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Birth Order and Health of Newborns: What Can We Learn from Danish Registry Data?

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Birth Order and Health of Newborns: What Can We Learn from Danish Registry Data?

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Abstract

We ask whether birth order differences in health are present at birth using matched administrative data for more than 1 million children born in Denmark between 1981 and 2010. Using family fixed effects models, we find a positive and robust birth order effect; lower parity children are less healthy at birth. Looking at the potential mechanisms, we find that during earlier pregnancies women have higher labor market attachment, are more likely to smoke, receive more prenatal care, and are diagnosed with more medical pregnancy complications. Yet, none of these factors explain the birth order differences at birth. Data on hospital admissions reveal that the health advantage of higher parity children persists in the first years of life and disappears by age 7.

JEL classification: I10, I12, I14, J12, J13

Keywords: Birth order, parity, child health, fetal health, health at birth, education

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1 Introduction

The negative association between birth order (or parity of a child) and cognitive test scores, IQ, and educational outcomes is well established in the economics literature. To explain the observed birth order effects, the empirical literature has mainly focused on the social environment.¹ However, some researchers have hypothesized that birth order differences in later outcomes might also, in part, be explained by health differences at birth.² Understanding birth order differences is particularly relevant for research that focuses on within family differences, especially when this research connects early life circumstances with later life outcomes. To date, evidence on the origins of birth order differences is ambiguous.

In this paper, we use a unique data set covering over 1 million children to investigate whether a birth order effect is already present at birth. We look at birth order differences within families, focusing on different measures of health at birth that we derive from the medical literature. In addition to the analysis of the existence of an effect, we study the potential mechanisms, through which birth order differences at birth operate. Moreover, we show how birth order differences in health evolve after birth, from age 1 through age 17.

Our results are three-fold. *First*, we challenge traditional predictions in the economics literature and show that later-born children have a health advantage around birth that is robust to numerous definitions of health at birth and apparent in different subpopulations.

Second, we test several specifications to understand the positive birth order effect at birth and find that during earlier pregnancies women have higher labor market attachment; are more likely to smoke; visit more often their general practitioner (GP) and their midwife; and have higher rates of hospitalizations for medical pregnancy complications. Because we focus on a country with universal health care, concerns about heterogeneity in the access to care are limited. At the very low end of the health-at-birth distribution (5th percentile), observable changes in the prenatal environment across pregnancies can explain a substantial part of the birth order differences; overall, the positive birth order effect in health of newborns is insensitive to changes in the prenatal environment within families. Based on our empirical results and evi-

¹See for instance Price (2008), Lehmann et al. (2014), Hotz and Pantano (2015), and Pavan (2016).

²See for instance Behrman and Taubman (1986), Ejrnæs and Pörtner (2004), and Hotz and Pantano (2015).

dence from the medical literature, we tentatively suggest that biology might be driving the early life advantage.

Third, the positive birth order effect at birth stands in stark contrast to the widely acknowledged negative birth order effect in educational performance that we find in our data as well.³ Previous studies have argued that the childhood environment might shape sibling differences after birth. These studies have looked at allocation of parental quality time (Price 2008), financial resources (de Haan 2010), and intellectual stimulation of the parents (Lehmann et al. 2014; Hotz and Pantano 2015). Our paper is consistent with this literature by showing that the health advantage of firstborns continues to exist in hospitalization data through age 6. However, from age 7, firstborns seem no longer disadvantaged and there is some indication of a potential firstborn health advantage in adolescence.

The rest of the paper is organized as follows: Section 2 discusses the literature to motivate our empirical work. Section 3 describes our data and Section 4 our empirical strategy. Section 5 presents our main birth order estimates for health at birth and studies mechanisms of these birth order differences. Finally, Section 6 examines the evolution of birth order differences in health during childhood and Section 7 concludes.

2 Mechanisms of the Birth Order Effect in Education

Studies on birth order effects find a strong negative correlation between the birth order and cognitive test scores (Lehmann et al. 2014; Hotz and Pantano 2015; Pavan 2016), schooling outcomes (Behrman and Taubman 1986; Plug and Vijverberg 2003; Kantarevic and Mechoulan 2006), and IQ scores (Kristensen and Bjerkedal 2007; Sulloway 2007; Black et al. 2011). Broadly, to explain these birth order effects, previous studies have discussed differences in the social environment and differences in health at birth across siblings.

³In line with the previous literature, we observe a *negative* birth order effect in educational performance, see Appendix Table A1.

Social Environment

Parental investments differ across birth orders. Lehmann et al. (2014) show that higher parity children receive less cognitive support in early life. Supporting this finding, Price (2008) reveals that, at age 4 to 13, parents spent less quality time with later-born children than with firstborns at the same age. Likewise, Hotz and Pantano (2015) find that parents are less stringent with later-born children, i.e. with respect to the intensity of monitoring of homework or the existence of TV watching rules. Using structural models, Pavan (2016) shows that differences in parental behavior across siblings can explain more than one-half of the birth order gap in cognitive test scores, yet a large part of the gap remains unexplained.

Health at Birth

In addition to the role of the social environment, research has suggested that birth order effects in education are already present at birth, but the economic and medical literature come to different conclusions. Theoretically, the economics literature has argued that higher birth order children should show worse health at birth (a.o. Behrman and Taubman 1986; Behrman 1988; Ejrnaes and Pörtner 2004; Hotz and Pantano 2015). The underlying argument is the natural correlation between parity and maternal age, the latter has long been assumed to be negatively associated with health at birth. Tests of this relationship are found mainly in the empirical medical literature which shows, *opposite* to the predictions of the studies just mentioned, a positive relationship between birth order and health at birth.⁴ Good health at birth is an indicator for better later life outcomes and, therefore, the results from the medical literature stand in contrast to the negative birth order effects found at older ages (a.o. Behrman and Rosenzweig 2004; Cunha and Heckman 2007; Figlio et al. 2014). However, medical studies mostly do not account for socio-economic factors or between family heterogeneity. We will later show that not accounting for unobserved family heterogeneity may severely underestimate birth order differences in health at birth and that socio-economic factors, like labor force participation, may systematically change with birth order.

⁴For references to the medical literature, see Camilleri and Cremona (1970), Swamy et al. (2012), and Hinkle et al. (2014).

Empirical economic studies on this topic have been few in number. Black et al. (2011) argue that higher birth order children are better off at birth in a sample of Norwegian men, though without showing any empirical result. Lehmann et al. (2014) estimate family fixed effects models of the effect of birth order on health at birth for children in the NLSY79. They conclude that later born children are not worse off at birth, but cannot reveal anything beyond this conclusion as their estimates are relatively imprecisely estimated: they leave open whether there are positive birth order effects at birth or no birth order effects at all.

Until now, clear evidence on whether and why birth order differences in health at birth exist is still missing. Importantly, if birth order differences are present at birth, it will be essential to understand what drives these differences.

3 Data

Our primary data source is the Danish birth register that covers birth information for the universe of all children born in Denmark between 1973 and 2010. Using unique personal identifiers, we match the birth records to a collection of additional administrative registers, such as the fertility register, national patient register, and income register. Thereby we can link each child to his or her parents and can follow it from birth to adulthood. The data is maintained by Statistics Denmark and reported by professionals in the health care sector and different authorities in the public sector. Additionally, a great advantage of the data is the exceptional large observation size: we only experience attrition in the rare case of out-migration or death and we can link each child to his or her parents, following the child from birth to adulthood.

To construct the sample for analysis, we use the following restrictions. We restrict the sample to mothers who conceived their first child in 1980 or later since the registers on parental characteristics started in that year. We exclude families with at least one multiple birth (e.g. twins) as birth orders are more difficult to assign in these families. We keep only families with more than one child, families where all children have the same mother and father (biological siblings), and families with at least two children with non-missing birth outcomes.⁵ For reason

⁵We set biological implausible birth outcomes to missing, using the help of a physician. Missing health at birth information might further arise due to in utero mortality.

of space, we exclude families with five or more children from the main analysis. Our results also hold when we look at families with 5–8 children.

Panel a) of Table 1 shows the frequencies of children with birth order 1, 2, 3, and 4. Having two children is the most popular family size. The average child in the sample lives in a family with 2.4 children with a median of 2 children. The frequency of parents with four children is low, less than 2 percent of all children are of birth order 4. The share of boys and girls is equal in the sample.

[Table 1 about here.]

3.1 Birth Outcomes

The birth records contain a rich set of variables measuring different dimensions of child health at birth. Table 1 panel a) summarizes these variables.

Birth weight for gestational age z-score relates the birth weight of a child at a given gestational age at birth to what would be expected for a healthy child at the same gestational age. We define birth weight for gestational age z-score using Scandinavian fetal growth curves based on ultrasonically estimated fetal weights in uncomplicated pregnancies (Marsál et al. 1996).⁶ We prefer to use the birth weight z-score rather than birth weight, because the latter cannot differentiate between variation in gestational length and fetal growth. Put differently, children can be born premature and for that reason have a low birth weight (but are otherwise perfectly healthy) or children can be born with low birth weight even though they are in the range of a normal gestational age; the latter would reflect fetal growth restriction. The mean z-score in the sample is close to zero implying that, on average, the birth weight of each offspring coincides with the reference for uncomplicated pregnancies. As a robustness check, we also consider birth weight in natural logarithms, a measure previous studies have used (Black et al. 2007; Figlio et al. 2014).

