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Does Grief Transfer across Generations? Bereavements during Pregnancy and Child Outcomes†

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Using population data from Norway, we examine the effects of stress induced by the death of the mother's parent during pregnancy on both the short-run and the long-run outcomes of the infant. Using a variety of empirical strategies to address the issue of nonrandom exposure to death during a pregnancy, we find small negative effects on birth outcomes. However, we find no evidence of adverse effects on adult outcomes. This suggests that, though there may be measurable effects on birth outcomes, acute psychological stressors during pregnancy have limited adverse consequences for the child's success in education and the labor market. (*JEL* I12, J13, J16)

Much is now known about the effects of shocks to the physical health of pregnant women on the outcomes of their in utero children, with evidence that adverse health or nutrition shocks to pregnant women have significant and often long-lasting effects on the outcomes of their children.[1] However, in developed countries, a possibly more relevant issue is the effect of psychological stresses. As women are increasingly attached to the labor market, they are less able to avoid stress while pregnant; as a result, it is important to understand the role of psychological stress on the outcomes of the children in utero. In addition, psychological stress could be a key mechanism through which physical shocks translate into shocks to child health.[2] In this paper, we use register data on the population of Norway to examine

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[1] See Almond and Currie (2010) and Currie (2011) for surveys of some of this work. This includes studies on the effects of the 1918 flu epidemic (Almond 2006), the 1957 Asian flu pandemic (Kelly 2011), the 1959 to 1961 Chinese famine (Almond et al. 2010), the Dutch famine in 1945–1946 (Scholte, van den Berg, and Lindeboom 2012), exposure to radiation (Almond, Edlund, and Palme 2009; Black et al. 2013), temperature during gestation (Bruckner et al. 2014), and the effects of maternal smoking and drinking (Currie, Neidell, and Schmieder 2009; Fertig and Watson 2009).

[2] See, for instance, Scholte, van den Berg, and Lindeboom (2012) examining the Dutch famine and Almond (2006) examining the effect of exposure to disease.

the effect of stress caused by the death of a pregnant woman's parent on both the short-run and long-run outcomes of her children.[3]

There are a number of mechanisms through which stress could affect a developing fetus. One plausible biological mechanism is that stress triggers the production of a placental corticotrophin-releasing hormone (CRH), which has been shown to lead to reduced gestational age and low birth weight (Hobel and Culhane 2003). In addition, stress suppresses the immune system, thereby making pregnant mothers more susceptible to sickness, and can cause high blood pressure, which increases the chance of having preterm labor or a low birth weight infant. Finally, there may be behavioral responses to stress, such as smoking cigarettes or drinking alcohol, which can also have adverse effects on the health of the fetus.

There is a limited amount of research examining the effects of stress while pregnant on children's outcomes. The majority of these studies focus on stress induced by large disasters, such as earthquakes (Glynn et al. 2001, Torche 2011), extreme weather events such as hurricanes (Simeonova 2011, Currie and Rossin-Slater 2013), the terrorist attacks of 9/11 (Berkowitz et al. 2003, Lauderdale 2006, Brown 2013), armed conflict (Mansour and Rees 2012), and the prevalence of landmines in Columbia (Camacho 2008).[4] These studies tend to find a negative effect of stress on children's outcomes at birth. However, a key limitation of this work is that these disasters may have direct effects on the pregnant women, and hence the effects observed may be due to the combination of the direct (physical) and indirect (through stress) effects on the mother.

While using parental death as a shock to the mother's stress level eliminates a number of the problems faced by earlier identification strategies, some issues remain. First, parental death can affect individuals in ways other than through stress.[5] In particular, parents may be important sources of financial support or parents and children may co-reside—as a result, parental death might represent a shock to one's lifestyle or income. To reduce the potential impact of these issues, we restrict the sample to women who have children between the ages of 25–45, when they are less likely to be dependent on parental resources. We also conduct a number of specification checks to confirm that it is not the loss of time the mother spends with her parent or a shock to income from an inheritance during the pregnancy that is driving our results.

Second, individuals who have a parent die younger are not a random sample of the population. Lower income families are likely to both have parents who die earlier and poorer child outcomes, both in the short-run and in the longer run. To deal with this, we integrate two approaches in our estimation strategy.

[3] The death of a parent of the father may also increase the stress levels of the mother during pregnancy. We have investigated this issue and found no evidence for any adverse effect of such an event on child outcomes.

[4] There are a limited number of exceptions. Most notably, Aizer, Stroud, and Buka (2012) use a sample of pregnancies from the early 1960s in Providence and Boston and estimate sibling fixed effects models of the effects of cortisol levels (a marker for maternal stress) during pregnancy on educational attainment. While this study has the advantage of having a direct measure of stress (cortisol levels), it is somewhat limited by small sample sizes. Additionally, there remains the concern that stress levels are correlated with unobserved events that have direct effects on the mother.

[5] The death of a parent is generally regarded as a very stressful event. For example, the Holmes-Rahe Stress Inventory treats the death of a close family member as the fifth most stressful life event (the death of a spouse is considered to be the most stressful life event).

Our first approach involves comparing the outcomes of children who experience the death of a grandparent while in utero to the outcomes of similar children who experience the death of a grandparent in the period just before or just after the in utero period. By making this comparison, we are able to isolate the effect of a death during pregnancy from the effect of a death in the general time period around pregnancy. The second approach is to use mother fixed effects. In this case, we are comparing two children born to the same mother, with the mother experiencing a parental death during only one of the pregnancies.[6] This approach relies on entirely different variation and demonstrates the robustness of our results to the choice of specification.

There are a few papers that examine the effect of stress resulting from the death of someone close to the pregnant mother on the birth outcomes of the children. Most closely related to our own work is work done concurrently by Persson and Rossin-Slater (2014), who look at the death of a family member in utero on the short- and long-run health outcomes of children in Sweden.[7] Using a similar identification strategy comparing children in utero for the death of a close family member to those who experience a similar death immediately after birth, the authors find that in utero exposure to stress through the death of a family member affects health at birth and later psychological conditions. While we use a slightly different identification strategy, examining only the death of grandparents of the child in utero to avoid any other confounding factors associated with the death, such as changes in resources, we view this paper as a complement to our own—despite their finding of longer run effects on mental health, we find no significant effects on education or future labor market success.

We find that, regardless of which approach we use, a parental death experienced while pregnant leads to small negative effects on birth outcomes, including lower birth weight and an increased probability of a Caesarian Section. However, despite these small negative effects at birth, we find no evidence for adverse effects on the children's outcomes later in life, suggesting no persistent negative effects. These results are quite robust to the choice of specification and a variety of robustness checks.

The paper unfolds as follows. Section II describes our empirical strategy, and Section III describes our data. Section IV presents the results for the effects on birth outcomes and describes heterogeneous effects by cause of death and by grandparent characteristics. Section V then shows the longer run effects on education and earnings. Section VI describes the various robustness checks we conduct, showing the insensitivity of the results to sample selection and specification choices. Section VII then concludes.

[6] Much of the research in the literature on child outcomes has used mother fixed effects, for example, Currie and Rossin-Slater (2013).

[7] Other related work includes that by Catalano and Hartig (2001), who examine the effect of the assassination of Olaf Palme in Sweden on pregnancy outcomes just after, thereby relying on time-series variation, and work by Li et al. (2010), who use micro data from Denmark and compare the Body Mass Index (BMI) of children of mothers who experienced a death during pregnancy to children of those who did not. However, a key limitation is that this study does not deal with the nonrandom timing of fertility or deaths. Our paper attempts to isolate the causal effect of stress by taking into account the nonrandom timing of fertility and deaths.

I. Empirical Approach

As previously noted, because family deaths are not randomly assigned, a simple regression of birth weight on an indicator of whether the mother experienced the death of a parent while pregnant may lead to inconsistent estimates of the effect of death on birth outcomes. Poorer families have lower life expectancy so the existence of a parental death while pregnant is likely to be correlated with the unobserved characteristics of the mother and child.[8] In order to obtain consistent estimates, we use two different estimation strategies, both separately and, ultimately, combined; the first is a comparison of the effects of a death during a pregnancy to the effects of a death immediately before or after birth, and the second is a mother fixed effects approach.

To implement the first approach, we include two indicator variables in our regressions—an indicator for whether the mother experienced a parental death at any point in the period right before, during, or right after the pregnancy, and an indicator equal to one if this death occurred during the pregnancy itself. For mothers who experience a parental death either during pregnancy or just before or after pregnancy, it may be a matter of chance whether the death occurs specifically before, during, or after pregnancy. Therefore, conditional on a death around the time of pregnancy, experiencing a death during pregnancy can be considered random. The indicator for death during pregnancy now reflects the additional effect of having a death during pregnancy relative to the effect of experiencing a death in the window around the pregnancy. We later present results when, rather than control for a death during the window, we limit our sample to just the observations within the window to show that this does not affect our results.[9]

The equation we estimate is as follows:

$$H_{ift} = \alpha_0 + \alpha_1 DW_{it} + \alpha_2 D_{it} + \beta \mathbf{X}_{it} + \gamma_t + \epsilon_{ift}. \tag{1}$$

Here, H_{ift} represents outcomes, such as birth weight, for child i from family f at time t. DW is an indicator variable for whether there was a death (of a parent of the mother) in the window around pregnancy (in the year before, during the pregnancy, or in the year afterwards) and D is our variable of interest—an indicator for whether there was a death while the child was in utero. $\mathbf{X}$ is a vector of controls that includes age of mother at birth (in years), birth order of the child, years of education of both father and mother, and the gender of the child. We also include controls for year of birth by month of birth indicators (γ_t).

We implement this approach by choosing a window based on the conception date (as gestation is potentially endogenous). Our benchmark window includes all births in which a grandparent death occurs in the year before the conception date, during

[8] Appendix Table A1 presents summary statistics of the characteristics of those mothers who experienced a parental loss while pregnant compared to those who did not for our analysis sample. Clearly there are some systematic differences—pregnancies that have a death involve parents who are older and less educated than other pregnancies. Also, pregnancies with a death are less likely to occur later in the sample period. We control for all of these variables in estimation, but this highlights the importance of controlling for selection.

[9] These two methods of implementation are exactly equivalent in the absence of any control variables.

the nine-month interval after the conception date, or in the year immediately following this nine-month interval. Appendix Table A2 presents summary statistics by the timing of parental death to provide a basic sense of the comparison we are making—we are essentially comparing the outcomes for those children whose mother experienced a death while pregnant (in utero) relative to those who experienced it just before or after—and, observably, these groups are quite similar.

