	(0.078)	(0.661)
Mean	9.86	9.53	.332	2.49	6.8	.0029	3.61
N	60787	60787	60787	60787	60787	60787	60787

Coefficients and standard errors clustered at mothered level are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings.

Table 9 Effect of pregnancy loss on maternal health during pregnancy: diagnoses during primary health care

	(1) Pregnancy Related	(2) Psychological	(3) Not Pregnancy Related	(4) Contraception	(5) Pregnancy Concerns	(6) Diabetes	(7) Hypertension	(8) Other
Panel A: All								
Miscarriage	0.420***	-0.007	0.076	-0.009**	0.239***	0.008	-0.003	0.190***
	(0.087)	(0.031)	(0.078)	(0.004)	(0.075)	(0.009)	(0.003)	(0.063)
Mean	8.66	.294	3.61	.0212	6.23	.0436	.00532	2.42
N	280553	280553	280553	280553	280553	280553	280553	280553
Panel B: Boys								
Miscarriage	0.388***	0.011	0.085	-0.012**	0.227**	0.008	-0.006*	0.173**
	(0.120)	(0.046)	(0.111)	(0.005)	(0.104)	(0.012)	(0.004)	(0.088)
Mean	8.62	.293	3.6	.0209	6.21	.0418	.00522	2.39
N	144556	144556	144556	144556	144556	144556	144556	144556
Panel C: Girls								
Miscarriage	0.455***	-0.024	0.066	-0.007	0.248**	0.008	0.002	0.214**
	(0.125)	(0.040)	(0.109)	(0.005)	(0.108)	(0.014)	(0.006)	(0.090)
Mean	8.7	.296	3.62	.0214	6.24	.0455	.00543	2.44
N	135997	135997	135997	135997	135997	135997	135997	135997
Panel D: High educated mother								
Miscarriage	0.414***	-0.013	0.060	-0.009*	0.225**	0.004	-0.004	0.198***
	(0.103)	(0.027)	(0.090)	(0.005)	(0.090)	(0.010)	(0.005)	(0.074)
Mean	8.37	.243	3.37	.0204	6.07	.0373	.00551	2.28
N	173804	173804	173804	173804	173804	173804	173804	173804
Panel E: Low educated mother								
Miscarriage	0.436***	0.010	0.112	-0.009	0.270**	0.017	0.000	0.175
	(0.158)	(0.072)	(0.147)	(0.006)	(0.134)	(0.018)	(0.005)	(0.115)
Mean	9.14	.379	4	.0224	6.49	.0539	.00501	2.63
N	106749	106749	106749	106749	106749	106749	106749	106749
Panel F: Same father								
Miscarriage	0.405***	-0.029	0.071	-0.009**	0.238***	0.007	-0.003	0.177***
	(0.087)	(0.026)	(0.076)	(0.004)	(0.076)	(0.009)	(0.004)	(0.063)

Mean	8.59	.26	3.52	.0205	6.19	.0431	.00532	2.38
N	260723	260723	260723	260723	260723	260723	260723	260723
Panel G: School sample								
Miscarriage	0.924	0.040	0.532	-0.008	0.668	-0.001	0.003	0.267
	(1.303)	(0.273)	(1.604)	(0.032)	(1.159)	(0.066)	(0.006)	(0.798)
Mean	7.82	.227	2.71	.0198	5.88	.0171	.00426	1.93
N	60787	60787	60787	60787	60787	60787	60787	60787

Coefficients and standard errors clustered at mothered level are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings.