Moreover, we focus on children at different parts of the birth weight distribution. Of all children, 3.1 percent are small for gestational age (SGA), an indicator taking the value 1 if the birth weight z-score falls below -2 standard deviations and 0 otherwise. In comparison,

⁶For each gestational age and gender, we calculate the z-score as: $\frac{\text{Birth weight} - \text{Birth weight from reference}}{\text{Standard deviation from reference}}$.

the almost same share is born large for gestational age (LGA), an indicator taking the value 1 if the birth weight z-score exceeds +2 standard deviations and 0 otherwise. These shares are as expected given that the z-scores are normally distributed. While SGA is a commonly used indicator for poor neonatal health, LGA is associated with an increased risk of infant mortality, injuries during delivery, and potentially long-term adverse health effects (Surkan et al. 2004).

In addition, we look at a severe form of intrauterine growth restriction. Symmetrical growth restriction is a global growth restriction meaning that the fetus has developed slowly throughout the whole pregnancy. By contrast, in the case of asymmetric growth, the child is also growth restricted but the head has continued to grow at a (nearly) normal rate. Robinson (2013) finds that while symmetric and asymmetric growth restriction impairs physical health, brain sparing is prevalent only for the asymmetric growth restricted offspring. Symmetrical growth restriction can hence be understood as a more severe form of SGA. We define symmetrical growth restricted (SGR) as an indicator equal to 1 if a child is SGA and lean where leanness is based on the ponderal index z-score.⁷ About half of SGA children are SGR.

As a complement to the anthropometric measures, we also consider the 5-Minute Apgar score.⁸ With an average of 9.86, the average nearly corresponds to 10, the maximum score possible. Given the highly skewed distribution of the Apgar score, we define the variable low Apgar score (Apgar score < 7), which is associated with higher infant mortality and severe neurological morbidity (Thorngren-Jerneck and Herbst 2001). Less than 1 percent of all children are classified with a low Apgar score.⁹

Given the large number of outcome measures and the potential concern of finding spurious correlations, we define a summary index following Kling et al. (2007). To construct the index,

⁷More precisely, we calculate the ponderal index as the ratio between weight (in kg) and height (in cm) and construct a z-score based on Lykke et al. (2012). Leanness is ponderal index z-score below -1 standard deviation. Children that are SGA and not lean are, hence, asymmetric growth restricted; we do not study this group further, as we already look at SGA.

⁸The 5-Minute Apgar score is a diagnostic test measured five minutes after birth and based on five criteria: heart rate, respiratory effort, muscle tone, reflex irritability, and color. For each criteria 0, 1, or 2 points are assigned with the score ranging between 0 and 10. The Apgar score has been found to be highly correlated with cognitive ability, health and behavioral problems in later childhood (Almond et al. 2005) and has been used in several economic studies to measure health at birth (Chay and Greenstone 2003; Almond et al. 2005, among others).

⁹Given the low prevalence of low Apgar scores, we used alternative specifications where we increased the cut-off to 8 Apgar score points and where we looked at Apgar score as a continuous variable. The results remain unchanged.

we first standardize the birth outcomes (birth weight z-score, SGA, LGA, SGR, and low Apgar score) with mean 0 and standard deviation of 1. We then rescale each standardized birth outcome so that a higher value correspond to a more beneficial outcome.¹⁰ The summary index for health at birth is an equally weighted average of the standardized health outcomes, where a higher value on the score reflects better health at birth. The health index has the unit of the mean standard deviation of the five variables.¹¹

3.2 Prenatal Environment

Our data contains a rich set of prenatal maternal characteristics and investments, depicted in Panel c) of Table 1.¹² The top part of panel c) summarizes maternal age and the pregnancy interval. The pregnancy interval measures the time between the previous birth and the date of conception of the subsequent pregnancy. The second part of panel c) shows summary statistics for socio-economic characteristics of the mother during pregnancy. The variables working, student, unemployed, and out of the labor force measure labor force participation during pregnancy and are based on the main source of income in the year before birth.¹³ Parental income is based on the disposable income in the year before birth (i.e. income after tax and interest rate) and defined as the percentile of the income distribution in the observed year.

The third part of panel c) summarizes measures of maternal behavior. Information about whether the mother smoked at the time of the first midwife visit is available since 1991.¹⁴ About 17 percent of all women smoked at the time of the first midwife visit. Prenatal care is grouped into visits at the GP, the midwife, and the specialist. Pregnant women see a GP about twice during pregnancy, the midwife 5 times, and a specialist a little more than 3 times.¹⁵

The bottom part of panel c) shows summary statistics for hospitalizations for medical pregnancy complications, which are measured by three dummy variables that take the value 1 if

¹⁰A negative sign is given to SGA, LGA, SGR, and low Apgar score, while a positive sign is given to the birth weight z-score.

¹¹Using principal components analysis instead reveals very similar results in the analysis.

¹²We include measures of the prenatal environment also for those children with missing birth outcomes to eliminate problems of selection, which is why the sample size increases in comparison to panel a–b).

¹³Not in the labor force means that mothers are neither working nor student nor unemployed.

¹⁴The first midwife visit is scheduled at the end of the first trimester or beginning of the second trimester.

¹⁵The practice has naturally changed over time. Today, the standard for an uncomplicated pregnancy is about 3 visits at the GP, 6 visits at the midwife and 2 visits at the specialist.

the mother was hospitalized for that condition and 0 otherwise. Hospitalizations for pregnancy complications constitute a very important dimension of maternal (and fetal) health, because they capture actual complications that need to be treated in the hospital and are, thus, registered for every affected woman.¹⁶

Gestational diabetes is a form of diabetes in women without previously diagnosed diabetes. A family history of diabetes contributes to the probability of gestational diabetes. Other determinants are pregnancy factors (i.e. high blood pressure), maternal age, prepregnancy weight, pregnancy weight gain, and obesity (Ben-Haroush et al. 2004). About 1 percent of all women were diagnosed with gestational diabetes.¹⁷

Gestational hypertension and preeclampsia are blood pressure disorders developing at near term. To be diagnosed with preeclampsia, the woman needs to have both gestational hypertension and proteinuria (large amount of protein in the urine). In our measure of preeclampsia, we consider mild and severe preeclampsia, eclampsia and the HELLP (Haemolysis, Elevated Liver enzyme levels, Low Platelet count) syndrome. Causes of preeclampsia can be related to biological factors of the mother (systolic blood pressure) but also relate to behavior during pregnancy (smoking, obesity) (Sibai et al. 1995). We define gestational hypertension conditional on not experiencing preeclampsia, as women with preeclampsia are necessarily also diagnosed with gestational hypertension in the same pregnancy. With this condition, we ensure that we do not capture an intermediate diagnoses for women who develop preeclampsia later in the same pregnancy. Less than 1 percent of all women are diagnosed with gestational hypertension, however, almost 3 percent experience preeclampsia.¹⁸

¹⁶Diagnoses are based on the International Statistical Classification of Disease and Related Health Problems, 8th and 10th Revisions (ICD-10 and ICD-8). The reporting standard changed in 1994 from ICD-8 to the ICD-10 codes. However, we can still use information for all diagnoses in our sample, using the recoding of the old ICD-8 codes from Lykke et al. (2012) to merge with the ICD-10 codes.

¹⁷Casey et al. (1997) reports that between 1–3 percent of all pregnancies in the U.S. are diagnosed with gestational diabetes.

¹⁸If women experiencing preeclampsia are counted, the figure for gestational hypertension would increase to 4 percent. Sibai (2003) notes a prevalence of 6–17 percent for nulliparous women and 2–4 percent for multiparous women. These numbers fit in line with the 4 percent given that we have 43 percent nulliparous and 57 percent multiparous births in our sample.

4 Empirical Strategy

We now turn to our econometric model to examine the relationship between birth order and child health. The following linear model is to be estimated:

$$Y_{ifym} = \alpha + \beta_j \sum_{j=2}^4 1(\text{Birth order}_i = j) + \gamma \text{Boy} + \tau_{ym} + \rho_f + \varepsilon_{ifym}, \quad (1)$$

where Y_{ifym} is the outcome of child i , born in family f , conceived in year y and month m . The sum represents a set of dummies for birth order, $1(\text{Birth order}_i = j)$ for $j = 2, 3$, and 4 where $1(\cdot)$ is the indicator function. Children of birth order 1 represent the omitted category so that β_j , our coefficients of interest, capture differences with respect to birth order 1. We flexibly account for time effects by including year of conception by month of conception dummies (τ_{ym}). θ_f are family fixed effects, Boy is an indicator for male gender. Finally, ε_{ifym} is the error term. Given the grouped structure of our data, standard errors are clustered at the family level to allow for serial autocorrelation within families.

Identification is based on comparing second-, third-, and fourth-born children who are conceived across different years and months to firstborns within the same family. While family fixed effects control for any time-invariant observable and unobservable heterogeneity within families (i.e. family size, maternal age at first birth, genetic endowments), month and year of conception capture cohort and seasonal trends in the outcome variable.