In applying this approach, we must make two main assumptions. The first assumption is that the unobserved characteristics of the pregnancy are uncorrelated with whether a death occurs during it rather than just before or after it. This would be problematic if the health of the grandparent was affected by a difficult pregnancy. However, using the individuals who experienced a death before pregnancy as a comparison group would mitigate this issue, as the quality of the pregnancy is unobserved at the time of the death. It could also be the case, however, that fertility decisions of parents could be affected by grandparent death. We have examined this directly and find little evidence that this is the case (see Section VI). However, using individuals who experienced a death after the birth of the children as the comparison group should mitigate this issue, as the death followed the fertility choice.

The second assumption required is that there is no direct effect of a death just outside the in utero window on child outcomes.[10] This could be problematic if the grandparent was dying during the in utero period but didn't actual die until after the birth—to the extent that the mother still experienced stress in utero, this would lead to a downward bias. When the comparison group is those who experienced a death just before pregnancy, an implicit assumption is no long-term direct effect of grief. If this assumption is violated, we would tend to underestimate the effects of a death in utero.[11]

In our primary specifications, we use both individuals who experienced a death before pregnancy and those who experienced it after pregnancy as our comparison group. However, we later show the results when we use each group separately as the comparison group. While each of these comparison groups (those who experience death before and after the pregnancy) has their own limitations, it is comforting that our results are very similar regardless of which we use.

Our second approach incorporates mother fixed effects. By using mother fixed effects, we are exploiting the fact that many mothers have more than one birth during the sample period. If a mother has two births, by chance one pregnancy might coincide with the death of one of the mother's parents. By comparing the outcomes of the two births, we can evaluate the effect of the death, differencing out any time-invariant characteristics of the mother or family background more generally that could bias the results. To implement this design, we restrict the sample to mothers who have at least two births and include mother fixed effects in the regression.

[10] To the extent that this assumption is violated and there are direct effects of death just outside the in utero window on child outcomes, this analysis will understate the true effect of parental death in utero. The fact that we observe the largest effects when the death was more likely to be unexpected (cardiovascular disease) suggests that there may in fact be spillovers from longer illnesses, leading to potential underestimates.

[11] While we have not found much evidence on this point, there is some evidence of long-term (mortality) effects for parents who lose a child, indicating long lasting effect of grief in this circumstance (Rostilla, Saarela, and Kawaschi 2011).

In the fixed effects specifications, we exclude mother's education because it is time invariant and mother's age at birth as it is subsumed by the year of birth by month of birth dummies.[12] An advantage of this fixed effects approach over the first approach is that there is no potential confounding from direct effects of deaths just before or after pregnancy on child outcomes. However, for the longer run outcomes, to the extent that the investment behavior of mothers responds to the relative endowments of her children, estimates using mother fixed effects may be biased.[13]

While the mother fixed effect helps eliminate differences in the fixed family characteristics of those who are more likely to lose a parent at a younger age, there may still be time-varying factors correlated with the death of a parent (for example, caring for a sick parent). To address this, in our final approach, we combine the two methodologies by including both mother fixed effects and a control for whether there is a death in the window around pregnancy.

A final issue that arises in estimating the effect of a pregnant woman's parental death on children's outcomes is the mechanical relationship between duration of pregnancy and probability of experiencing a death. While gestation generally lasts about nine months, it varies across pregnancies. If a pregnancy lasts longer, it is more likely that a grandparent death occurs during gestation. This leads to a mechanical positive relationship between a death in utero and gestation length. Given that gestation is correlated with birth weight and other birth outcomes, this relationship biases against finding a negative effect of family deaths on birth outcomes.

We deal with this issue by adopting an instrumental variable strategy used by Currie and Rossin-Slater (2013). Since we observe gestation length in the data, we can determine the conception date by counting backward from the birth date. We create a predicted gestation period as the period from the conception date until nine months after the conception date and measure family deaths that take place during this period. We then use family deaths in this predicted gestation period as an instrument for family deaths during the actual gestation. In practice, the first-stage relationship is extremely strong so the instrumental variables estimates are very similar to the reduced form.

Appendix Table A3 presents the results when we run balancing tests for our three main specifications to verify that there are no observable differences in the characteristics of parents who experience a death while pregnant, conditional on window indicators and/or mother fixed effects. The outcome variables we study are mother's and father's education and earnings in the year of birth (in 2010 krona), mother's and father's age at birth, birth order and gender of the child, whether the mother is married or cohabiting at birth, and whether the mother is a Norwegian native. We do this first for the specification with the window dummy, second for the specification with mother fixed effects, and third for the specification with both the window dummy and mother fixed effects. As we can see from the results, there are statistically significant differences for the mother fixed effects specification as mothers

[12] One complication that arises is that the father of the children could potentially be different across births. Therefore, we include controls for paternal education. We also tested the robustness of our results when we restrict the sample to siblings with the same father; results are insensitive to this constraint.

[13] Compensating responses could reduce endowment effects while reenforcing behavior would increase them.

are more likely to be bereaved while pregnant if they are older and for later births. Consistent with these life-cycle effects, bereavement during pregnancy is associated with higher mother earnings and higher probability of being married or cohabiting. This shows the necessity of our controls for maternal age and birth order in the main regressions.

In the window specification without mother fixed effects, bereavement in utero is associated with higher maternal education and earnings. However, the specification with both the window dummy and mother fixed effects passes all the balancing tests as there is no statistically significant relationship of bereavement in utero with any of the outcome variables. This suggests that there are unlikely to be unobservable differences as well; as a result, this is our preferred specification.

II. Data

A. *Birth Records*

Our primary data source is the Medical Birth Registry of Norway that includes the records for all Norwegian births from 1967 to 2009. All births, including those born outside of a hospital, are included as long as the gestation period was at least 12 weeks. The birth records contain information on year and month of birth, birth weight, gestational length, age of mother, and a range of variables describing infant health at birth.[14] We can also distinguish between singleton and multiple births, and we exclude multiple births from the sample.[15]

B. *Death Records*

The Norwegian Death Register has information on deaths that occur in Norway between 1961 and 2010. For each death, we know the exact date of death and the cause of death. Using the individual identifiers, we merge date of death to other information about the individual.

C. *Other Register Data*

Using the unique personal identifiers, we match the birth and death files to the Norwegian Registry Data, a linked administrative dataset that covers the population of Norwegians alive at any point between 1960 and 2010 and is a collection of different administrative registers, such as the education register, family register, and the tax and earnings register. These data provide information about educational attainment, labor market status, earnings, a set of demographic variables (such as age and gender), and information on families.

[14] In the empirical work we treat births as taking place on the fifteenth day of each month.
[15] We have verified that our results are robust to the inclusion of multiple births.

D. *Military Data*

We are also able to match the birth records to the Norwegian military records from 1984 to 2010 that contain information on height, weight, and IQ scores. In Norway, military service is compulsory for every able young man. Before entering the service, their medical and psychological suitability is assessed; this occurs for the great majority between their eighteenth and twentieth birthday.[16] We use the height, Body Mass Index (BMI—defined as kilograms divided by meters squared), and test score data as outcome variables for men.[17]

E. *Outcomes*

We study a variety of different outcomes, both at birth and later in life. One of the key variables we examine is birth weight, available beginning in 1967. [18] In the literature, different variants of birth weight have been used as the primary variable of interest. These include birth weight, log(birth weight), and fetal growth (defined as birth weight divided by weeks gestation). Given that there is no obvious choice a priori, we report estimates for all of these variables in our analysis.[19] We also report effects of parental bereavement on weeks of gestation and the height of the baby at birth, all available beginning in 1967.

To augment these results, we incorporate a number of other characteristics of the birth or the first weeks of life that are reported in the Birth Register. A key indicator of health at birth is the 5-minute APGAR score. APGAR scores are a composite index of a child's health at birth and take into account Activity (and muscle tone), Pulse (heart rate), Grimace (reflex irritability), Appearance (skin coloration), and Respiration (breathing rate and effort). Each component is worth up to two points for a maximum of ten.[20] We also study whether the birth was via Caesarian section, and whether the child was in the Neonatal intensive care (NICU) after birth.[21] We consider both of these as potentially reflecting the presence of problems at birth that may be associated with poor infant health.

Among the long-run outcomes, for the cohorts of men born from 1967 up to 1991, we have information from the military records on height and BMI, both of which were measured as part of the medical examination. The military records also contain an IQ score that is reported in stanine (Standard Nine) units, a method of

[16] Of the men in the 1967–1987 birth cohorts, 1.2 percent died before one year and 0.9 percent died between one year of age and registering with the military at about age 18. About 1 percent of the sample of eligible men had emigrated before age 18, and 1.4 percent of the men were exempted because they were permanently disabled. An additional 6.2 percent are missing for a variety of reasons including foreign citizenship and missing observations. See Eide et al. (2005) for more details.

[17] There is an extensive literature suggesting that height is a useful indicator of health, both in developed as well as developing nations. See Strauss and Thomas (1998) for references.

[18] We set birth weight to missing in cases where it is reported to be less than 500 grams.

[19] The incidence of low birth weight ($<$ 2,500 grams) is also frequently studied in the literature. Only 3 percent of our sample is low birth weight and we have found tiny insignificant effects when we have looked at the effect of parental deaths on this variable.

[20] APGAR scores are available in the birth records beginning in 1977.

[21] We do not report results for infant mortality as it is very rare in our sample (less than 1 percent of births). When we have used it as an outcome we found tiny and insignificant effects.

standardizing raw scores into a 9 point standard scale that has a discrete approximation to a normal distribution, a mean of 5, and a standard deviation of 2.[22]

For both men and women, we study years of education for the cohorts born between 1967 and 1985 (and who are therefore at least 25 in 2010). Our measures of educational attainment are reported by the educational establishment directly to Statistics Norway, thereby minimizing any measurement error due to misreporting.[23] We also create a binary indicator for whether the person has at least 12 years of education. For this variable, we include persons aged at least 21 in 2010, so we have cohorts up to 1989.

Finally, we study labor market outcomes for both men and women. We first consider attachment to the labor force by studying whether individuals who are at least 25 years old are full-time, full-year workers in 2010 (the last year of our panel). To identify this group, we use the fact that our dataset identifies individuals who are employed and working full time (30+ hours per week) at one particular point in the year (in the second quarter in the years 1986–1995, and in the fourth quarter thereafter).[24] We label these individuals as full-time workers; about 60 percent of persons in our sample worked full time in 2010.