Table 10 Effect of pregnancy loss on maternal health in primary care visits in the years after birth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
years	1	2	3	4	5	6	7
Panel A: All							
Miscarriage	-0.384***	-0.938***	-0.713***	-0.350***	-0.082	-0.051	-0.083
	(0.092)	(0.113)	(0.118)	(0.112)	(0.115)	(0.111)	(0.111)
Mean	5.67	7.36	7.11	6.64	6.48	6.39	6.25
N	301008	320039	324829	327319	321939	310213	295362
Panel B: Boys							
Miscarriage	-0.284**	-0.860***	-0.680***	-0.444***	0.036	0.010	0.001
	(0.132)	(0.160)	(0.167)	(0.159)	(0.163)	(0.158)	(0.157)
Mean	5.68	7.37	7.1	6.65	6.48	6.38	6.25
N	155118	164847	167341	168615	165812	159757	152036
Panel C: Girls							
Miscarriage	-0.399***	-0.873***	-0.718***	-0.256	-0.204	-0.105	-0.167
	(0.129)	(0.159)	(0.166)	(0.158)	(0.162)	(0.156)	(0.156)
Mean	5.66	7.35	7.13	6.62	6.47	6.39	6.25
N	145890	155192	157488	158704	156127	150456	143326
Panel D: High educated mother							
Miscarriage	-0.228**	-0.905***	-0.701***	-0.236*	-0.048	-0.096	-0.080
	(0.103)	(0.133)	(0.137)	(0.129)	(0.132)	(0.127)	(0.128)
Mean	5.06	6.86	6.52	5.91	5.73	5.62	5.46
N	185931	197180	199563	200643	196523	188354	178320
Panel E: Low educated mother							
Miscarriage	-0.620***	-0.921***	-0.687***	-0.536**	-0.118	0.018	-0.083
	(0.181)	(0.207)	(0.219)	(0.209)	(0.213)	(0.204)	(0.199)
Mean	6.66	8.16	8.05	7.79	7.64	7.57	7.47
N	115077	122859	125266	126676	125416	121859	117042
Panel F: Same father							
Miscarriage	-0.399***	-0.873***	-0.661***	-0.301***	-0.055	-0.074	-0.083
	(0.091)	(0.113)	(0.117)	(0.111)	(0.113)	(0.110)	(0.109)
Mean	5.53	7.23	6.95	6.44	6.26	6.16	6.01
N	279829	297673	302544	305254	300112	288846	274616
Panel G: School sample							
Miscarriage	-0.638	-0.877*	-0.128	-0.096	-0.111	0.056	-0.015
	(0.634)	(0.485)	(0.353)	(0.264)	(0.229)	(0.187)	(0.162)
Mean	5.08	6.8	6.65	6.23	6.08	6.03	5.89
N	80159	98200	114802	130180	142291	151838	159875

Coefficients and standard errors clustered at mothered level are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings.

Table 11 Number of primary care visits during the first year after pregnancy: diagnoses

	(1) Unspecified	(2) Blood, Immune System	(3) Digestive	(4) Ear, Eye	(5) Cardiovascular	M
Miscarriage	-0.048	-0.003	-0.013	0.030	-0.004	
	(0.034)	(0.010)	(0.026)	(0.023)	(0.011)	
mean	.941	.0772	.396	.243	.1	
N	301008	301008	301008	301008	301008	

	Psychological	Respiratory	Skin	Endocrine	Urological	C
Miscarriage	-0.012	-0.029	0.011	-0.016	-0.002	
	(0.034)	(0.025)	(0.019)	(0.023)	(0.012)	
mean	.464	.663	.364	.31	.134	
N	301008	301008	301008	301008	301008	

Coefficients and standard errors clustered at mothered level are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings.

Table 12 Number of primary care visits during the second year after pregnancy: diagnoses

	(1) Unspecified	(2) Blood, Immune System	(3) Digestive	(4) Ear, Eye	(5) Cardiovascular	(6) Musculo al
Miscarriage	-0.063*	-0.008	-0.013	0.009	0.005	0.01
	(0.038)	(0.011)	(0.027)	(0.029)	(0.013)	(0.04
mean	1.15	.0869	.464	.283	.114	.858
N	320039	320039	320039	320039	320039	3200

	Psychological	Respiratory	Skin	Endocrine	Urological	Pregna Contrace
Miscarriage	0.019	0.015	0.015	0.004	-0.009	-0.974
	(0.041)	(0.029)	(0.018)	(0.022)	(0.013)	(0.08
mean	.657	.895	.344	.312	.175	2.37
N	320039	320039	320039	320039	320039	3200

Coefficients and standard errors clustered at mothered level are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings.