β_j gives the causal effect of being born later within the family. However, in equation 1, we cannot differentiate between the different channels, through which the sign of the β_j may be explained. We subsequently explore the richness of our underlying data to disentangle the channels. We do so by accounting for distinct measures of the prenatal environment X that, as we show, varies systematically by birth order:

$$Y_{ifym} = \alpha + \beta_j \sum_{j=2}^4 1(\text{Birth order}_i = j) + \gamma \text{Boy} + X'_{ifym} \delta + \tau_{ym} + \rho_f + \varepsilon_{ifym}. \quad (2)$$

5 Birth Order and Health of Newborns

In this section, we present our statistical estimates. We begin with a graphical analysis of the relationship between birth order and child health at birth before we show the empirical estimation results. After having established the relationship between birth order and child health at birth, we turn to the potential mechanisms.

5.1 Main Results

Figure 1 plots the mean of the health at birth measures by birth order and family size (number of children) together with the 95 percent confidence interval for the mean. This approach allows us to show how health differences by family size evolve across birth orders. In graphs (a) and (f), higher values reflect better health, while the opposite is the case for the remaining graphs. The *non-parametric* comparisons in Figure 1 show that birth order is positively correlated with birth weight z-score (a) and negatively correlated with SGA (b), SGR (d), and low Apgar score (e). Thereby Figure 1 reflects that higher birth order is associated with improved health outcomes at birth. In contrast, the positive relationship between birth order and LGA (c) indicates that for some children the positive effect on birth weight exceeds the value of what is considered healthy. Overall, these results point towards better health with increasing birth order. This finding is supported by the positive correlation between the health index (which encompasses all these individual measures) and birth order (f).

[Figure 1 about here.]

We note three things regarding the shape of the birth order gradient. (1) The largest change in health happens between first- and second-born children. (2) The relationship between birth order and health at birth slightly reverts at the fourth parity for SGA and SGR. However, the whiskers for the 95 percent confidence interval indicate that this slight reversion of the trend at the fourth parity is not significant. (3) Consistent with correlations shown in other studies, we find level differences between the three family sizes with children of larger families doing generally worse. The level differences, however, are constant across birth orders. Therefore, in

the following, we pool all children but control for family fixed effects. As a robustness check, we later show the results by family size.

[Table 2 about here.]

We now test whether the positive correlation between birth order and child health also holds within a regression framework. Table 2 panel a) presents the results of estimating equation 1 without family fixed effects but including dummies for family size. For convenience, we only report the estimates of our key explanatory variables. Remarkably, the simple correlations previously discussed are robust to any time effects and controls for gender, and all coefficients are statistically significant at the 1 percent level.

To account for unobserved family heterogeneity, we include family fixed effects in Table 2 panel b). The positive pattern observed in panel a) remains, however, the birth order coefficients clearly increase in magnitude; on average by 62, 86, and 117 percent for birth order 2, 3, and 4. Thus, not accounting for unobserved family heterogeneity may severely underestimate birth order differences in health at birth.

The positive birth order effect in newborn health is remarkable. The birth weight z-score is on average 0.395, 0.548 and 0.665 standard deviations higher for birth order 2, 3, and 4 compared to firstborns in the same family [column (1)]. The coefficients are jointly significantly different from zero and the increase for each additional birth order is significant at the 1 percent level. This result translates into a reduced risk of being SGA [column (2)] and a quantitative similar increase in risk of being LGA [column (3)]. The probability of SGR is reduced by 1.2 to 1.9 percentage points [column (4)]. Hence, more later-born children are too large for their gestational age at birth, but fewer children are growth restricted, resulting also in a decrease in the more unfavorable outcome of SGR. The positive association between birth order and child health unfolds furthermore in the decrease in the prevalence of a low Apgar score [column (5)]. Again, the effect is increasing in birth order with the F-test rejecting equal pair coefficients and joint equal coefficients at the 1 percent level. Finally, the results in column (1)–(5) are translated into a higher score in the standardized health index for birth order 2, 3, and 4 compared to firstborns [column (6)].

The positive birth order effect in health of newborns is perpetuated by alternative measures of health at birth.¹⁹ The results, presented in Appendix Table A2, buttress that the positive relationship between birth order and child health is clearly not driven by the way we define health at birth.

The birth order effects we find are substantial compared to other determinants of newborn health. To compare the magnitude of the birth order effects with findings in other empirical economic studies, we refer to the alternative measures in Appendix Table A2, which are predominantly used in these studies. Currie and Walker (2011) find that the introduction of electronic toll collection reduces traffic congestion and vehicle emissions, resulting in a decrease of prematurity and low birth weight (< 2,500 g) of 10.8 percent and 11.8 percent among mothers living within 2 km of a toll plaza. Using variation in college openings, Currie and Moretti (2003) find that an additional year of maternal education reduces prematurity by 6 percent and low birth weight by 10 percent. Deschênes et al. (2009) find that global climate change will increase the probability of low birth weight by 5 to 5.9 percent by the end of the century. In comparisons, we see that being born second, third or fourth reduces the probability of prematurity by 55 to 73 percent compared to firstborns in the same family; the probability of low birth weight (not reported) is almost completely eliminated with higher order pregnancies.

Mortality

Our findings might be the result of elevated mortality at higher parities. If the children who survive are positively selected, our proposed relationship between birth order and child health might be driven from a “culling of the weakest”. We can test this hypothesis by looking at the relationship between birth order and perinatal death, in column (6) of Appendix Table A2. Perinatal death is defined as fetal deaths occurring with a stated or presumed gestation of 28 weeks or more or deaths occurring within the first 7 days of life.²⁰ The coefficients in column

¹⁹These include the natural logarithm of birth weight and birth length, an indicator for being premature (i.e. born before 37 weeks of gestation at delivery), head circumference (available since 1997), and an indicator for being diagnosed for a condition relating to the perinatal period (available since 1994).

²⁰These children are grouped on the assumption that similar factors have caused the death (Barfield 2011). The definition is furthermore the official definition for perinatal death used by the National Center for Health Statistic and the World Health Organization. Notice that we have more observations for perinatal deaths than for our other health outcomes, as not all children dying in the perinatal period have information on these other outcomes.

(6) show that birth order and perinatal death are negatively related. Consequently, these results suggest that the findings in Table 2 reflect, if at all, a lower bound of the true birth order effect in health at birth.

Heterogeneity by Family Size

Heterogeneity in the birth order effect by family size could be at play, although we did not detect such heterogeneity in the descriptive figures. For example, families that experience larger improvements in health at birth with increasing birth order might end up having more children in total. In other words, child health at birth could affect subsequent fertility. If this is the case, we should see that the coefficient for a specific parity increases across family size.

We test the heterogeneity by family size and estimate all regressions separately by the number of children. To rule out families with incomplete fertility, we restrict the sample to families where the mother is at least 38 in December 2010.²¹ Imposing completed family size does not change the pattern (Table 3); a positive birth order effect exists for all family sizes. In the case of SGA, we see larger birth order effects with increasing family size; similar differences in the SGR, the more severe form of SGA, are not apparent in the data. Focusing on the health index, we observe no systematic pattern. There is some indication that the birth order effect increases with family size when comparing 2-child families with 3-child and 4-child families; however, when comparing 3-child and 4-child families, this pattern reverses again. In conclusion, we do not find evidence for selective fertility based on experienced birth. Therefore, we will continue to pool family sizes and use the health index, as it reflects the pattern of the individual components very accurately.²²

Complementary heterogeneity analysis perpetuate that the positive birth order effect in health of newborns is not subject to specific groups. Our data reveals positive birth order effects irrespective of maternal age at first birth, mother's education, and gender of the child.

Appendix Figure A1– A3 depict these subsample analyses graphically.

²¹This is a reasonable cut-off, as 91 percent of all women who were above 45 years in 2010 got their last child before the age of 38.

²²To alleviate concerns about an inverse u-shaped relationship between birth order and health at birth, we have also studied birth order differences for families with more than 4 children. The results (not reported) rule out an inverse u-shaped relationship between birth order and health at birth; also in larger families, health at birth is increasing by birth order.

[Table 3 about here.]

Quantile Regressions

We now consider heterogeneous effects at different parts of the health-at-birth distribution. For example, we might see a positive relationship between birth order and child health at some parts of the distribution but a negative relationship at other parts of the distribution. To explore this, we estimate quantile regressions for the health index at the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles. Figure 2 plots the quantile estimates by birth order, together with the 95 percent confidence interval. The results suggest substantial effects at the lower end of the health distribution. However, the birth order effect is not solely driven by improvements at the lower end. We still see birth order differences at the 10th to 75th percentiles; the improvements at the upper end of the health distribution are less pronounced but still present.²³ Overall, we suggest that the birth order effect at birth is present across the entire health-at-birth distribution. This is a very important result, because when we want to understand what drives the birth order effect at birth, we need to find factors that address the entire health-at-birth distribution. We aim to identify these factors in the following section.

[Figure 2 about here.]

5.2 What Explains the Positive Relationship?

Based on our findings of a substantial birth order effect in health at birth, the objective is now to understand the mechanisms. We look at parental prenatal investments and characteristics that can change across pregnancies and are presumed or known to affect health of newborns. In a first step, we show how these prenatal factors change across higher order pregnancies. In a second step, to assess their role, we account for them in equation 2.

²³Appendix Table A3 lists the coefficients of the quantile model as well as the OLS and fixed effects coefficients for a comparison. The OLS and fixed effects estimates reported in Table A3 differ marginally from those reported in Table 2 column (6) as we were unable to fit month by year of conception effects in the quantile model. Instead we control for month of conception dummies and a month by year of conception trend, squared, and cubic. That produces very similar coefficients.