We also study the earnings of individuals who are at least 25 years old in 2010, measured as total pension-qualifying earnings reported in the tax registry. These are not topcoded and include labor earnings, taxable sick benefits, unemployment benefits, parental leave payments, and pensions.

F. *Sample Restrictions*

We restrict our sample to births where the mother is between 25 and 45 years old at the time of birth, drop multiple births, and drop cases with missing information on the control variables or with missing identifiers for the parents of the mother. We also include only live births with gestation of at least 26 weeks, although we later test the sensitivity of our results to this restriction. Because we primarily use specifications with mother fixed effects, we limit our sample to mothers with at least two births; Table 1 presents summary statistics for all births and for the sample where mothers have at least two births (which we call the analysis sample). The means of most variables are similar in the two samples, but parents in the analysis sample have higher education and their children tend to have better average outcomes. The analysis sample is used for all subsequent empirical work in this paper unless otherwise specified. We do, however, show the robustness of our results to the choice of estimating sample in Section VI.

[22] The IQ measure is the mean score from three IQ tests—arithmetic, word similarities, and figures (see Sundet, Barlaug, and Torjussen 2004; and Thrane 1977 for details). The arithmetic test is quite similar to the arithmetic test in the Wechsler Adult Intelligence Scale (WAIS) (Sundet et al. 2005, Cronbach 1964), the word test is similar to the vocabulary test in WAIS, and the figures test is similar to the Raven Progressive Matrix test (Cronbach 1964). The correlation between this IQ measure and the WAIS IQ score has been found to be 0.73 (Sundet, Barlaug, and Torjussen 2004).

[23] See Møen, Salvanes, and Sørensen (2003) for a description of these data.

[24] An individual is labeled as employed if currently working with a firm, on temporary layoff, on up to two weeks of sickness absence, or on maternity leave.

TABLE 1—DESCRIPTIVE STATISTICS FOR FULL SAMPLE AND ANALYSIS SAMPLE

	Full sample			Analysis sample		
	Count	Mean	SD	Count	Mean	SD
Birth weight	1,052,263	3,586.16	567.38	750,697	3,607.32	557.20
log birth weight (*10)	1,052,263	81.70	1.81	750,697	81.77	1.75
Fetal growth rate	1,052,263	90.25	12.99	750,697	90.77	12.79
Weeks gestation	1,053,524	39.65	1.93	751,578	39.67	1.88
Height (birth length)	1,018,616	50.36	2.46	727,284	50.43	2.40
5 minute APGAR	975,505	9.33	0.85	702,813	9.34	0.82
C-section	1,053,524	0.12	0.33	751,578	0.11	0.32
Neonatal ward	1,021,308	0.04	0.20	726,709	0.04	0.20
Education (2010)	205,900	13.27	2.51	134,221	13.50	2.50
Education $\geq$ 12 (2010)	311,285	0.83	0.37	211,212	0.85	0.35
Full time (2010)	225,003	0.60	0.49	146,895	0.60	0.49
log(earnings)	207,931	12.61	0.82	135,977	12.61	0.84
log(earnings) full-time workers	134,142	12.92	0.44	87,503	12.93	0.45
IQ score at 18	176,695	5.31	1.74	122,644	5.43	1.73
Height at 18	191,980	180.47	6.55	132,974	180.66	6.56
BMI at 18	191,793	22.90	3.78	132,843	22.80	3.66
Education of mother	1,053,524	12.90	2.72	751,578	13.20	2.69
Education of father	1,053,524	12.71	2.78	751,578	12.99	2.80
Age of mother at birth	1,053,524	29.96	3.81	751,578	30.30	3.79
Month of birth	1,053,524	6.38	3.37	751,578	6.36	3.36
Year of birth	1,053,524	1994	9.98	751,578	1994	9.50
Birth order	1,053,524	2.04	1.00	751,578	2.09	1.04
Female	1,053,524	0.49	0.50	751,578	0.49	0.50
Death during pregnancy	1,053,524	0.01	0.11	751,578	0.01	0.11
Death in window	1,053,524	0.04	0.20	751,578	0.04	0.20
Grandmother age at death	283,622	73.30	13.15	199,022	73.37	13.11
Grandfather age at death	464,918	70.90	12.60	329,824	71.13	12.50
Age of father at birth	1,053,524	32.82	5.10	751,578	32.97	5.03
Married at birth	1,053,524	0.65	0.48	751,578	0.68	0.47
Married or cohabiting at birth	1,053,524	0.95	0.22	751,578	0.96	0.20
Native Norwegian	1,053,524	0.98	0.14	751,578	0.98	0.14
Earnings of father (2010 krona)	1,053,332	369,550	408,467	751,488	377,365	462,111
Earnings of mother (2010 krona)	1,052,734	196,911	145,304	751,176	203,484	144,083

Note: The analysis sample includes all women who have at least two births during the sample period.

III. Results

The first rows of Table 2 present the "naïve" cross-sectional OLS estimates without mother fixed effects or an indicator for a death in the window around the pregnancy to demonstrate the importance of instrumenting for death during pregnancy with death during the nine months after conception. The first row presents the simple OLS results of the effect of a grandparent death while in utero for each outcome, the second row presents the reduced form when an indicator of death of grandparent in utero is replaced with an indicator for death of a grandparent up to 9 months after conception, and the third row presents the results when death of a grandparent in utero is instrumented with an indicator for death of a grandparent within 9 months after conception. In all specifications, we control for maternal and paternal education, age of mother at birth, birth order of the child, gender of the child, and year-by-month of birth indicators.

TABLE 2—— EFFECT OF A DEATH DURING PREGNANCY ON VARIOUS CHILD OUTCOMES

	Birth weight (1)	log(birth weight) (2)	Fetal growth (3)	Weeks gestation (4)	Height (5)	5 minute APGAR (6)	C-section (7)	Neonatal ward (8)
OLS								
Death in utero	−8.081	−0.017	−0.236*	0.017	0.004	−0.002	0.002	0.000
	(5.857)	(0.018)	(0.134)	(0.020)	(0.025)	(0.009)	(0.003)	(0.002)
Reduced form								
Death in utero	−22.055**	−0.069**	−0.397**	−0.086**	−0.058**	−0.005	0.006*	0.003
	(6.056)	(0.019)	(0.138)	(0.021)	(0.026)	(0.009)	(0.004)	(0.002)
IV								
Death in utero	−22.391**	−0.070**	−0.403**	−0.087**	−0.058**	−0.005	0.006*	0.003
	(6.153)	(0.020)	(0.140)	(0.021)	(0.027)	(0.009)	(0.004)	(0.002)
IV window								
Death in utero	−16.234**	−0.049**	−0.273*	−0.076**	−0.050	−0.010	0.006	0.001
	(7.222)	(0.023)	(0.165)	(0.025)	(0.031)	(0.011)	(0.004)	(0.002)
Death in window	−6.297	−0.021*	−0.133	−0.012	−0.008	0.005	0.001	0.002
	(3.834)	(0.012)	(0.088)	(0.013)	(0.016)	(0.006)	(0.002)	(0.001)
IV FE								
Death in utero	−15.257**	−0.044**	−0.246*	−0.075**	−0.023	−0.018	0.010**	−0.001
	(5.782)	(0.019)	(0.131)	(0.023)	(0.028)	(0.012)	(0.003)	(0.003)
IV window FE								
Death in utero	−20.879**	−0.062**	−0.363**	−0.089**	−0.079**	−0.022	0.013**	−0.003
	(6.839)	(0.023)	(0.155)	(0.027)	(0.033)	(0.014)	(0.004)	(0.003)
Death in window	5.863	0.019	0.121	0.015	0.058**	0.005	−0.004*	0.002
	(3.717)	(0.012)	(0.084)	(0.015)	(0.018)	(0.008)	(0.002)	(0.002)
Observations	750,697	750,697	750,697	751,578	727,284	702,813	751,578	726,709

Notes: Standard errors are in parentheses. Specifications without mother fixed effects have standard errors clustered by mother.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

The upward bias of "naïve" OLS due to the spurious relationship between gestation length and family deaths is obvious in the estimates. This is particularly apparent when weeks pregnant is the dependent variable, as the sign flips from positive to negative when we go from OLS to IV.[25] While the first stage is not reported, the first-stage coefficient is close to one, leading the reduced form and IV estimates to be very similar.[26] While these estimates generally show adverse effects of a death

[25] To reassure that the magnitude of the change is reasonable, we have implemented a small monte carlo using a distribution of gestation lengths and a grandparent death rate that matches those in our sample. We found differences between "naïve" OLS and IV estimates that mimic those we find in Table 2 for weeks gestation, suggesting that the differences between OLS and IV results are driven by the mechanical relationship between gestation length and the probability of a death during pregnancy.

[26] Despite the strong first-stage relationship, the substantial difference between OLS and IV estimates occurs because of the extreme reverse causality that arises from the fact that any event (including a death) is more likely to occur during pregnancy if gestation is longer. Let Y be our outcome, X our endogenous variable (death while pregnant), and Z be our instrument (death within nine months after conception). Because we have control variables, we first partial these out from Y, X, and Z. We then calculate the relevant variance and covariance terms that make up our OLS and IV estimates. When Y is birth weight, we find that the OLS estimate $= \text{cov}(X, Y)/\text{var}(X) = -0.093/0.011 = -0.08$. The IV estimate $= \text{cov}(Z, Y)/\text{cov}(Z, X) = -0.251/0.011 = -0.22$. Note that $\text{var}(X)$ is approximately equal to $\text{cov}(Z, X)$ because the instrument is so highly correlated with the endogenous variable. Therefore, the difference between OLS and IV almost entirely arises from the difference in the numerators. The analogous exercise for weeks gestation gives OLS $= \text{cov}(X,Y)/\text{var}(X) = 0.0002/0.0115 = 0.017$ and IV $= \text{cov}(Z,Y)/\text{cov}(Z,X) = -0.0098/0.0112 = -0.087$. Here we see that the sign change occurs because although a death in utero (X) is

on birth outcomes, we do not focus on these results because the specification does not allow for unobserved factors that may be correlated with timing of fertility and bereavement. All estimates going forward present instrumented results.

We first present the results from specifications where we include the indicator for a death in the window around the pregnancy but no mother fixed effects (IV Window, rows 4 and 5 of Table 2), then the results from specifications where we include just mother fixed effects and not the indicator for death in the window, (IV FE, row 6 of Table 2) and, finally, the specification that includes both (IV Window FE, rows 7 and 8 of Table 2). Note that all estimates instrument for death during pregnancy with death in the 9 months postconception.