Table 13 Number of primary care visits during the third year after pregnancy: diagnoses

	(1) Unspecified	(2) Blood, Immune System	(3) Digestive	(4) Ear, Eye	(5) Cardiovascular	(Muscu a
Miscarriage	-0.032	-0.011	0.016	0.001	-0.018	0.0
	(0.042)	(0.011)	(0.027)	(0.030)	(0.014)	(0.0
mean	1.17	.0859	.43	.284	.125	.8
N	324829	324829	324829	324829	324829	324

	Psychological	Respiratory	Skin	Endocrine	Urological	Pregn Contra
Miscarriage	0.058	0.018	0.029	-0.021	-0.005	-0.8
	(0.043)	(0.031)	(0.020)	(0.022)	(0.014)	(0.0
mean	.677	.834	.347	.311	.173	2.
N	324829	324829	324829	324829	324829	324

Coefficients and standard errors clustered at mothered level are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings.

Appendix

Appendix A1 Nulliparity

Table A1a Effect of a pregnancy loss before the birth of the first child on maternal health during pregnancy

	(1) Gestational diabetes	(2) Hypertension	(3) Eclampsia	(4) Pre-eclampsia	(5) Early pre-eclampsia
Panel A: All					
Miscarriage	0.001	0.003**	0.000	0.007***	0.000
	0.001	0.001	0.000	0.002	0.001
N	383712	383712	383712	383712	383712
Panel B: Boys					
Miscarriage	0.002	0.000	0.000	0.006***	0.001
	0.001	0.002	0.000	0.002	0.001
N	198172	198172	198172	198172	198172
Panel C: Girls					
Miscarriage	-0.002	0.004**	0.000	0.004*	-0.001
	0.001	0.002	0.000	0.002	0.001
N	185540	185540	185540	185540	185540
Panel D: High educated mothers					
Miscarriage	0.002	0.002	0.000	0.007***	0.001
	0.001	0.002	0.000	0.002	0.001
N	246326	246326	246326	246326	246326
Panel E: Low educated mothers					
Miscarriage	-0.001	0.004*	0.000	0.005**	0.000
	0.002	0.002	0.000	0.003	0.001
N	137386	137386	137386	137386	137386
Panel F: Same father					
Miscarriage	0.001	0.002	0.000	0.005***	0.000
	0.001	0.001	0.000	0.002	0.001
N	357314	357314	357314	357314	357314

Coefficients and standard errors are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings, and maternal health (asthma, hypertension, kidney disease, rheumatism, epilepsy, and diabetes). The sample is restricted to mothers of two children who had at most a single miscarriage, which occurred before their first live birth. Point estimates are for their first born child, conditional on the outcomes of their second child.

Appendix A2 Non-smokers

Table A2a Non-smokers: Effect of a previous pregnancy loss on maternal investment in the subsequent pregnancy

	(1) Folic acid before	(2) Folic acid after	(3) Multivitamin before	(4) Multivitamin after	(5) Ultrasound
Panel A: All					
Miscarriage	0.095***	0.029***	0.025***	0.017***	-0.003*
	0.005	0.005	0.004	0.006	0.002
N	244848	244848	244848	244848	244848
Panel B: Boys					
Miscarriage	0.092***	0.031***	0.022***	0.013	-0.005**
	0.007	0.007	0.006	0.008	0.002
N	126518	126518	126518	126518	126518
Panel C: Girls					
Miscarriage	0.100***	0.030***	0.029***	0.024***	-0.001
	0.008	0.007	0.006	0.008	0.002
N	118330	118330	118330	118330	118330
Panel D: High educated mothers					
Miscarriage	0.097***	0.026***	0.026***	0.023***	-0.003*
	0.007	0.006	0.005	0.007	0.002
N	167928	167928	167928	167928	167928
Panel E: Low educated mothers					
Miscarriage	0.100***	0.030***	0.029***	0.024***	-0.001
	0.008	0.007	0.006	0.008	0.002
N	118330	118330	118330	118330	118330
Panel F: Same father					
Miscarriage	0.096***	0.030***	0.025***	0.018***	-0.004**
	0.006	0.005	0.005	0.006	0.002
N	232296	232296	232296	232296	232296

Coefficients and standard errors are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings, and maternal health (asthma, hypertension, kidney disease, rheumatism, epilepsy, and diabetes). The sample is restricted to non-smokers.