Maternal Age and Pregnancy Interval

We first focus on maternal age at birth. Economic studies have suggested a negative relationship between birth order and child health at birth due to the natural correlation between birth order and maternal age (a.o. Behrman and Taubman 1986; Ejrnaes and Pörtner 2004). Given that we find a positive birth order effect at birth and following the argument of the just mentioned studies, maternal age cannot be a mechanism. However, the relationship between maternal age is a priori not necessarily negative or linear (Swamy et al. 2012), which is why we place the discussion of the role of maternal age here.

In our data, women are on average, 26.5 years old at the birth of their first child. At the fourth birth, average maternal age increases to 33.4 years. We observe substantial differences by family size at a given parity. Women with four children are younger at the birth of their first child (23.9 years) than women with three children (25.5) and women with two children (27.0 years). This pattern remains for second and third births.

Within the family fixed effects model, maternal age measures the increase in maternal age at birth compared to age at first birth. Therefore, the analysis of an increase in maternal age at higher order births is empirically closely related to an analysis of the interval between two pregnancies. In our sample, the mean pregnancy interval is increasing by birth order: from around 19 months between the first and second pregnancy to 32 months between the second and third pregnancy to 35 months between the third and fourth pregnancy.

Socio-Economic Characteristics

A positive birth order effect in health at birth could also be the result of differences in socio-economic characteristics across birth orders. For example, while a woman works during the first pregnancy, she may decide to stay at home after the birth of the first child. Women may also increase their labor market participation with higher order births when financial constraints are present or when a transition from higher education to the labor market occurs. We might also see changes in the socio-economic status, i.e. income, which varies over the life cycle and, thus, with birth order.

[Table 4 about here.]

To demonstrate how prenatal socio-economic characteristics evolve across birth orders, we estimate equation 1 with the outcome being either one of four indicators for labor force participation (working, student, unemployed, out of the labor force) or income during pregnancy.²⁴ Table 4 panel a) shows the result of these estimations. Compared to the first pregnancy, women are, on average, 8.1 and 24.4 percentage points (around 10 and 30 percent of the mean) less likely to work during respectively the second and fourth pregnancy. The probability of being a student decreases by 1.0–2.1 percentage points (25–53 percent of the mean) at the second and third pregnancy compared to the first; we see a small but imprecisely estimated coefficient at the fourth parity. The probability of being unemployed or out of the labor force is positively associated with birth order, buttressing a reduced participation at the labor market. Yet, prenatal parental income is slightly increasing with birth order; the increase is about 1–3 percentiles. Compared to the mean of 0.66 (fathers) and 0.56 (mothers), the change in income is rather small.²⁵ Hence, we interpret the change in labor force participation at higher order pregnancies as a shift in maternal time from the labor market to the household at a relatively constant family income.

Maternal Behavior

The relationship between birth order and health at birth might also be the result of changes in maternal behavior reflecting mothers' risk perceptions. For example, if a woman smokes during her first pregnancy, she will be exposed to a midwife advising her to quit smoking. Viscusi et al. (1986) show that the stock of information about product hazards produces precautionary behavior. If the midwife alters the woman's information stock, we should observe a reduction in smoking at higher order pregnancies. Likewise, prenatal checkups may respond to experiences in previous pregnancies. Based on Arrow (1963), Dardanoni and Wagstaff (1990) show theoretically that the demand for medical care falls if uncertainty about the effectiveness of medical care decreases or if individuals become better informed about health outcomes, i.e. due to

²⁴We omit the gender dummy from this specification.

²⁵Looking solely at parental wage income, we see a decrease with birth order that is consistent with the reduction in mother's labor market participation. Disposable income, the measure that we use in column (5) and (6) account for non-wage income as well, i.e. allowances that are paid until the child reaches age 17. For children under age 3, family allowances amount to 198 EUR or 223 USD per month.

greater confidence in self-diagnosis. For prenatal checkups, this implies that demand falls (1) if checkups in the first pregnancy provide increased knowledge about their effectiveness and (2) if a woman learns about her own health and child health at birth through observations during the first pregnancy. As we use data from a country with universal health insurance, concerns about heterogeneity in access to care are limited. Moreover, it makes it much less likely that financial constraints play a role for access to prenatal care.²⁶

Table 4 panel b) shows how prenatal maternal behavior changes with birth order. We estimate again equation 1 with the outcome being an indicator for smoking during pregnancy or the number of prenatal checkups (at the GP, the midwife, or the specialist). The probability of smoking decreases between 2.7 and 3.4 percentage points (16–20 percent of the mean) after the first pregnancy. While the effect is increasing between birth order 2 and 3, the difference between birth order 3 and 4 is insignificant.²⁷ All types of prenatal checkups decrease with higher order pregnancies, a finding that is in line with Buckles and Kolka (2014) and Lehmann et al. (2014) who focus on whether a woman received prenatal care in the first semester or not. The different types of prenatal care that we observe allows us to make conclusions that go beyond previous literature. Checkups at the GP fall by 0.1–0.2 visits (3–6 percent of the mean) with higher order pregnancies; checkups at the midwife by 0.2 and 0.4 visits (4–9 percent of the mean). The change in checkups at the specialist is economically not meaningful and imprecisely estimated for birth order 3 and 4. Our results suggest that women moderately reduce prenatal checkups associated largely with mental preparation and consulting (GP and midwife), while they do not change prenatal checkups associated with medical procedures (specialist). This indicates that women do not necessarily behave less responsibly at higher order pregnancies.

²⁶While labor force participation and income might also encompass behavioral aspects, smoking and prenatal checkups present choices of the mother that are more clearly the result of the mother's perceptions about risks. We acknowledge, however, that prenatal checkups also reflect maternal health in general.

²⁷This finding is consistent with Black et al. (2015) but opposite to Lehmann et al. (2014). Yet, while Lehmann et al. (2014) look at a subsample of their data with previous smokers, our results are based on the entire sample.

Hospitalizations for Medical Pregnancy Complications

As a fourth group of variables, we assess the role of hospitalizations for severe pregnancy complications as a measure of impaired maternal health. To the extent that maternal health is affected by behavior, changes in maternal health reflect this behavioral change. At the same time, changes in maternal health might reflect physiological changes unrelated to behavior. Gluckman and Hanson (2004) argue that higher order pregnancies face lower constraints; this should unfold in reduced hospitalizations for severe pregnancy complications.

Table 4 panel c) reveals a strong positive association between maternal health and birth order, i.e. a significant reduction in suffering from gestational diabetes, gestational hypertension or preeclampsia with higher order pregnancies. The results for diabetes also suggest that the increase in LGA is not the result of an increase in the prevalence of diabetes.²⁸

The Role of the Prenatal Environment

In summary, we find systematic changes in the observable prenatal environment with higher order pregnancies. With increasing birth order, we observe an increase in maternal age with similar changes in the pregnancy interval; a pronounced lower maternal labor market attachment and a slightly increased parental income; a reduction in the likelihood to smoke and a moderate reduction in the number of visits at the GP and midwife; as well as strongly reduced rates of hospitalizations for medical pregnancy complications. We now ask how much of the birth order effect in health at birth can be explained by changes in the prenatal environment and how much remains unexplained.

[Figure 3 about here.]

Figure 3 demonstrates the role of changes in the prenatal environment across higher order pregnancies. The light gray bars are the predicted values for the health index at birth taking into account maternal age, socio-economic characteristics, maternal behavior, and hospitalizations for pregnancy complications. The dark gray bars are the predicted values had birth order

²⁸While the coefficients are significantly increasing with parity for gestational hypertension and preeclampsia, the coefficients for gestational diabetes at the fourth parity is smaller than at the third parity, however, still negative and highly significant.

2, 3, and 4 been exposed to the prenatal environment of the firstborn in the family (*as if* values). Despite systematic changes in the prenatal environment with higher order pregnancies, the dark gray bars are not significantly (neither statistically nor economically) different from the light gray bars: the large birth order effect at birth seems insensitive to changes in the prenatal environment across higher order pregnancies. The reason seems to be the surprisingly low correlation between the changes in the prenatal environment within families and health at birth. Exceptions are hospitalizations for gestational hypertension and preeclampsia, but the prevalence of these conditions in the population is so low that the large changes in these conditions that we observe in Table 4 decrease only weakly the average birth order effect.

We also sequentially account for the different measures of the prenatal environment. Appendix Table A4 depicts the results which strongly perpetuate the findings from Figure 3.²⁹ Using the conditional decomposition proposed by Gelbach (2016), which accounts for sequence-sensitivity when covariates are added, provides very similar results. Thus, the findings that higher birth order children show better health at birth is persistent.

[Figure 4 about here.]

Figure 4 plots the quantile estimates by birth order accounting for prenatal socio-economic, behavioral, and maternal hospitalization variables. This stands in contrast to Figure 2 where we did not account for differences in the prenatal environment.³⁰ The estimates at the 10th to 95th percentiles closely resemble the estimates depicted in Figure 2. However, we see a large reduction in the estimates at the 5th percentile; albeit the birth order differences at the 5th percentile are still the largest in magnitude, they are 5–8 times smaller when we account for the prenatal environment. This result suggests that observed differences in the prenatal environment across pregnancies explain a sufficient part of the differences across birth orders

²⁹We see the largest reductions in birth order coefficients when we include hospitalizations for medical pregnancy complications in column (5). This reduction is partially offset by accounting for prenatal checkups (column (4)). Accounting for the pregnancy interval in Appendix Table A5 leaves the birth order coefficients nearly unchanged. Note, that we have to separate the pregnancy interval analysis as, by definition, no pregnancy interval is defined for birth order 1. Hence, the analysis of the role of the interval is limited to families with 3–4 children.