It is important to observe that the results are quite consistent across specifications—this is particularly notable given that the identifying variation is quite different across the different approaches. Given this, we focus on our preferred specification, which includes mother fixed effects and an indicator for whether there was a death in the window surrounding the pregnancy.

The first finding is that there is a negative effect of bereavement in utero on birth weight. To get a sense of the magnitudes, the estimate of the birth weight effect is about 21 grams. This is relative to a mean of about 3,500 grams and standard deviation of about 500 grams, so it is approximately 4 percent of a standard deviation. The coefficient in the log birth weight regression is about -0.006 (note that, for presentation purposes, this estimate is multiplied by ten in the tables), which implies that a death reduces birth weight by less than 1 percent.[27] These small birth weight effects occur both because of a small reduction in gestation length (by 0.09 weeks or less than one day) and due to a fall in the rate of fetal growth. The reduction in birth weight is mirrored by a negative effect on birth length (infant height). Once again this effect is very small as the coefficient implies a magnitude of less than one tenth of a centimeter. Overall, our results for birth weight and length imply adverse but very small effects of a grandparent death in utero.

Table 2 also presents results for other birth outcomes. Again focusing on the specification with both mother fixed effects and an indicator for a death within the window surrounding the pregnancy, we find that stress leads to an increased likelihood of having a caesarian section. This effect is relatively large; a death in utero increases the probability of a C-section by about 1 percent (from a baseline of about 11 percent).[28] Finally, we find no evidence of any effect on the APGAR score or the likelihood of the child being transferred to the Neonatal Ward.[29]

In Table 2, we also report the coefficients on the variable that measures whether there is a death in the window that envelops the pregnancy. However, it is difficult to interpret these coefficients, as they may reflect true causal effects of deaths just

positively correlated with weeks gestation (Y), a death in the nine months after conception (Z) is negatively correlated with weeks gestation.

[27] Based on the Black, Devereux, and Salvanes (2007) estimates of the effects of birth weight on adult outcomes, this would imply that a family death reduced the probability of finishing high school and log earnings by only about 0.0006 and 0.0008, respectively.

[28] It appears that the relationship between parental death and gestation length is not due to the increase in C-sections (which may lead to shorter gestation periods). When we estimate the effect on the subsample of vaginal births, we find similar effects.

[29] Because data on APGAR scores begin in 1977, sample sizes are smaller for this outcome.

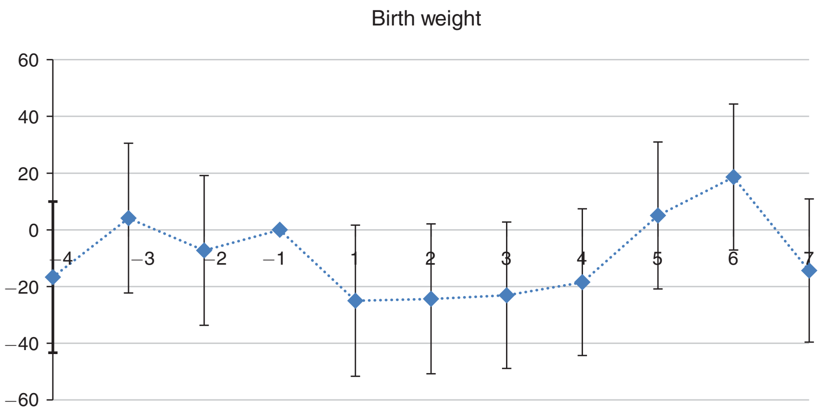

Figure 1. Effect of Grandparent Death on Birth Weight

Notes: This figure shows the effect of a grandparent death on birth weight by quarter relative to conception. In the graph, −4 denotes deaths 10–12 months before conception, −3, −2, and −1 denote deaths 7–9, 4–6, and 1–3 months before conception, respectively. Then 1 denotes a death in the first three months after conception, and 2, 3, etc. denote the subsequent quarters.

before or just after pregnancy, or they could be picking up systematic differences between the unobserved characteristics of pregnancies that occur during periods with a death and periods without a death.

In Figure 1, we provide a visual description of the birth weight estimates. To create this picture, we use our preferred specification, with both the window and mother fixed effects, and include dummy variables for deaths in each of the quarters in the window around conception (the omitted category is a death in the three months before conception). In the graph, −4 denotes deaths 10–12 months before conception, −3, −2, −1 denote deaths 7–9, 4–6, and 1–3 months before conception, respectively. Then 1 denotes a death in the first 3 months after conception, and 2, 3, etc denote the subsequent quarters. One can clearly see the negative effects of a death in each of the three quarters after conception.

A. *Magnitudes*

In terms of how these estimates compare to the existing literature, most credible studies find small negative effects of stress in utero on birth outcomes. Using a family fixed effects strategy, Currie and Rossin-Slater (2013) find no evidence of effects of hurricanes on birth weight or gestation length but some evidence of effects on C-sections and abnormalities. Simeonova (2011) finds a natural disaster reduces birth weight by 1 gram and weeks of gestation by 0.01, and Camacho (2008) finds that living near a landmine explosion in Colombia reduces birth weight by nine grams. Persson and Rossin-Slater (2014) find that exposure to maternal bereavement in utero leads to increases in the likelihood of low birth weight and very low birth weight and an increase in the likelihood of a small-for-gestation-age birth. Our findings of small negative effects are in line with these other estimates.

B. *By Cause of Death*

While it is clearly stressful to lose a parent to any cause, there may be some types of deaths that are more stressful than others. For example, more sudden, unexpected deaths, such as those resulting from a heart attack, may lead to more concentrated stress at the time of the passing. Appendix Table A4 presents the causes of grandparent deaths during pregnancy for the analysis sample. As is well known, the two major distinct causes of death are cancers and cardiovascular disease; we hypothesize that those resulting from cardiovascular disease may have been more unexpected than those from cancer or other causes.

To examine whether there are differential effects by cause of death, we include separate dummy variables for each of three causes of death —cardiovascular disease, cancer, and other or unknown. Table 3 Column 1 presents the results when birth weight is the outcome and Appendix Table A5 presents the results for all other short-term outcomes. In these tables, and in the remaining tables for birth outcomes, we report estimates from the instrumental variables estimator including both mother fixed effects and the indicator for a death within the window.

Importantly, although the coefficients are not statistically different across the three different types of deaths, the estimates are generally larger and more statistically significant for deaths from cardiovascular disease, which we argue are less expected. There is less evidence of negative birth outcomes related to death by cancer or other causes.[30]

C. *Timing*

Given that stress does seem to matter for birth outcomes, we then investigate when during the pregnancy the fetus is most vulnerable. To do so, we divide the pregnancy into trimesters. Table 3, column 2 presents the results when we estimate the effect of the death of a grandparent on birth weight by trimester of exposure, and Appendix Table A6 presents the results for all other short-run outcomes. The results suggest no clear pattern of timing—while some specifications are statistically significant, the coefficient sizes are relatively constant across the trimesters, leaving us reluctant to draw any strong conclusions about timing.

D. *By Grandparent Characteristics*

One concern about our interpretation of a grandparent death as being a source of grief or stress is that grandparents may provide support to the mother during pregnancy (helping with housework, looking after other children etc). While we cannot examine this directly, we can investigate whether the effects vary by grandparent characteristics in a manner that would be consistent with this interpretation. We look

[30] We also tried examining whether there were bigger effects when "younger" parents died, hypothesizing that younger deaths are more likely to be unexpected and shocking. When we split the sample into deaths before age 60 (we hypothesize that deaths this young might be particularly unexpected) and those after age 60, the results are indistinguishable.

TABLE 3—— EFFECT OF A DEATH DURING PREGNANCY BY CAUSE OF DEATH
(*IV Window FE Estimates*)

Dependent variable: Birth weight	(1)	(2)	(3)	(4)
Cardiovascular	−31.573**			
	(10.863)			
Cancer	−19.105			
	(15.238)			
Other cause	−11.908			
	(10.738)			
1st Trimester		−21.645**		
		(10.644)		
2nd Trimester		−20.784**		
		(10.493)		
3rd Trimester		−20.418*		
		(10.711)		
Death of grandmother in utero			−6.657	
			(12.688)	
Death of grandfather in utero			−27.729**	
			(8.068)	
Death in utero—same county				−23.674**
				(8.473)
Death in utero—different county				−16.998
				(11.696)

Notes: Sample size is 750,697 in all specifications. More complete results are presented in Appendix Tables A5–A8. When testing for equality among coefficients within the same regression, we could not reject equality at levels of less than 10 percent. Standard errors are in parentheses. The sample includes all women who have at least two births during the sample period. All specifications include controls for paternal education, gender of child, birth order of child, and year of birth by month of birth dummies.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

at two different splits of the data. The first is whether it is the grandmother or grandfather who dies, with our prior being that the grandmother is likely to provide more direct help to the pregnant daughter and, as a result, her loss might affect the daughter both because of stress and perhaps also a loss of help. We also examine whether the grandparent dies in the same county as the birth occurs, again hypothesizing that grandparents are more likely to provide assistance for the pregnant daughter if they live nearby.

The estimates for birth weight by grandparent gender are also in Table 3 (estimates for all birth outcomes are in Appendix Table A7). For most birth outcomes, the grandfather estimate is bigger in absolute terms than the grandmother estimate. The only exception is that the grandmother death coefficient is larger for C-sections. While none of the coefficients are statistically different, there is stronger evidence for adverse effects of grandfather deaths. If grandmothers are more likely to provide help than grandfathers, our finding above of a significant effect for grandfathers suggests stress is likely to be driving our results.

We also look at how the effects of a death differ depending on the geographic proximity of the grandparent to the mother. To do so, we look at differential effects by whether the death occurred in the same county as the birth.[31] These estimates are presented in the last column of Table 3 for birth weight (and for all birth outcomes in Appendix Table A8). There are no statistically significant differences and, while the estimates are sometimes bigger for deaths that occur in the same county, there is no clear pattern, with evidence of adverse effects on birth outcomes when the death occurs in a different county. This reinforces our view that stress/grief is the important component of the effect of grandparent deaths. Note that these results also suggest that it is unlikely that our results are driven by some common shock like a local flu epidemic that both leads to the death of the grandparent and to adverse consequences for the fetus.