Table A2b Non-smokers: Effect of a previous pregnancy loss on birth outcomes in the subsequent pregnancy

	(1) Weight (grams)	(2) Apgar 1	(3) Apgar 5	(4) C-section	(5) Gestation (weeks)
Panel A: All					
Miscarriage	21.021***	0.007	0.008	-0.001	0.002
	5.111	0.014	0.01	0.004	0.129
N	244630	244376	244398	244848	243604
Panel B: Boys					
Miscarriage	23.850***	-0.006	0.007	-0.007	0.061
	7.232	0.02	0.015	0.005	0.184
N	126410	126260	126278	126518	125906
Panel C: Girls					
Miscarriage	12.180*	0.013	0.005	0.006	-0.051
	7.19	0.02	0.015	0.006	0.181
N	118220	118116	118120	118330	117698
Panel D: High educated mothers					
Miscarriage	17.668***	0.005	0.005	0.002	-0.006
	6.095	0.017	0.012	0.005	0.154
N	167786	167642	167658	167928	167162
Panel E: Low educated mothers					
Miscarriage	24.680***	0.006	0.012	-0.006	-0.003
	9.363	0.027	0.019	0.007	0.237
N	76844	76734	76740	76920	76442
Panel F: Same father					
Miscarriage	11.162**	-0.006	0.001	0.001	0.011
	5.257	0.015	0.011	0.004	0.133
N	232090	231850	231874	232296	231134

Coefficients and standard errors are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings, and maternal health (asthma, hypertension, kidney disease, rheumatism, epilepsy, and diabetes). The sample is restricted to non-smokers.

Table A2c Non-smokers: Effect of a previous pregnancy loss on school outcomes in the subsequent pregnancy

	(1) GPA	(2) Math	(3) English	(4) Reading
Panel A: All				
Miscarriage	-0.246	-0.077	-0.094	0.001
	0.468	0.177	0.219	0.134
N	84410	80530	66496	79198
Panel B: Boys				
Miscarriage	0.185	0.098	0.121	-0.047
	0.67	0.255	0.316	0.191
N	43342	41290	33886	40408
Panel C: Girls				
Miscarriage	-0.638	-0.262	-0.288	0.056
	0.655	0.246	0.304	0.188
N	41068	39240	32610	38790
Panel D: High educated mothers				
Miscarriage	-0.318	-0.089	-0.059	0.201
	0.568	0.212	0.265	0.16
N	57414	55366	45802	54556
Panel E: Low educated mothers				
Miscarriage	-0.188	-0.064	-0.246	-0.448*
	0.832	0.322	0.392	0.246
N	26996	25164	20694	24642
Panel F: Same father				
Miscarriage	-0.094	-0.025	-0.078	0.071
	0.478	0.181	0.224	0.137
N	81228	77704	64204	76384

Coefficients and standard errors are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings, and maternal health (asthma, hypertension, kidney disease, rheumatism, epilepsy, and diabetes). The sample is restricted to non-smokers.

Table A2d Non-smokers: Effect of a previous pregnancy loss on parental labor market engagement