³⁰Appendix Table A6 lists the estimates and shows the OLS and fixed effects results for a comparison.

(roughly 80 percent) for those at the very low end of the health-at-birth distribution.³¹ Yet, the overall prevalence of the birth order coefficients at all percentiles underlines once more the persistence of the health differences at birth.

It is unlikely that unobserved social and behavioral changes exert a strong role. For example, social values of the parents may change with higher order pregnancies but given the in utero environment is not shaped by parent-child interactions, the inability to control for social values should not affect our results. Another example is a potential change in the stress level during pregnancy. Deaton and Stone (2014) find that parents experience more daily joy and more daily stress than non-parents. If one of these factors prevail and if they vary by child age, we should have seen that the pregnancy interval matters. That was not the case. Moreover, we can refute the concern of stress playing a role by looking at quasi-experimental evidence. Persson and Rossin-Slater (2014) find that the death of a close relative during pregnancy, a very severe form of stress, increases prematurity by 0.6 percentage points. In comparison, we see that firstborns face an increased risk of 2.2 to 2.9 percentage points (all effects compared to a mean of 4 percent). In addition, Persson and Rossin-Slater (2014) find no effect on SGA and LGA. Using a similar empirical strategy, Black et al. (2016) find no effect on the Apgar score. We argue that stress can neither be a strong mechanism nor a strong confounding factor.

Nature

The persistent positive relationship between birth order and child health suggests that unobservable factors, unrelated to behavior or social factors, are the underlying cause of the birth order effect in health at birth. As discussed earlier, a reduction in hospitalizations for severe pregnancy complications across birth orders may be the result of physiological changes unrelated to maternal behavior. The reason is that later pregnancies face lower maternal constraints that influence fetal growth (Gluckman and Hanson 2004). General improvements in maternal physiology, i.e. a shift of the maternal health distribution across birth orders, will not be detected by the hospitalization variables as they can only speak for the bottom part of the

³¹Additional analysis revealed that the decrease in the coefficients is mainly driven by accounting for smoking, hospitalizations for medical pregnancy complications, and maternal age at birth where very young mothers have children with worse health at birth. Note, however, that the quantile model differs econometrically from the family fixed effects model, which is why we refrain from a generalization of this result.

maternal-health distribution. Improvements at upper parts of the distribution might even be unnoticed by the mother.

The general understanding of the medical literature is that physiological changes during the first pregnancy, necessary for fetal development, do not fully return to their baseline value (before the first pregnancy). Higher order children profit from this incomplete reversal. These physiological changes encompass the uterine blood supply (Hafner et al. 2000; Hollis et al. 2003; Khong et al. 2003; Prefumo et al. 2004) and an enlargement of the uterus (Woessner and Brewer 1963; Sørnes and Bakke 1989), both of which affect nutrient supply to the fetus (Gluckman and Hanson 2004). It has also been suggested that maternal sensitization to paternal antigens that occur at the first pregnancy affect birth weight of later-born children (Warburton and Naylor 1971; Chakraborty et al. 1975).

Animal studies perpetuate the findings from the medical literature. A positive birth order effect in health at birth appears for cattle (Johanson and Berger 2003) as well as sheep (Gardner et al. 2007). Animal studies occur in a controlled environment, for example with respect to nutrition, and therefore alleviate concerns about endogenous behavioral differences of the mother.

All this evidence suggests that the positive relationship between birth order and child health might be a biological effect, determined by nature. While no data set exists to detect the nature channel, the persistence of the birth order effect to controls for the social and behavioral environment supports the existence of the role of biology.³²

6 Health from Birth through Adolescence

The results from the previous section raise the inevitable question about how birth order differences evolve between birth and adolescence. In this section, we answer part of this question

³²We considered the possibility of applying quasi-experimental events. Kristensen and Bjerkedal (2007) use death of a sibling to generate allegedly exogenous variation in social and biological birth order. We considered the possibility of a similar approach exploiting miscarriages as an instrument for social and biological birth order. However, miscarriages might have negative obstetric consequences for following pregnancies (Hathout et al. 1982; Bhattacharya et al. 2008). At the same time, experiencing a miscarriage might change behavior during a following pregnancy, possibly in the favor of the unborn child. Hence, applying this approach will not be superior to our within family approach. In contrast, the impossibility of disentangling the consequences of a miscarriage might even confound the results.

by studying birth order differences in hospital admissions.

As our measure of health, we use the occurrence of any hospital admission for each year from age 1 through 17. Our data enables us to observe diagnoses given from hospital admissions for each child at a given age. We focus on ICD-10 diagnosis codes chapter I–XIV, which includes all diagnoses except conditions relating to pregnancy and childbirth, congenital malformations, conditions originating from the perinatal period, as well as injuries and other external causes of morbidity and mortality. Injuries and others causes are excluded, because they do not necessarily capture a general health status. Similarly, we exclude emergency room visits, as they might somehow reflect differences in parental behavior across birth orders; for a given illness, parents might, for instance, be more worried with the first child and therefore demand emergency admission, while they would only seek care at the GP for subsequent children. Otherwise, the data includes all outpatient as well as inpatient contacts with the hospital.³³ Because the classification system changed in Denmark in 1994 from ICD-8 to ICD-10, we focus on hospital admissions from 1994 to 2011, but include children born between 1981 to 2010.³⁴ Appendix Table A7 shows summary statistics for the sample. We have about 600,000 children in each age group from age 1 to 13 and 400,000 to 500,000 children in the age group 14 to 17.

We estimate model 1 for each age $a \in (1; 17)$ with the dependent variable being a dichotomous (0/1) variable for any hospital admission at age a .³⁵ Figure 5 depicts the coefficients of the birth order estimates for each age group together with the 95 percent confidence interval; note that the estimates are obtained from separate regressions for each age group.

[Figure 5 about here.]

The results show an *early life* health advantage of later-borns compared to firstborns. The advantage is largest at age 3 and 4 where later-borns are 0.6-1.1 percentage points less likely to

³³We include chapters I) Certain infections and parasitic diseases, II) Neoplasms, III) Diseases of the blood and blood-forming organs and certain diseases, IV) Endocrine, nutritional and metabolic diseases, V) Mental and behavioral disorders, VI) Diseases of the nervous system, VII) Diseases of the eye and adnexa, VIII) Diseases of the ear and mastoid process, IX) Diseases of the circulatory system, X) Diseases of the respiratory system, XI) Diseases of the digestive system, XII) Diseases of the skin and subcutaneous tissue, XIII) Diseases of the musculoskeletal system and connective tissue, XIV) Diseases of the genitourinary system.

³⁴Due to the restriction of the hospital admission data, we do not observe the oldest cohort when they are young. For example, the cohort born in 1981 will be observed from age 13 onwards.

³⁵We also looked at the natural logarithm of the number of distinct hospital admissions at each age. The results (not reported) produce very similar results.

have a contact with the hospital. Given a mean of 8 percent, this represents a substantial effect. After age 4, the advantage of later-borns weakens and eventually becomes insignificant from age 7 onwards. At age 13 and 16, the results indicate that firstborns are better-off: later-borns are 0.3–1.4 percentage points more likely to be admitted to a hospital (mean is 6 percent and 9 percent, respectively). This firstborn advantage is, however, not precisely estimated at age 15 and 17; and partially at age 14. ³⁶

Overall, the patterns in Figure 5 highlight once more the early life advantage of later-borns over their firstborn counterparts. The disappearance of the effect from age 7 onwards and the indication of a firstborn advantage in adolescence is consistent with the positive birth order effect at birth, presented in the previous sections, and the negative birth order effect in educational performance found in previous studies, which we replicate in Appendix Table A1.

7 Conclusions

Our study provides new evidence on the relationship between birth order and child health using a unique data set from Denmark. Using family fixed effects models, we find large and positive birth order differences in health at birth that are robust to the way we define health at birth and hold irrespective of family size; lower parity children are less healthy at birth. While the socio-economic environment, risk behavior of the mother, and hospitalizations for pregnancy complications differ by birth order, these prenatal factors cannot explain the health advantage of later-born children. Combining findings from the medical literature with our results, we suggest that birth order differences in health at birth might have a biological dimension (nature) being the result of first pregnancies changing maternal physiology in favor of later-borns. Looking at health differences between age 1 and 17, we show that the health disadvantage of firstborns persists through age 6. From age 7 onwards, firstborns seem no longer disadvantaged and there is some indication of a potential firstborn health advantage in adolescence.

Our findings raise important questions for future research focusing on within family differences. The *positive* birth order effect in health at birth stands in stark contrast to the *negative* birth order effects in education. Our data suggests that the birth order effect in health reverses

³⁶The results are similar when performing the analysis by family size (not reported).

during childhood. Yet, what drives this reversal remains unanswered. Pavan (2016) finds that differences in parental behavior across siblings partially explain the negative birth order effect in cognitive test scores. Is parental behavior also responsible for the reversal in the birth order effect in health? More research is needed to understand why and if birth order differences in health arise after birth and how they relate to birth order differences in educational performance. Black et al. (2015) show that health differences by birth order exist in adulthood. The pattern, however, is mixed, showing that there is no clear firstborn disadvantage or advantage.