Finally, one may be concerned about the role of parental financial resources. While we do not have any data on inheritances or bequests, so we cannot examine this directly, we address this is by examining whether the effects differ between a first or second parent death; in the case of the first parent, it is less likely that there is an inheritance. We found no statistically different effects but the coefficients are larger when it is the first parent who passes away, suggesting that our results are not driven by changes in financial resources.[32]

E. *By Child Gender*

There is some evidence in the literature that boys are more vulnerable to insults in utero than are girls (See, for example, Eriksson et al. 2010). To examine this directly, we interact the death-in utero variable with the gender of the child.[33] Note that we also interact the death-in-window variable with gender and include a control for whether the child is male.

Table 4 presents the estimates with the gender interaction. The results suggest bigger effects for boys than girls. For the birth weight outcomes, fetal growth, and height, the interaction with male is statistically significant and the effect is bigger for boys than girls. Indeed while there is evidence that gestation is shortened and the probability of C-section is increased for both boys and girls, there is no other evidence that girls are adversely affected by a death.[34]

IV. Long-Run Outcomes

Given the negative (albeit small) effects of stress on birth outcomes, we next examine whether there are any longer run effects on children's outcomes. Earlier work on the effect of physical insults in utero, such as those generated as a result of exposure to nuclear fallout from Chernobyl while pregnant, found little if any effect

[31] There are 19 counties in Norway. We treat Oslo and Akershus as one county as Akershus contains many suburbs of Oslo.

[32] Because the father is more likely to die first, we attempted to determine whether the grandfather effect was driven by the fact that he was most likely the first parent to die. Unfortunately, our estimates are sufficiently imprecise that we cannot distinguish between the two hypotheses.

[33] The alternative approach of splitting the sample by gender gives consistent results but is less efficient as it requires restricting the sample to mothers who have at least two children of the same sex.

[34] We have also examined whether the size of the effects differ by parental education. We find no systematic evidence of differences in this dimension.

TABLE 4—EFFECT OF A DEATH DURING PREGNANCY ON VARIOUS CHILD OUTCOMES (*IV Windows FE Estimates*) INTERACTION WITH MALE CHILD

	Birth weight (1)	log(birth weight) (2)	Fetal growth (3)	Weeks gestation (4)	Height (5)	5 minute APGAR (6)	C-section (7)	Neonatal ward (8)
Death in utero	−5.838	−0.012	0.014	−0.082**	0.011	−0.018	0.011**	−0.005
	(9.824)	(0.033)	(0.223)	(0.039)	(0.048)	(0.021)	(0.006)	(0.005)
Death in utero × male	−29.015**	−0.097**	−0.727**	−0.014	−0.173**	−0.009	0.004	0.005
	(13.635)	(0.045)	(0.309)	(0.054)	(0.066)	(0.029)	(0.008)	(0.006)
Male	133.295**	0.363**	3.349**	−0.013**	0.842**	−0.064**	0.007**	0.009**
	(1.252)	(0.004)	(0.028)	(0.005)	(0.006)	(0.003)	(0.001)	(0.001)
Death in window	1.483	0.006	−0.004	0.026	0.043*	−0.004	−0.003	0.002
	(5.223)	(0.017)	(0.118)	(0.021)	(0.025)	(0.011)	(0.003)	(0.002)
Death in window × male	8.465	0.025	0.242	−0.022	0.029	0.016	−0.001	−0.001
	(7.109)	(0.024)	(0.161)	(0.028)	(0.035)	(0.015)	(0.004)	(0.003)
Observations	750,697	750,697	750,697	751,578	727,284	702,813	751,578	726,709

Notes: Standard errors are in parentheses. The sample includes all women who have at least two births during the sample period. All specifications include controls for paternal education, gender of child, birth order of child, and year of birth by month of birth dummies. All regressions include mother fixed effects and instrument the indicator variable for death during pregnancy with an indicator variable for a death within nine months of the conception date. The interaction of death in utero with male is also instrumented by the interaction of male with the instrument. Coefficients on log(birth weight) are multiplied by ten. The window around birth includes the year prior to conception, the nine months post-conception, and the year subsequent to that.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

on short-run health outcomes but did find longer run cognitive effects (Almond, Edlund, and Palme 2009), so it is not clear what our expectation is in terms of exposure to stress.

Table 5 presents the results when we estimate the relationship between grandparent death in utero and the long-run outcomes of children.[35] Because of sample size issues, we pool men and women to increase the precision of the estimates and include a dummy variable for child gender.[36] As before, we report estimates using several different strategies.

We find little evidence of any persistent effect of death experienced in utero on the long-run outcomes of children. This is true both using the window approach and the mother fixed effects approach; again, the similarity of the estimates from two methods that exploit very different sources of variation is reassuring.[37] In addition, we are able to reject large effects with our estimates. For example, when we use our preferred specification with mother fixed effects and a control for death in the window, the confidence intervals imply that we can rule out negative effects on

[35] When we estimate our short-run effect on the subsample of individuals for whom we also observe long-run effects, our birth weight estimates are somewhat smaller and our gestation estimates larger. Both are much less precisely estimated.

[36] We have tried interactions with a male dummy variable but they are never statistically significant. We do not report any of the results from the battery of heterogenous effects that we estimated for the birth outcomes because interaction terms are almost always statistically insignificant.

[37] Each identification strategy has limitations, so the fact that we find the same results regardless highlights the robustness of the results. The window approach may be problematic for longer run outcomes to the extent that the loss of a grandparent has adverse consequences on all children born around the time of the death. The mother's fixed effects approach may be problematic because other children in the family may be affected by the loss of the grandparent. As a test of this, we have allowed the effect of grandparent death to vary by child spacing and by birth order and we find no differences, suggesting that this may not be a problem.

Table 5—Effect of a Death during Pregnancy on Various Child Outcomes—Later Outcomes

	Completed education (1)	Education 12 years or more (2)	Full time (3)	log(earnings) (4)	log(earnings) if full time (5)	Cognitive score (6)	Height at 18 (7)	BMI at 18 (8)
OLS								
Death in utero	−0.041	0.002	−0.010	−0.004	−0.013	−0.006	−0.083	0.105
	(0.052)	(0.006)	(0.011)	(0.018)	(0.012)	(0.038)	(0.149)	(0.085)
Reduced form								
Death in utero	−0.054	0.002	−0.010	−0.004	−0.012	−0.015	−0.105	0.124
	(0.053)	(0.006)	(0.011)	(0.018)	(0.012)	(0.038)	(0.151)	(0.086)
IV								
Death in utero	−0.055	0.002	−0.010	−0.004	−0.012	−0.015	−0.106	0.126
	(0.053)	(0.007)	(0.011)	(0.018)	(0.012)	(0.039)	(0.152)	(0.087)
IV window								
Death in utero	−0.049	0.002	0.000	0.005	−0.003	−0.024	0.034	0.079
	(0.062)	(0.008)	(0.013)	(0.022)	(0.014)	(0.046)	(0.181)	(0.102)
Death in window	−0.006	0.000	−0.010	−0.009	−0.009	0.009	−0.144	0.048
	(0.033)	(0.004)	(0.007)	(0.011)	(0.008)	(0.024)	(0.099)	(0.054)
IV FE								
Death in utero	−0.061	0.009	−0.008	−0.001	−0.003	0.022	0.095	0.139
	(0.072)	(0.009)	(0.016)	(0.026)	(0.020)	(0.065)	(0.211)	(0.131)
IV window FE								
Death in utero	−0.112	0.004	0.009	−0.004	−0.012	−0.006	−0.008	0.106
	(0.084)	(0.010)	(0.018)	(0.030)	(0.023)	(0.077)	(0.251)	(0.156)
Death in window	0.055	0.005	−0.018*	0.003	0.009	0.029	0.108	0.035
	(0.045)	(0.005)	(0.010)	(0.016)	(0.013)	(0.042)	(0.137)	(0.086)
Observations	134,221	211,212	146,895	135,977	87,503	122,644	132,974	132,843

Notes: Standard errors are in parentheses. Specifications without mother fixed effects have standard errors clustered by mother.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

completing 12 years or more of schooling of more than 1.6 percent, negative effects on full-time earnings of more than 6 percent, negative effects on IQ score (for men) of more than 8 percent of a standard deviation, and negative effects on adult height (of men) of more than half a centimeter. Moreover, the fact that all coefficients are small and are of varying sign provides strong evidence that there are not large effects on later outcomes. In Figure 2, we provide a visual description of the education estimates—there is no obvious effect of a parental death in utero on this outcome.

This is an important finding in the context of the existing research in the area. The literature on the effects of physical insults in utero has been mixed, with most work finding adverse effects on both birth outcomes and on later measures of cognitive development, educational attainment, and labor market success. However, the literature on the effects of stress during pregnancy on child outcomes has generally focused only on short-run outcomes of children and found small adverse effects. We have been left to wonder whether these imply that affected children will also have poorer later outcomes. The death of a parent clearly causes acute stress to pregnant women, but we have found no evidence of significant effects on later outcomes of children. This suggests that, even with measurable effects on birth outcomes, we may be able to be more sanguine about the effects of acute psychological stressors on later child outcomes.

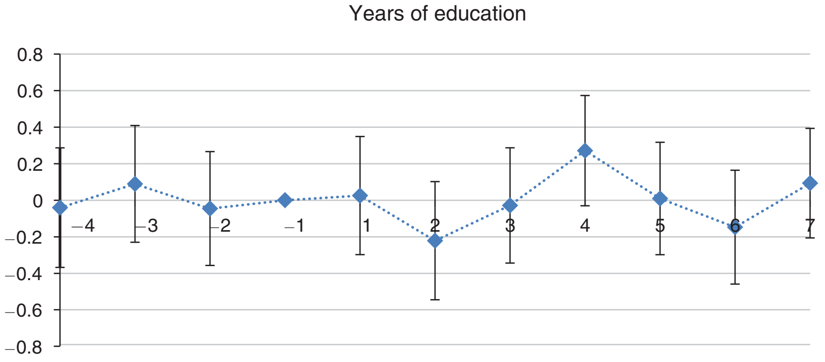

Figure 2. Effect of Grandparent Death on Child Educational Attainment

Notes: This figure shows the effect of a grandparent death on child education in 2010 by quarter relative to conception. In the graph, −4 denotes deaths 10–12 months before conception, −3, −2, and −1 denote deaths 7–9, 4–6, and 1–3 months before conception, respectively. Then 1 denotes a death in the first three months after conception, and 2, 3, etc. denote the subsequent quarters.

V. Robustness Checks

While our estimates are quite robust to choice of specification, we next examine how robust our results are to other choices we have made.