	(1) Sick days pregnancy	(2) Sick pay pregnancy	(3) Maternal income 2 years	(4) Paternal income 2 years
Panel A: All				
Miscarriage	3.551***	2119.732***	-0.034***	0.008
	0.693	471.353	0.008	0.005
N	244848	244848	192860	203180
Panel B: Boys				
Miscarriage	3.156***	2311.211***	-0.035***	0.004
	0.999	681.012	0.011	0.007
N	120038	120038	95072	99868
Panel C: Girls				
Miscarriage	2.607**	1102.071	-0.025**	0.000
	1.02	697.274	0.011	0.007
N	112258	112258	89490	93840
Panel D: High educated mothers				
Miscarriage	2.328***	1520.428***	-0.032***	0.001
	0.826	586.252	0.009	0.006
N	162270	162270	130326	135174
Panel E: Low educated mothers				
Miscarriage	4.160***	2270.302***	-0.022	0.006
	1.389	870.918	0.015	0.01
N	70026	70026	54236	58534
Panel F: Same father				
Miscarriage	2.939***	1766.503***	-0.030***	0.002
	0.714	487.254	0.008	0.005
N	232296	232296	184562	193708

Coefficients and standard errors are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings, and maternal health (asthma, hypertension, kidney disease, rheumatism, epilepsy, and diabetes). The sample is restricted to non-smokers.

Table A2e Non-smokers: Effect of a previous pregnancy loss on maternal physical health in the subsequent pregnancy

	(1) Gestational diabetes	(2) Hypertension	(3) Eclampsia	(4) Pre-eclampsia	(5) Early pre-eclampsia
Panel A: All					
Miscarriage	-0.001	-0.004**	0.000	-0.003	0.000
	0.001	0.002	0.000	0.002	0.001
N	244848	244848	244848	244848	244848
Panel B: Boys					
Miscarriage	-0.001	-0.004	0.000	-0.002	0.000
	0.002	0.002	0.000	0.003	0.001
N	126518	126518	126518	126518	126518
Panel C: Girls					
Miscarriage	0.000	-0.003	0.000	-0.004	0.000
	0.002	0.002	0.000	0.003	0.001
N	118330	118330	118330	118330	118330
Panel D: High educated mothers					
Miscarriage	0.000	-0.004**	0.000	-0.004	0.000
	0.002	0.002	0.000	0.003	0.001
Observations	167928	167928	167928	167928	167928
Panel E: Low educated mothers					
Miscarriage	-0.001	-0.003	-0.001	-0.002	-0.001
	0.003	0.003	0.001	0.004	0.001
N	76920	76920	76920	76920	76920
Panel F: Same father					
Miscarriage	-0.001	-0.004**	0.000	-0.001	0.000
	0.001	0.002	0.000	0.002	0.001
Observations	232296	232296	232296	232296	232296

Coefficients and standard errors are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings, and maternal health (asthma, hypertension, kidney disease, rheumatism, epilepsy, and diabetes). The sample is restricted to non-smokers.

Number of GP visits post during pregnancy

	(1) 1	(2) 2	(3) 3	(4) 4	(5) 5	(6) 6	(7) 7
Miscarriage	-0.302***	-0.849***	-0.663***	-0.338***	-0.088	-0.058	-0.068
	(0.088)	(0.109)	(0.114)	(0.108)	(0.110)	(0.107)	(0.107)
mean	5.33	6.94	6.71	6.25	6.1	6.03	5.9
N	301008	320039	324829	327319	321939	310213	295362
Boys							
Miscarriage	-0.190	-0.767***	-0.627***	-0.446***	0.019	0.010	0.024
	(0.125)	(0.154)	(0.160)	(0.153)	(0.155)	(0.152)	(0.151)
mean	5.34	6.95	6.69	6.26	6.1	6.02	5.9
N	155118	164847	167341	168615	165812	159757	152036
Girls							
Miscarriage	-0.331***	-0.789***	-0.672***	-0.229	-0.199	-0.117	-0.158
	(0.123)	(0.153)	(0.161)	(0.151)	(0.157)	(0.150)	(0.151)
mean	5.33	6.93	6.73	6.24	6.1	6.03	5.91
N	145890	155192	157488	158704	156127	150456	143326
High educated mother							
Miscarriage	-0.157	-0.822***	-0.662***	-0.231*	-0.059	-0.100	-0.060
	(0.098)	(0.129)	(0.132)	(0.124)	(0.128)	(0.123)	(0.124)
mean	4.79	6.52	6.2	5.59	5.42	5.32	5.17
N	185931	197180	199563	200643	196523	188354	178320
Low educated mother							
Miscarriage	-0.521***	-0.817***	-0.618***	-0.510**	-0.115	0.006	-0.074
	(0.171)	(0.199)	(0.209)	(0.200)	(0.201)	(0.195)	(0.191)
mean	6.21	7.63	7.53	7.29	7.16	7.12	7.02
N	115077	122859	125266	126676	125416	121859	117042
Same father							
Miscarriage	-0.308***	-0.779***	-0.610***	-0.285***	-0.061	-0.080	-0.061
	(0.087)	(0.109)	(0.113)	(0.107)	(0.108)	(0.106)	(0.106)
mean	5.21	6.84	6.58	6.07	5.9	5.82	5.68
N	279829	297673	302544	305254	300112	288846	274616
School sample							
Miscarriage	-0.502	-0.829*	-0.105	-0.074	-0.102	0.053	0.011
	(0.603)	(0.471)	(0.339)	(0.255)	(0.216)	(0.182)	(0.158)
mean	4.76	6.42	6.29	5.89	5.76	5.73	5.62
N	80159	98200	114802	130180	142291	151838	159875