Our results may furthermore enable a vitally important link for any future research that focuses on connecting early life differences within families with later life outcomes. Our results suggest that despite substantial differences in the prenatal environment across birth orders, differences in the observed prenatal environment *within families* are not very decisive for child health (at least in Denmark); nature might potentially play a much larger role.

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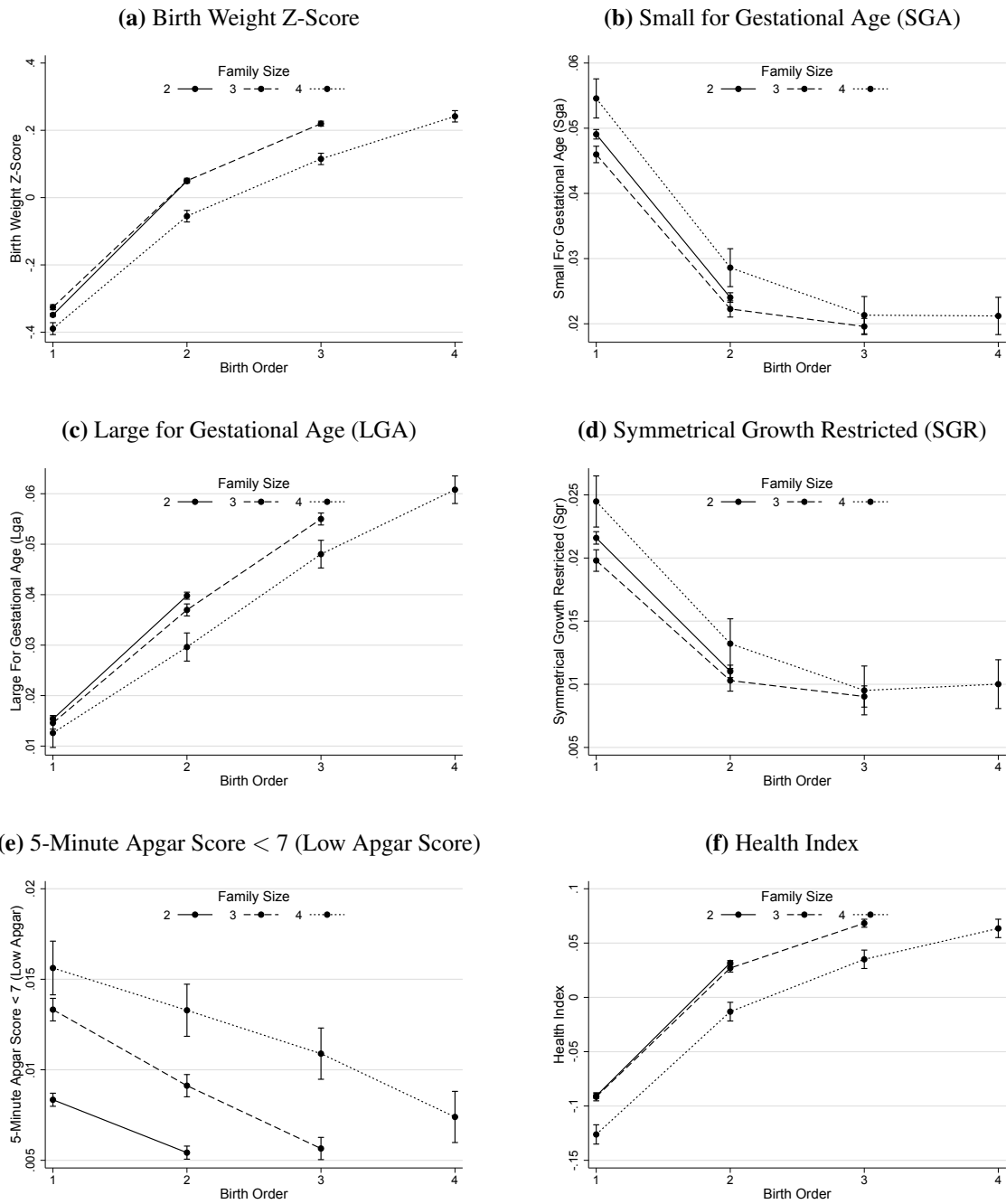
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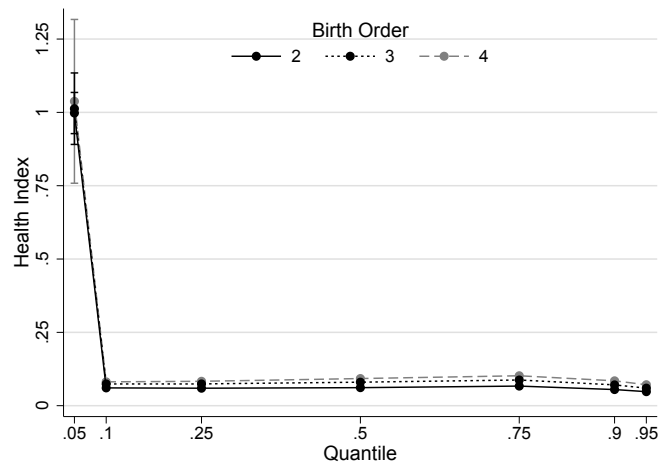
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Figure 1
Birth Outcomes by Birth Order and Family Size



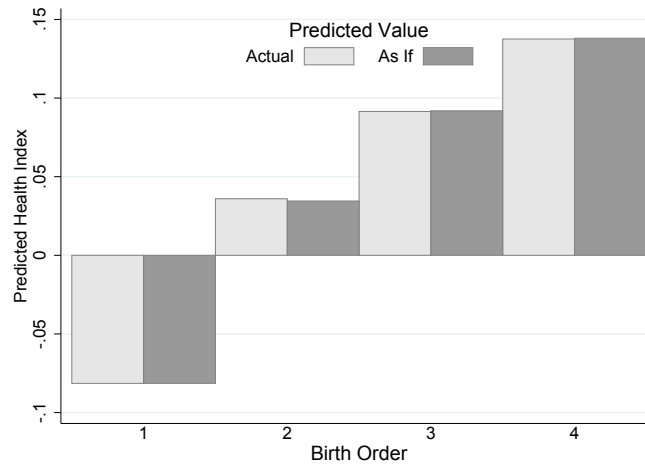
Notes: The figure plots the mean of the variable by birth order and family size. Health index is a summary index based on Kling et al. (2007) using the following variables: birth weight z-score, SGA, LGA, SGR, and low Apgar score. The whiskers represent the 95 percent confidence interval for the mean.

Figure 2
Quantile Regression Estimates



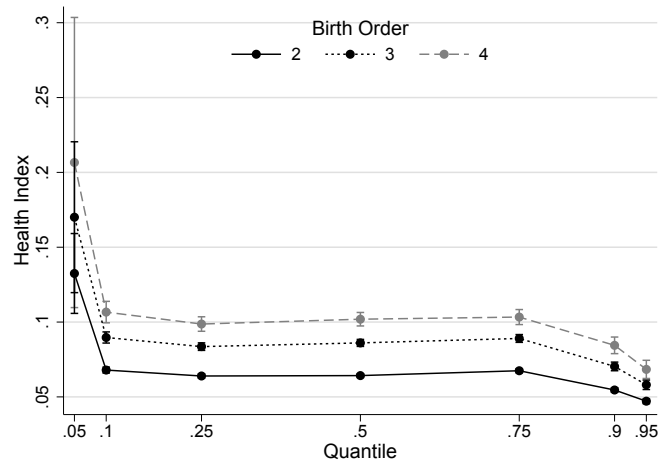
Notes: The figure plots the quantile regression estimates. Dependent variable is the health index at birth. The sample includes families with 2–4 children. The omitted category is birth order 1. The model includes month and year of conception trend, squared and cubic; dummies for month of conception, gender of the child, family size, maternal age at first birth, and mother’s highest education. The whiskers represent the 95 percent confidence interval

Figure 3
 Predictions Health Index by Birth Order and Prenatal Controls



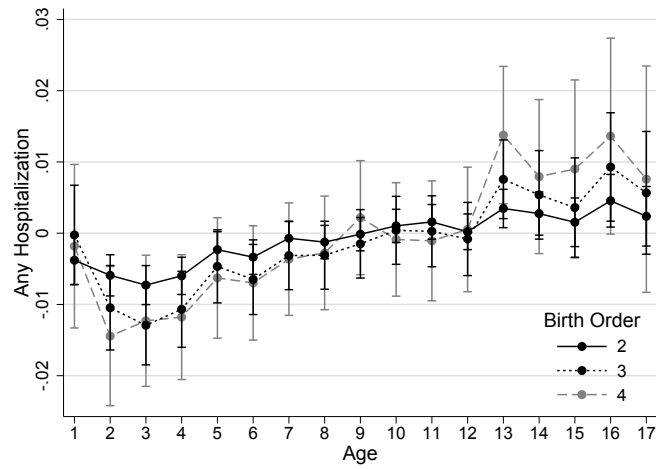
Notes: The figure plots the predictions for health index at birth. Predictions are based on family fixed effects estimation. The sample includes families with 2–4 children. The model includes dummies for year by month of conception; gender of the child; maternal age at birth; mother’s labor force participation in the year before birth; smoking during pregnancy; hospitalizations for gestational diabetes, gestational hypertension, and preeclampsia; controls for mother’s and father’s income in the year before birth; number of prenatal checkups at the GP, the midwife, and the specialist. The dark gray bars use the value of all controls for birth order 1 for the prediction. The whiskers represent the 95 percent confidence interval

Figure 4
 Quantile Regression Estimates with Prenatal Controls



Notes: The figure plots the quantile regression estimates. Dependent variable is the health index at birth. The sample includes families with 2–4 children. The omitted category is birth order 1. The model includes month and year of conception trend, squared and cubic; dummies for month of conception, family size, maternal age at first birth, education of the mother, gender of the child, maternal age at birth, labor force participation in the year before birth, smoking during pregnancy, hospitalizations for gestational diabetes, gestational hypertension, and preeclampsia; controls for mother’s and father’s income in the year before birth; number of prenatal checkups at the GP, the midwife, and the specialist. The whiskers represent the 95 percent confidence interval.