A. *Selection into Sample*

One concern is that we are using only live births with at least 26 weeks gestation when creating our sample. To the extent that bereavement early in a pregnancy may lead to a miscarriage or a stillbirth, we will understate the effect of bereavement on birth outcomes. To address this, we have tried a variety of tests. First, we examined whether or not bereavement increases the probability of a stillbirth, conditional on gestation lasting at least 12 weeks, and found no evidence of an effect. Second, we tried including all pregnancies with at least 12 weeks gestation, whether they are born live or not.[38] We have estimated specifications where we use this less restrictive sample inclusion criterion and found very similar, if not slightly larger, effects of stress during pregnancy on birth outcomes. This suggests that our results are unlikely to be tainted by differential selection into our sample along that dimension.

Another concern is the potential fertility response to a parental death. To address this, we have taken all women aged 25–45 who experienced a parental death and looked at the probability that they conceive in the months just before or after the death. These numbers are reported in Appendix Table A9. As can be seen, the probability of conception in any month varies between 0.0033 and 0.0039. The probability is at its lowest in the month of death, suggesting a small negative immediate impact of a death on conception probability. However, these differences are small and, combined with the fact that our results are similar when we limit our control group to

[38] Many miscarriages occur before the twelfth week of pregnancy. However, the birth register does not have information on pregnancies that last less than 12 weeks.

those who experienced a death after the birth (as shown in the next section), they suggest our results are not being driven by this type of selection.

B. *Before versus After*

As noted earlier, a particular concern with the window approach is that there may be selection in terms of who chooses to become pregnant subsequent to parental death. This type of selection would imply that the group of births where the mother was bereaved in the year before pregnancy might not be a suitable control for births where a death is experienced during pregnancy. While we believe this is unlikely to be a concern given our fertility analysis, in Appendix Table A10, we address this by separating the comparison group—first, it is a death in utero compared to a death in the 12 months before (implemented by including a control variable for a death occurring just before or during pregnancy), and then, it is a death in utero compared to a death in the 12 months after (implemented by instead including a control variable for a death occurring during or just after pregnancy). Once again, we do this both with and without mother fixed effects. The estimates are very similar in both cases, suggesting that our findings are generally robust to the choice of control group.

C. *Analysis Sample versus Full Sample*

For consistency, we have used the analysis sample for all of our specifications. However, because only families with at least two children are in this sample, one might worry that these results are not generalizable to the broader population. In Appendix Table A11, we present the results when we use the full sample—not limited to families with at least two children—in our estimation using the IV Window specification, and then provide the estimates from the same specification using the analysis sample for comparison. The results are quite consistent across samples, suggesting the results are likely not driven by our choice of sample.

D. *Using Only Observations in the Window*

As we noted earlier, the simplest way to implement the IV Window approach is to restrict the sample to births where a death occurred just before, during, or after the pregnancy and estimate the differential effect of experiencing the death while pregnant. For robustness, Appendix Table A11 also show the results when we restrict our sample to just those observations, both on the full and the analysis samples separately. Not surprisingly, the results are quite insensitive to the exact method of implementation of the IV Window approach.

VI. Conclusions

While we have substantial evidence that physical health shocks while pregnant have deleterious effects on the outcomes of children, much less is known about the effects of mental health shocks while pregnant on the well-being of the baby. Using unique data from Norway, we are able to estimate the effect of stress induced by the death of a mother's parent while pregnant on the outcomes, both short- and long-run, of the in utero children.

We find that maternal bereavement has small but statistically significant adverse effects on birth outcomes, and these effects are larger for boys than for girls. The effects on birth outcomes are most apparent for deaths due to cardiovascular causes, suggesting that sudden deaths due to heart attacks may be more stressful than deaths due to more persistent causes (such as cancer). However, there is no evidence of any adverse effects on any of our later outcomes including cognitive test scores, educational attainment, and earnings. This suggests that, even though there may be measurable effects on birth outcomes, acute psychological stressors during pregnancy have limited adverse consequences on the child's success in education and the labor market.

One remaining issue is the mechanisms through which bereavement affects birth outcomes. While the medical literature posits a number of possible channels for physiological responses to stress or grief, we are limited in our ability to distinguish between them. Importantly, we find that the effects are consistent across trimester of the pregnancy, suggesting it isn't just driven by deaths early or late in the pregnancy and may not be related to maternal weight gain (which predominantly occurs in the third trimester). Beyond that, however, our findings are not able to shed light on which physiological channels may be at work.

While the process may by purely physiological and be related to the body's natural responses to stress and grief, there may also be behavioral responses of the mother that affect the fetus. One such possibility is that stress increases the likelihood or level of maternal smoking. We have information on smoking behavior of mothers from 1998 onward and we have used it to see whether bereavement affects smoking. We found no evidence of any effect. This suggests that behavioral responses may not be an important part of the story, but more research with more detailed data (for example, on other behaviors such as drinking and pre-natal care) will be required to verify this conclusion.

Appendix

Table A1—Parental and Birth Characteristics by Whether Death during Pregnancy

	All		No death in utero		Death in utero	
	Mean	SD	Mean	SD	Mean	SD
Education of mother	13.20	2.69	13.20	2.69	12.88	2.76
Education of father	12.99	2.80	12.99	2.80	12.82	2.89
Age of mother at birth	30.30	3.79	30.28	3.78	31.37	4.16
Month of birth	6.36	3.36	6.36	3.36	6.32	3.35
Year of birth	1,994	9.50	1,994	9.50	1,993	9.49
Birth order of child	2.09	1.04	2.09	1.04	2.26	1.13
Female	0.49	0.50	0.49	0.50	0.48	0.50
Age of father at birth	32.97	5.03	32.96	5.02	33.92	5.35
Married at birth	0.68	0.47	0.68	0.47	0.70	0.46
Married or cohabiting at birth	0.96	0.20	0.96	0.20	0.96	0.20
Native Norwegian	0.98	0.14	0.98	0.14	0.99	0.12
Earnings of father (2010 krona)	377,365	462,111	377,520.40	464,175	364,209	227,264
Earnings of mother (2010 krona)	203,484	144,083	203,661.79	144,091	188,399	142,670
Observations	751,578		742,799		8,779	

Note: The sample includes all women who have at least two births during the sample period.

Table A2—Parental and Birth Characteristics by Timing of Death

	Death in utero (1)	Death before (2)	Death after (3)	Death before or after (4)
Education of mother*	12.87	12.77	12.79	12.78
Education of father	12.80	12.75	12.77	12.75
Age of mother at birth	31.38	31.40	31.39	31.38
Month of birth	6.32	6.35	6.36	6.35
Year of birth*	1,992.82	1,992.55	1,992.55	1,992.56
Birth order	2.26	2.26	2.24	2.25
Female	0.48	0.49	0.48	0.49
Death during pregnancy*	0.99	0.01	0.02	0.02
Age at death (grandmother)	69.21	69.10	69.68	69.43
Age at death (grandfather)	67.76	67.17	68.27	67.72
Age of father at birth	33.93	33.95	33.93	33.94
Married at birth	0.70	0.70	0.71	0.70
Married or cohabiting at birth	0.96	0.95	0.95	0.95
Native Norwegian	0.99	0.98	0.98	0.98
Earnings of father (2010 krona)	363,840	361,169	364,021	362,571
Earnings of mother (2010 krona)*	188,567	183,256	184,815	184,105
Oberservations	8,695	11,304	12,306	23,473

Notes: Death in utero is 1 if a grandparent death occurs in the 9 months following conception. Death before is 1 if a grandparent death occurs in the 12 months before conception. Death after is 1 if a grandparent death occurs in the 12 months after the predicted due date. A * implies that we can reject at the 5 percent level that the mean for cases with a death in utero differs from cases with a death before or after (i.e. comparison of columns 1–4).

TABLE A3—BALANCING TESTS (*IV Estimates*)

	Father's education (1)	Age of mother at birth (2)	Birth order of child (3)	Female child (4)	Mother's earnings (5)	Father's earnings (6)	Mother married or cohabiting (7)	Age of father at birth (8)
Mother fixed effects								
Death in utero	0.004	0.897**	0.188**	−0.006	3,462.6**	9,135.2	0.006**	0.857**
	(0.007)	(0.051)	(0.014)	(0.007)	(1,172.9)	(6,526.8)	(0.003)	(0.051)
Observations	751,578	751,578	751,578	751,578	751,176	751,488	751,578	751,571

	Mother's education (1)	Father's education (2)	Age of mother at birth (3)	Birth order of child (4)	Female child (5)	Mother's earnings (6)	Father's earnings (7)	Mother married or cohabiting (8)	Age of father at birth (9)
Window approach									
Death in utero	0.096**	0.048	0.006	0.015	−0.006	4,492.1**	1,169.1	0.004	0.002
	(0.036)	(0.037)	(0.053)	(0.014)	(0.006)	(1,837.3)	(3,200.1)	(0.003)	(0.069)
Death in window	−0.436**	−0.245**	1.131**	0.164**	0.001	−20,147.8**	−15,314.7**	−0.007**	0.999**
	(0.020)	(0.020)	(0.029)	(0.008)	(0.003)	(991.7)	(2,064.1)	(0.001)	(0.038)
Observations	751,578	751,578	751,578	751,578	751,578	751,176	751,488	751,578	751,571

	Father's education (1)	Age of mother at birth (2)	Birth order of child (3)	Female child (4)	Mother's earnings (5)	Father's earnings (6)	Mother married or cohabiting (7)	Age of father at birth (8)
Window approach with mother fixed effects								
Death in utero	−0.004	0.000	−0.012	−0.006	890.7	−1525.3	0.003	−0.002
	(0.009)	(0.060)	(0.016)	(0.009)	(1,388.2)	(7,724.6)	(0.003)	(0.061)
Death in window	0.009*	0.933**	0.208**	−0.000	2,675.9**	11,090.2**	0.003	0.894**
	(0.005)	(0.032)	(0.009)	(0.005)	(753.9)	(4194.4)	(0.002)	(0.033)
Observations	751,578	751,578	751,578	751,578	751,176	751,488	751,578	751,571

Note: Standard errors are in parentheses.
**Significant at the 5 percent level.
*Significant at the 10 percent level.