Coefficients and standard errors clustered at mothered level are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings.

Number of ER visits post during pregnancy

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	1	2	3	4	5	6	7
Miscarriage	-0.082***	-0.090***	-0.049***	-0.012	0.006	0.007	-0.015
	(0.018)	(0.019)	(0.019)	(0.019)	(0.018)	(0.017)	(0.017)
mean	.334	.416	.397	.387	.376	.361	.349
N	301008	320039	324829	327319	321939	310213	295362
Boys							
Miscarriage	-0.094***	-0.093***	-0.053**	0.002	0.017	0.000	-0.023
	(0.026)	(0.025)	(0.027)	(0.025)	(0.026)	(0.024)	(0.024)
mean	.34	.419	.4	.391	.381	.363	.352
N	155118	164847	167341	168615	165812	159757	152036
Girls							
Miscarriage	-0.068***	-0.084***	-0.046*	-0.026	-0.006	0.012	-0.009
	(0.025)	(0.028)	(0.026)	(0.028)	(0.024)	(0.023)	(0.025)
mean	.329	.413	.394	.383	.371	.36	.347
N	145890	155192	157488	158704	156127	150456	143326
High educated mother							
Miscarriage	-0.071***	-0.083***	-0.039*	-0.004	0.010	0.003	-0.020
	(0.020)	(0.022)	(0.022)	(0.021)	(0.019)	(0.018)	(0.017)
mean	.265	.344	.323	.316	.312	.3	.29
N	185931	197180	199563	200643	196523	188354	178320
Low educated mother							
Miscarriage	-0.099***	-0.104***	-0.069**	-0.026	-0.002	0.011	-0.008
	(0.034)	(0.033)	(0.035)	(0.035)	(0.035)	(0.031)	(0.035)
mean	.447	.532	.515	.498	.477	.455	.44
N	115077	122859	125266	126676	125416	121859	117042
Same father							
Miscarriage	-0.091***	-0.095***	-0.051***	-0.017	0.006	0.006	-0.022
	(0.018)	(0.019)	(0.018)	(0.018)	(0.017)	(0.016)	(0.015)
mean	.316	.395	.376	.366	.356	.341	.329
N	279829	297673	302544	305254	300112	288846	274616
School sample							
Miscarriage	-0.136	-0.047	-0.023	-0.022	-0.009	0.003	-0.026
	(0.110)	(0.070)	(0.054)	(0.035)	(0.036)	(0.025)	(0.021)
mean	.318	.381	.364	.343	.321	.299	.27
N	80159	98200	114802	130180	142291	151838	159875

Coefficients and standard errors clustered at mothered level are reported. Significance levels: * < 0.10, ** < 0.05, *** < 0.01. Each set of parameters is from a separate maternal level fixed effects regression of the outcome variables on miscarriage history (1 = a single pregnancy loss between births, 0 = no history of pregnancy loss). All specifications include controls for mothers' civil status, child gender, parents' ages, education and earnings.