Figure 5
 Evolution of the Effect of Birth Order on Health: Any Hospital Admission



Notes: The figure plots the evolution of the birth order differences in any hospital admission for ICD-10 diagnosis codes chapter I–XIV, from age 1–17. The sample includes families with 2–4 children. The omitted category is birth order 1. All regressions include dummies for year by month of conception and gender of the child. Estimates for each age are obtained from separate regressions. The whiskers represent the 95 percent confidence interval.

Table 1
Child Characteristics and Prenatal Environment of Main Sample

Panel a: Demographic Characteristics			
Variable	Mean	S.D.	N
Number of Children	2.440	0.622	1,060,007
Birth Order 1	0.429	0.495	1,060,007
Birth Order 2	0.433	0.496	1,060,007
Birth Order 3	0.119	0.324	1,060,007
Birth Order 4	0.018	0.134	1,060,007
Child is Male	0.514	0.500	1,060,007
Month of Conception	6.714	3.421	1,060,007
Year of Conception	1995.981	7.638	1,060,007
Panel b: Birth Outcomes			
Variable	Mean	S.D.	N
Birth Weight Z-Score	-0.069	1.078	1,060,007
Small for Gestational Age (SGA)	0.031	0.174	1,060,007
Large for Gestational Age (LGA)	0.032	0.176	1,060,007
Symmetrical Growth Restricted (SGR)	0.014	0.117	1,060,007
5-Minute Apgar Score < 7 (Low Apgar Score)	0.007	0.085	1,060,007
Panel c: Prenatal Maternal Characteristics			
Variable	Mean	S.D.	N
Maternal Age (Years)	28.696	4.458	1,095,954
Pregnancy Interval (Spacing)	31.179	20.838	624,139
Working	0.845	0.362	1,095,954
Student	0.042	0.200	1,095,954
Unemployed	0.020	0.141	1,095,954
Not in the Labor Force	0.093	0.290	1,095,954
Mother's Income Percentile	0.558	0.214	1,095,954
Fathers's Income Percentile	0.663	0.237	1,084,797
Mother's Highest Education (Years)	13.435	2.425	1,087,283
Smoking	0.165	0.371	720,014
Prenatal Checkup General Practitioner (GP)	2.143	1.453	990,483
Prenatal Checkup Midwife	4.855	1.994	1,068,938
Prenatal Checkup Specialist	3.159	3.616	989,495
Gestational Diabetes	0.011	0.106	1,095,954
Gestational Hypertension	0.009	0.092	1,095,954
Preeclampsia	0.029	0.168	1,095,954

Notes: Panel a–b): Included in the sample are all observations of families with at least two children with non-missing birth outcomes. Panel c): Included in the sample are also measures of the prenatal environment for those children with missing birth outcomes to eliminate problems of selection, which is why the sample size increases in comparison to panel a–b). Parental wage income is based on the disposable income in the year before birth and defined as the percentile of the income distribution in the observed year. Education is the length of the mother's highest completed education. Smoking is available since 1991. Pregnancy interval is the time between previous birth and conception and not defined for birth order 1. We always exclude families with multiple birth and only-child families, and we keep only families where all children have the same mother and father (biological siblings).

Table 2
Effect of Birth Order on Child Health at Birth

Panel a) Without Family Fixed Effects						
	Birth Weight Z-Score	SGA	LGA	SGR	Low Apgar Score	Health Index
Birth Order 2	0.339*** (0.002)	-0.020*** (0.000)	0.022*** (0.000)	-0.008*** (0.000)	-0.003*** (0.000)	0.102*** (0.001)
Birth Order 3	0.429*** (0.003)	-0.019*** (0.001)	0.035*** (0.001)	-0.007*** (0.000)	-0.006*** (0.000)	0.122*** (0.002)
Birth Order 4	0.494*** (0.007)	-0.019*** (0.001)	0.043*** (0.002)	-0.007*** (0.001)	-0.008*** (0.001)	0.137*** (0.004)
N	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007
Mean	-0.07	0.03	0.03	0.01	0.01	-0.01
Joint Test	14649.75	1032.74	1996.83	334.22	163.66	3611.62
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00
Panel b) With Family Fixed Effects						
Birth Order 2	0.395*** (0.003)	-0.028*** (0.001)	0.023*** (0.001)	-0.012*** (0.000)	-0.009*** (0.000)	0.142*** (0.002)
Birth Order 3	0.548*** (0.006)	-0.038*** (0.001)	0.037*** (0.001)	-0.016*** (0.001)	-0.018*** (0.001)	0.208*** (0.004)
Birth Order 4	0.665*** (0.011)	-0.047*** (0.002)	0.045*** (0.002)	-0.019*** (0.002)	-0.026*** (0.001)	0.262*** (0.007)
N	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007
Mean	-0.07	0.03	0.03	0.01	0.01	-0.01
Joint Test	6711.61	790.21	485.37	271.45	200.97	2148.16
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00

Notes: Panel (a) shows the results of pooled OLS models. Panel (b) shows the results of family fixed effects models. Each column represents a separate regression. The sample includes families with 2–4 children. The omitted category is birth order 1. All regressions include dummies for year by month of conception and gender of the child. Models in panel (a), additionally include dummies for family size. Standard errors, clustered at the family level, are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3

Effect of Birth Order on Child Health at Birth– by Family Size

Panel a) 2–Child Families						
	Birth Weight Z-Score	SGA	LGA	SGR	Low Apgar Score	Health Index
Birth Order 2	0.386*** (0.005)	-0.027*** (0.001)	0.022*** (0.001)	-0.012*** (0.001)	-0.005*** (0.001)	0.131*** (0.003)
N	468,302	468,302	468,302	468,302	468,302	468,302
Mean	-0.15	0.04	0.03	0.02	0.01	-0.03
Panel b) 3–Child Families						
	Birth Weight Z-Score	SGA	LGA	SGR	Low Apgar Score	Health Index
Birth Order 2	0.381*** (0.005)	-0.029*** (0.001)	0.022*** (0.001)	-0.011*** (0.001)	-0.013*** (0.001)	0.148*** (0.004)
Birth Order 3	0.554*** (0.010)	-0.039*** (0.002)	0.037*** (0.002)	-0.015*** (0.002)	-0.029*** (0.001)	0.233*** (0.007)
N	240,352	240,352	240,352	240,352	240,352	240,352
Mean	-0.02	0.03	0.04	0.01	0.01	0.00
Panel c) 4–Child Families						
	Birth Weight Z-Score	SGA	LGA	SGR	Low Apgar Score	Health Index
Birth Order 2	0.331*** (0.011)	-0.030*** (0.003)	0.015*** (0.002)	-0.011*** (0.002)	-0.012*** (0.002)	0.140*** (0.008)
Birth Order 3	0.490*** (0.017)	-0.043*** (0.004)	0.028*** (0.004)	-0.016*** (0.003)	-0.028*** (0.003)	0.229*** (0.011)
Birth Order 4	0.605*** (0.026)	-0.049*** (0.005)	0.037*** (0.006)	-0.017*** (0.004)	-0.045*** (0.004)	0.296*** (0.017)
N	59,160	59,160	59,160	59,160	59,160	59,160
Mean	-0.01	0.03	0.04	0.01	0.01	-0.01

Notes: The table shows the results of family fixed effects models; each column represents a separate regression. Standard errors, clustered at the family level, are in parentheses. Each panel represents a sample with different family size. The samples are restricted to include families where the mother is at least 38 in December 2010. The omitted category is birth order 1. All regressions include dummies for year by month of conception and gender of the child. Standard errors, clustered at the family level, are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4
Effect of Birth Order on Prenatal Environment

Panel a) Maternal Labor Force Participation and Parental Wage Income						
	Labor Force Participation				Family Income	
	Working	Student	Unemployed	Not in the Labor Force	Father's Income	Mother's Income
Birth Order 2	-0.081*** (0.001)	-0.010*** (0.001)	0.010*** (0.001)	0.081*** (0.001)	0.024*** (0.001)	0.011*** (0.001)
Birth Order 3	-0.140*** (0.002)	-0.021*** (0.001)	0.011*** (0.001)	0.150*** (0.002)	0.034*** (0.001)	0.033*** (0.001)
Birth Order 4	-0.244*** (0.004)	-0.004 (0.002)	0.014*** (0.002)	0.234*** (0.004)	0.018*** (0.003)	0.027*** (0.002)
N	1,095,954	1,095,954	1,095,954	1,095,954	1,084,797	1,095,954
Mean	0.85	0.04	0.02	0.09	0.66	0.56
Joint Test	1723.33	164.54	141.13	2477.22	617.33	297.61
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00