TABLE A4—CAUSE OF DEATH DURING PREGNANCY IN ANALYSIS SAMPLE

	Number	Percent
Mother's mother		
Cardiovascular disease	1,663	33.11
Cancer	1,023	20.37
External cause	111	2.21
Other illness	1,014	20.19
Unknown cause	1,212	24.13
Total	5,023	
Mother's father		
Cardiovascular disease	3,546	45.19
Cancer	1,241	15.81
External cause	154	1.96
Other illness	1,391	17.73
Unknown cause	1,515	19.31
Total	7,847	

Table A5—Effect of a Death during Pregnancy by Cause of Death (*IV Window FE Estimates*)

	Birth weight (1)	log(birth weight) (2)	Fetal growth (3)	Weeks gestation (4)	Height (5)	5 minute APGAR (6)	C-section (7)	Neonatal ward (8)
Cardiovascular	−31.573**	−0.104**	−0.501**	−0.157**	−0.118**	−0.045*	0.013**	0.003
	(10.863)	(0.036)	(0.246)	(0.043)	(0.053)	(0.023)	(0.006)	(0.005)
Cancer	−19.105	−0.046	−0.393	−0.061	−0.167**	−0.036	0.001	0.000
	(15.238)	(0.050)	(0.345)	(0.060)	(0.074)	(0.033)	(0.009)	(0.007)
Other cause	−11.908	−0.030	−0.203	−0.048	0.002	0.003	0.019**	−0.011**
	(10.738)	(0.036)	(0.243)	(0.042)	(0.052)	(0.022)	(0.006)	(0.005)
Death in window–Cardio	4.070	0.010	0.016	0.039*	0.044	0.026**	−0.003	0.000
	(5.889)	(0.020)	(0.133)	(0.023)	(0.029)	(0.013)	(0.003)	(0.003)
Death in window–Cancer	8.424	0.031	0.267	−0.012	0.093**	−0.003	−0.001	0.002
	(8.034)	(0.027)	(0.182)	(0.032)	(0.039)	(0.018)	(0.005)	(0.004)
Death in window–Other	7.191	0.022	0.153	0.013	0.056**	−0.012	−0.006*	0.003
	(5.791)	(0.019)	(0.131)	(0.023)	(0.028)	(0.012)	(0.003)	(0.003)
p-value: cardiovascular versus cancer	0.50	0.36	0.80	0.19	0.59	0.81	0.27	0.70
p-value: other versus cancer	0.70	0.80	0.65	0.87	0.06	0.33	0.09	0.17
Observations	750,697	750,697	750,697	751,578	727,284	702,813	751,578	726,709

Notes: Standard errors are in parentheses. The sample includes all women who have at least two births during the sample period. All specifications include controls for paternal education, gender of child, birth order of child, and year of birth by month of birth dummies. All regressions include mother fixed effects and instrument the indicator variable for a death during pregnancy with an indicator variable for a death within nine months of the conception date. Coefficients on log(birth weight) are multiplied by ten. The window around birth includes the year prior to conception, the nine months post-conception, and the year subsequent to that.

**Significant at the 5 percent level. *Significant at the 10 percent level.

Table A6—Effect of a Death during Pregnancy by Trimester (*IV Window FE Estimates*)

	Birth weight (1)	log(birth weight) (2)	Fetal growth (3)	Weeks gestation (4)	Height (5)	5 minute APGAR (6)	C-section (7)	Neonatal ward (8)
1st trimester	−21.645**	−0.067*	−0.248	−0.132**	−0.105**	−0.034	0.015**	−0.004
	(10.644)	(0.035)	(0.241)	(0.042)	(0.052)	(0.022)	(0.006)	(0.005)
2nd trimester	−20.784**	−0.062*	−0.497**	−0.043	−0.057	−0.021	0.014**	0.002
	(10.493)	(0.035)	(0.238)	(0.041)	(0.051)	(0.022)	(0.006)	(0.005)
3rd trimester	−20.418*	−0.058	−0.344	−0.094**	−0.074	−0.014	0.010*	−0.006
	(10.711)	(0.035)	(0.243)	(0.042)	(0.052)	(0.023)	(0.006)	(0.005)
Death in window	5.892	0.019	0.122	0.015	0.058**	0.005	−0.004*	0.002
	(3.717)	(0.012)	(0.084)	(0.015)	(0.018)	(0.008)	(0.002)	(0.002)
p-value: 1st versus 2nd	0.95	0.91	0.44	0.11	0.49	0.64	0.97	0.32
p-value: 1st versus 3rd	0.93	0.85	0.77	0.50	0.66	0.49	0.58	0.75
p-value: 2nd versus 3rd	0.98	0.94	0.63	0.36	0.81	0.81	0.60	0.19
Observations	750,697	750,697	750,697	751,578	727,284	702,813	751,578	726,709

Notes: Standard errors are in parentheses. The sample includes all women who have at least two births during the sample period. All specifications include controls for paternal education, gender of child, birth order of child, and year of birth by month of birth dummies. All regressions include mother fixed effects and instrument the indicator variables for a death during each trimester with indicator variables for a death within three months of the conception date, between four months and six months after the conception date, and between seven months and nine months after the conception date. Coefficients on log(birth weight) are multiplied by ten. The window around birth includes the year prior to conception, the nine months post-conception, and the year subsequent to that.

**Significant at the 5 percent level. *Significant at the 10 percent level.

Table A7—Effect of a Death during Pregnancy by Grandparent Gender (*IV Window FE Estimates*)

	Birth weight (1)	log(birth weight) (2)	Fetal growth (3)	Weeks gestation (4)	Height (5)	5 minute APGAR (6)	C-section (7)	Neonatal ward (8)
Death of grandmother in utero	−6.657	−0.012	−0.116	−0.018	−0.038	−0.006	0.019**	−0.004
	(12.688)	(0.042)	(0.288)	(0.050)	(0.062)	(0.027)	(0.007)	(0.006)
Death of grandfather in utero	−27.729**	−0.085**	−0.474**	−0.124**	−0.100**	−0.029*	0.011**	−0.003
	(8.068)	(0.027)	(0.183)	(0.032)	(0.039)	(0.017)	(0.005)	(0.004)
Death of grandmother in window	−1.572	−0.011	0.037	−0.043	0.061*	−0.016	−0.005	0.001
	(6.695)	(0.022)	(0.152)	(0.026)	(0.033)	(0.014)	(0.004)	(0.003)
Death of grandfather in window	9.529**	0.031**	0.158	0.043**	0.061**	0.012	−0.004	0.002
	(4.334)	(0.014)	(0.098)	(0.017)	(0.021)	(0.009)	(0.002)	(0.002)
p-value: grandmother versus grandfather	0.16	0.14	0.30	0.08	0.39	0.46	0.37	0.86
Observations	750,697	750,697	750,697	751,578	727,284	702,813	751,578	726,709

Notes: Standard errors are in parentheses. The sample includes all women who have at least two births during the sample period. All specifications include controls for paternal education, gender of child, birth order of child, and year of birth by month of birth dummies. All regressions include mother fixed effects and instrument the indicator variables for a death of each grandparent during pregnancy with an indicator variable for a death of that grandparent within nine months of the conception date. Coefficients on log(birth weight) are multiplied by ten. The window around birth includes the year prior to conception, the nine months post-conception, and the year subsequent to that.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table A8—Effect of a Death during Pregnancy by Whether Birth and Death Are in the Same County (*IV Window FE Estimates*)

	Birth weight (1)	log(birth weight) (2)	Fetal growth (3)	Weeks gestation (4)	Height (5)	5 minute APGAR (6)	C-Section (7)	Neonatal ward (8)
Death in utero–same county	−23.674**	−0.077**	−0.479**	−0.075**	−0.105**	−0.029	0.013**	−0.005
	(8.473)	(0.028)	(0.192)	(0.034)	(0.041)	(0.018)	(0.005)	(0.004)
Death in utero–different county	−16.998	−0.040	−0.156	−0.126**	−0.015	−0.013	0.014**	0.000
	(11.696)	(0.039)	(0.265)	(0.046)	(0.057)	(0.025)	(0.007)	(0.005)
Death in window–same county	5.055	0.016	0.133	−0.003	0.053**	0.007	−0.003	0.002
	(4.574)	(0.015)	(0.104)	(0.018)	(0.022)	(0.010)	(0.003)	(0.002)
Death in window–different county	5.886	0.018	0.070	0.041	0.057*	−0.004	−0.005	0.003
	(6.347)	(0.021)	(0.144)	(0.025)	(0.031)	(0.013)	(0.004)	(0.003)
p-value: Same county versus different county	0.64	0.43	0.32	0.37	0.20	0.60	0.95	0.49
Observations	750,697	750,697	750,697	751,578	727,284	702,813	751,578	726,709

Notes: Standard errors are in parentheses. The sample includes all women who have at least two births during the sample period. All specifications include controls for age of mother, paternal education, gender of child, birth order of child, and year of birth by month of birth dummies. All regressions include mother fixed effects and instrument the indicator variables for each type of death during pregnancy with an indicator variable for a death of that type within nine months of the conception date. Coefficients on log(birth weight) are multiplied by ten. The window around birth includes the year prior to conception, the nine months post-conception, and the year subsequent to that.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table A9 – Probability of Conception in Months Surrounding Bereavement

Month of conception	Proportion that conceive
6 months before death	0.0039
5 months before death	0.0037
4 months before death	0.0039
3 months before death	0.0037
2 months before death	0.0038
1 month before death	0.0035
Month of death	0.0033
1 month after death	0.0037
2 months after death	0.0038
3 months after death	0.0037
4 months after death	0.0036
5 months after death	0.0035
6 months after death	0.0035

Notes: Estimates are from a sample of all women aged 25–45 who experienced a parental death. The table shows the probability that they *conceive* in the months just before or after the death. There are 381,220 observations.

Table A10—Different Comparison Group—Short-Run Outcomes (*Part A*)

	IV window							
	Birth weight	log(birth weight)	Fetal growth	Weeks gestation	Height	5 minute APGAR	C-section	Neonatal ward
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Comparison: Death before								
Death in utero	−12.942	−0.036	−0.208	−0.066**	−0.024	−0.019	0.005	0.000
	(8.109)	(0.026)	(0.185)	(0.028)	(0.036)	(0.012)	(0.005)	(0.003)
Death just before	−9.477*	−0.034**	−0.196	−0.021	−0.035	0.014*	0.001	0.002
	(5.328)	(0.017)	(0.122)	(0.018)	(0.023)	(0.008)	(0.003)	(0.002)
Comparison: Death after								
Death in utero	−20.008**	−0.063**	−0.343*	−0.089**	−0.079**	−0.001	0.007	0.001
	(8.046)	(0.026)	(0.183)	(0.027)	(0.035)	(0.012)	(0.005)	(0.003)
Death just after	−2.393	−0.006	−0.061	0.002	0.021	−0.004	−0.000	0.001
	(5.116)	(0.016)	(0.117)	(0.017)	(0.022)	(0.008)	(0.003)	(0.002)
Observations	750,697	750,697	750,697	751,578	727,284	702,813	751,578	726,709
	IV estimates using mother fixed effects							
	Birth weight	log(birth weight)	Fetal growth	Weeks gestation	Height	5 minute APGAR	C-section	Neonatal ward
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Comparison: Death before								
Death in utero	−20.348**	−0.059**	−0.375**	−0.078**	−0.053	−0.037**	0.014**	−0.003
	(7.623)	(0.025)	(0.173)	(0.030)	(0.037)	(0.016)	(0.004)	(0.004)
Death just before	5.165	0.015	0.130	0.003	0.030	0.020*	−0.004	0.002
	(5.026)	(0.017)	(0.114)	(0.020)	(0.024)	(0.011)	(0.003)	(0.002)
Comparison: Death after								
Death in utero	−21.292**	−0.064**	−0.346**	−0.101**	−0.100**	−0.006	0.012**	−0.003
	(7.626)	(0.025)	(0.173)	(0.030)	(0.037)	(0.016)	(0.004)	(0.004)
Death just after	6.109	0.020	0.101	0.026	0.077**	−0.012	−0.003	0.002
	(4.913)	(0.016)	(0.111)	(0.019)	(0.024)	(0.010)	(0.003)	(0.002)
Observations	750,697	750,697	750,697	751,578	727,284	702,813	751,578	726,709

Notes: Standard errors are in parentheses. The sample includes all women who have at least two births during the sample period. All specifications include controls for age of mother, paternal education, gender of child, birth order of child, and year of birth by month of birth dummies. These IV estimates instrument the indicator variable for a death during pregnancy with an indicator variable for a death within nine months of the conception date. Coefficients on log(birth weight) are multiplied by ten. Death in utero is 1 if a grandparent death occurs in the 9 months following conception. Death just before is 1 if a grandparent death occurs in the 12 months before conception. Death just after is 1 if a grandparent death occurs in the 12 months after the predicted due date.

**Significant at the 5 percent level. *Significant at the 10 percent level.

Table A10—Different Comparison Groups—Later Outcomes (*Part B*)

	IV window							
	Completed education (1)	Education 12 years or more (2)	Full time (3)	log(earnings) (4)	log(earnings) if full time (5)	Cognitive score (6)	Height at 18 (7)	BMI at 18 (8)
Comparison: Death before								
Death in utero	−0.042	0.003	0.000	0.018	−0.011	−0.051	−0.029	0.077
	(0.070)	(0.009)	(0.014)	(0.025)	(0.016)	(0.052)	(0.206)	(0.116)
Death just before	−0.013	−0.001	−0.011	−0.022	−0.001	0.036	−0.078	0.049
	(0.046)	(0.006)	(0.009)	(0.017)	(0.011)	(0.034)	(0.139)	(0.077)
Comparison: Death after								
Death in utero	−0.062	0.002	−0.000	−0.006	0.003	0.008	0.091	0.079
	(0.070)	(0.009)	(0.014)	(0.024)	(0.017)	(0.051)	(0.204)	(0.115)
Death just after	0.007	0.001	−0.010	0.002	−0.016	−0.023	−0.199	0.047
	(0.045)	(0.006)	(0.009)	(0.015)	(0.011)	(0.033)	(0.134)	(0.074)
Observations	134,221	211,212	146,895	135,977	87,503	122,644	132,974	132,843

	IV estimates using mother fixed effects							
	Completed education (1)	Education 12 years or more (2)	Full time (3)	log(earnings) (4)	log(earnings) if full time (5)	Cognitive score (6)	Height at 18 (7)	BMI at 18 (8)
Comparison: Death before								
Death in utero	−0.078	0.008	0.006	0.014	−0.023	0.032	0.047	0.192
	(0.094)	(0.011)	(0.020)	(0.034)	(0.026)	(0.086)	(0.281)	(0.175)
Death just before	0.018	0.001	−0.015	−0.016	0.020	−0.010	0.049	−0.053
	(0.062)	(0.007)	(0.013)	(0.022)	(0.017)	(0.057)	(0.188)	(0.117)
Comparison: Death after								
Death in utero	−0.146	0.001	0.008	−0.017	−0.000	−0.033	−0.066	0.061
	(0.093)	(0.011)	(0.020)	(0.033)	(0.026)	(0.086)	(0.279)	(0.174)
Death just after	0.087	0.009	−0.016	0.017	−0.002	0.056	0.164	0.080
	(0.059)	(0.007)	(0.013)	(0.021)	(0.017)	(0.056)	(0.181)	(0.113)
Observations	134,221	211,212	146,895	135,977	87,503	122,644	132,974	132,843

Notes: Standard errors are in parentheses. The sample includes all women who have at least two births during the sample period. All specifications include controls for age of mother, paternal education, gender of child, birth order of child, and year of birth by month of birth dummies. These IV estimates instrument the indicator variable for a death during pregnancy with an indicator variable for a death within nine months of the conception date. Death in utero is 1 if a grandparent death occurs in the 9 months following conception. Death just before is 1 if a grandparent death occurs in the 12 months before conception. Death just after is 1 if a grandparent death occurs in the 12 months after the predicted due date.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table A11—IV Window Estimates without Mother Fixed on Multiple Samples—Birth Outcomes (*Part A*)

	Birth weight (1)	log(birth weight) (2)	Fetal growth (3)	Weeks gestation (4)	Height (5)	Five minute APGAR (6)	C-section (7)	Neonatal ward (8)
IV window-full sample								
Death in utero	−14.479**	−0.051**	−0.265*	−0.066**	−0.041	0.005	0.004	0.001
	(6.266)	(0.020)	(0.142)	(0.022)	(0.027)	(0.010)	(0.004)	(0.002)
Death in window	−9.307**	−0.027**	−0.205**	−0.011	−0.023	0.000	0.003	0.001
	(3.281)	(0.011)	(0.075)	(0.011)	(0.014)	(0.005)	(0.002)	(0.001)
Observations	1,052,263	1,052,263	1,052,263	1,053,524	1,018,616	975,505	1,053,524	1,021,308
IV window-full sample—using ONLY observations within the window								
Death in utero	−14.566**	−0.051**	−0.273*	−0.064**	−0.042	0.005	0.004	0.001
	(6.301)	(0.021)	(0.143)	(0.022)	(0.028)	(0.010)	(0.004)	(0.002)
Observations	44,296	44,296	44,296	44,370	42,849	40,275	44,370	43,202
IV window-analysis sample								
Death in utero	−16.234**	−0.049**	−0.273*	−0.076**	−0.050	−0.010	0.006	0.001
	(7.222)	(0.023)	(0.165)	(0.025)	(0.031)	(0.011)	(0.004)	(0.002)
Death in window	−6.297	−0.021*	−0.133	−0.012	−0.008	0.005	0.001	0.002
	(3.834)	(0.012)	(0.088)	(0.013)	(0.016)	(0.006)	(0.002)	(0.001)
Observations	750,697	750,697	750,697	751,578	727,284	702,813	751,578	726,709
IV window-analysis sample—using ONLY observations within the window								
Death in utero	−17.500**	−0.054**	−0.303*	−0.078**	−0.058*	−0.009	0.006	0.001
	(7.285)	(0.023)	(0.166)	(0.025)	(0.032)	(0.011)	(0.004)	(0.002)
Observations	31,944	31,944	31,944	31,997	30,928	29,433	31,997	31,134

Notes: Standard errors are in parentheses. Standard errors are clustered by mother. The analysis sample includes all women who have at least two births during the sample period. All specifications include controls for age of mother, maternal and paternal education, age of mother at birth, gender of child, birth order of child, and year of birth by month of birth dummies. Coefficients on log(birth weight) are multiplied by ten. These IV estimates instrument the indicator variable for a death during pregnancy with an indicator variable for a death within nine months of the conception date.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

Table A11—IV Window Estimates without Mother Fixed Effects on Multiple Samples—Long-Run Outcomes (*Part B*)

	Completed education (1)	Education 12 years or more (2)	Full time (3)	log (earnings) (4)	log (earnings) if full time (5)	Cognitive score (6)	Height at 18 (7)	BMI at 18 (8)
Full sample								
Death in utero	−0.065	−0.003	0.002	0.002	−0.007	−0.007	0.074	0.128
	(0.051)	(0.007)	(0.010)	(0.017)	(0.011)	(0.038)	(0.151)	(0.089)
Death in window	−0.020	−0.003	−0.009*	−0.004	−0.004	0.004	−0.192**	0.034
	(0.027)	(0.004)	(0.005)	(0.009)	(0.006)	(0.020)	(0.082)	(0.047)
Observations	205,900	311,285	225,003	207,931	134,142	176,695	191,980	191,793
Full sample—using ONLY observations within the window								
Death in utero	−0.054	−0.003	0.001	0.004	−0.007	−0.003	0.071	0.138
	(0.052)	(0.007)	(0.010)	(0.017)	(0.012)	(0.039)	(0.154)	(0.090)
Observations	1,0629	15,962	11,643	10,718	6,825	9,009	9,766	9,757
Analysis sample								
Death in utero	−0.049	0.002	0.000	0.005	−0.003	−0.024	0.034	0.079
	(0.062)	(0.008)	(0.013)	(0.022)	(0.014)	(0.046)	(0.181)	(0.102)
Death in window	−0.006	0.000	−0.010	−0.009	−0.009	0.009	−0.144	0.048
	(0.033)	(0.004)	(0.007)	(0.011)	(0.008)	(0.024)	(0.099)	(0.054)
Observations	134,221	211,212	146,895	135,977	87,503	122,644	132,974	132,843
Analysis sample—using ONLY observations within the window								
Death in utero	−0.040	0.002	0.003	0.004	−0.005	−0.020	0.059	0.085
	(0.064)	(0.008)	(0.013)	(0.022)	(0.015)	(0.047)	(0.186)	(0.105)
Observations	7,001	10,910	7,688	7,104	4,500	6,332	6,861	6,854

Notes: Standard errors are in parentheses. Standard errors are clustered by mother. The analysis sample includes all women who have at least two births during the sample period. All specifications include controls for age of mother, maternal and paternal education, age of mother at birth, gender of child, birth order of child, and year of birth by month of birth dummies. These IV estimates instrument the indicator variable for a death during pregnancy with an indicator variable for a death within nine months of the conception date.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

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