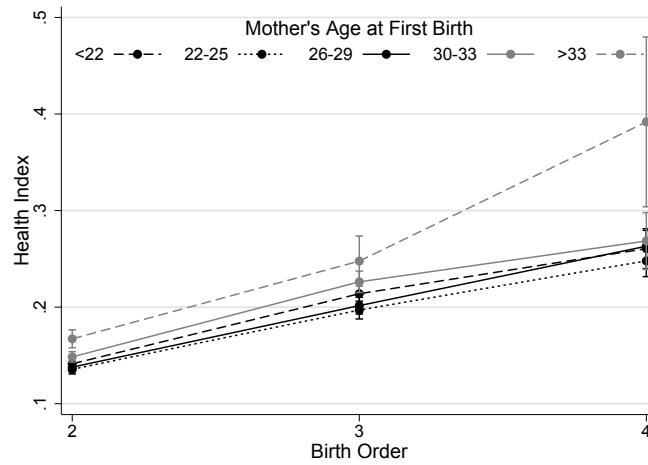
Panel b) Maternal Behavior				
	Smoking	Number of Prenatal Checkups at		
		GP	Midwife	Specialist
Birth Order 2	-0.027*** (0.001)	-0.070*** (0.003)	-0.190*** (0.006)	0.027*** (0.007)
Birth Order 3	-0.034*** (0.002)	-0.125*** (0.006)	-0.292*** (0.012)	0.001 (0.014)
Birth Order 4	-0.034*** (0.004)	-0.212*** (0.010)	-0.430*** (0.021)	-0.001 (0.024)
N	720,014	990,483	1,068,938	989,495
Mean	0.17	2.14	4.85	3.16
Joint Test	283.16	227.59	390.21	18.87
Prob > F	0.00	0.00	0.00	0.00

Panel c) Hospitalizations for Medical Pregnancy Complications			
	Gestational Diabetes	Gestational Hypertension	Preeclampsia
Birth Order 2	-0.006*** (0.000)	-0.006*** (0.000)	-0.029*** (0.001)
Birth Order 3	-0.013*** (0.001)	-0.009*** (0.001)	-0.035*** (0.001)
Birth Order 4	-0.010*** (0.002)	-0.010*** (0.001)	-0.038*** (0.002)
N	1,095,954	1,095,954	1,095,954
Mean	0.01	0.01	0.03
Joint Test	82.71	145.43	1193.86
Prob>F	0.00	0.00	0.00

Notes: The table shows the results of family fixed effects models. Each column represents a separate regression. The sample includes families with 2–4 children. The omitted category is birth order 1. All regressions include dummies for year by month of conception. Panel b) and c) additionally control for gender of the child. Mother's and father's income in panel a) is based on disposable income in the year before birth (after tax and interest rate) and defined as the percentile of the income distribution in the observed year. Standard errors, clustered at the family level, are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

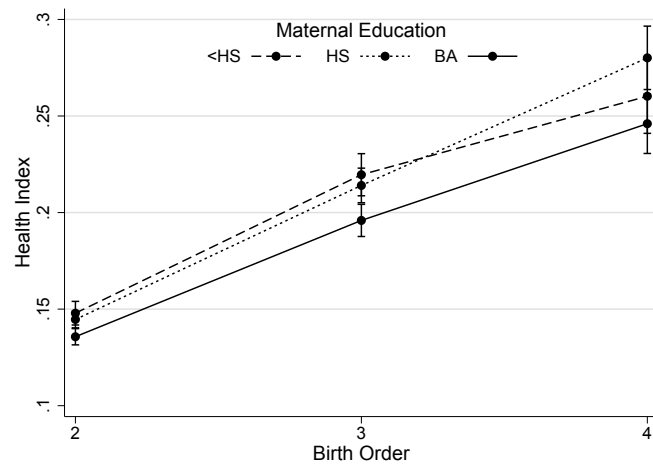
A Appendix

Figure A1
 Effect of Birth Order on Health at Birth by Maternal Age at First Birth



Notes: Figure A1 plots the coefficients of the interaction term between birth order and maternal age at first birth in the family fixed effects model (model 1 where the three birth order dummies are interacted with five dummies for maternal age at first birth). Dependent variable is the health index at birth, which is a summary index based on Kling et al. (2007) using the following variables: birth weight z-score, SGA, LGA, SGR, and low Apgar score. Age at first birth is divided into (1) < 22 years, (2) 22–25 years, (3) 26–29 years, (4) 30–33 years, (5) >33 years. Controls include dummies for year by month of conception, and gender of the child. The whiskers indicate the 95 percent confidence interval.

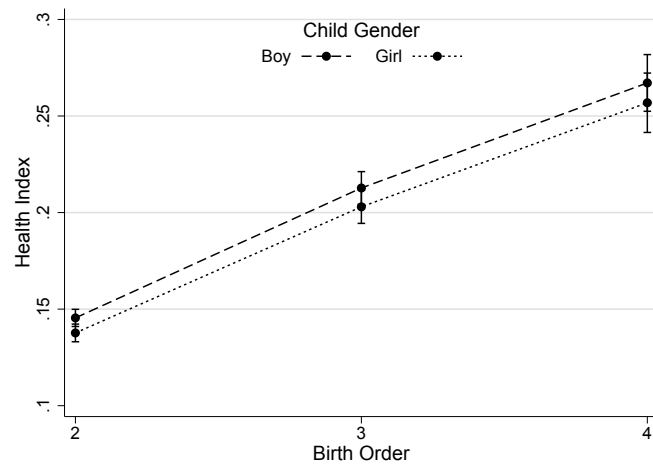
Figure A2
Effect of Birth Order on Health at Birth by Mother's Highest Education



Notes: Figure A2 plots the coefficients of the interaction term between birth order and education of the mother in the family fixed effects model (model 1 where the three birth order dummies are interacted with three dummies for mother's highest education). Dependent variable is the health index at birth, which is a summary index based on Kling et al. (2007) using the following variables: birth weight z-score, SGA, LGA, SGR, and low Apgar score. Education is divided into (1) < HS: no high school/education (< 12 years), (2) HS: high school and some vocational training or two years of college, and (3) BA: Bachelor degree or more. Controls include dummies for year by month of conception, and gender of the child. The whiskers indicate the 95 percent confidence interval.

Figure A3

Effect of Birth Order on Health at Birth by Gender of the Child



Notes: Figure A3 plots the coefficients of the interaction term between birth order and gender of the child (model 1 where the three birth order dummies are interacted with a dummy for boy and a dummy for girl). Dependent variable is the health index at birth, which is a summary index based on Kling et al. (2007) using the following variables: birth weight z-score, SGA, LGA, SGR, and low Apgar score. Controls include dummies for year by month of conception, and gender of the child. The whiskers indicate the 95 percent confidence interval.

Table A1
Effect of Birth Order Effects on Ninth Grade GPA

	Pooled	2-Child Family	3-Child Family	4-Child Family
Birth Order 2	-0.164*** (0.007)	-0.166*** (0.010)	-0.168*** (0.010)	-0.142*** (0.019)
Birth Order 3	-0.240*** (0.014)		-0.274*** (0.022)	-0.272*** (0.036)
Birth Order 4	-0.298*** (0.024)			-0.373*** (0.055)
N	240,583	134,020	83,515	21,990
Mean	0.09	0.12	0.10	-0.06
Joint Test	234.31		143.79	20.93
Prob > F	0.00		0.00	0.00

Notes: The table shows the results of family fixed effects models; each column represents a separate regression. Dependent variable is ninth grade GPA. The GPA is based on grades given from national exams in Danish, Math, and English, and are given for oral and written presentation as well as reading comprehension. The GPA is standardized by year of graduation to a mean of 0 and standard deviation of 1. Column (1) includes all families with 2–4 children, column(2) includes only families with two children, column (3) includes only families with three children, and column (4) includes only families with four children. The omitted category is birth order 1. All regressions include dummies for year by month of conception, gender of the child, age of the mother at birth, and year of graduation. Standard errors, clustered at the family level, are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2

Effect of Birth Order on Child Health at Birth - Additional Measures

	ln(Birth Weight)	ln(Birth Length)	Premature	Head Circumference	Perinatal Conditions	Perinatal Death
Birth Order 2	0.055*** (0.001)	0.010*** (0.000)	-0.023*** (0.001)	0.346*** (0.009)	-0.075*** (0.002)	-0.021*** (0.000)
Birth Order 3	0.077*** (0.001)	0.015*** (0.000)	-0.031*** (0.001)	0.504*** (0.018)	-0.093*** (0.004)	-0.053*** (0.001)
Birth Order 4	0.091*** (0.002)	0.018*** (0.001)	-0.033*** (0.002)	0.604*** (0.030)	-0.099*** (0.006)	-0.084*** (0.002)
N	1,060,007	1,060,007	1,060,007	466,488	608,644	1,095,940
Mean	8.16	3.95	0.04	35.18	0.14	0.01
Joint Test	4644.81	1622.94	440.61	627.91	822.04	1159.28
P>F	0.00	0.00	0.00	0.00	0.00	0.00

Notes: The table shows the results of family fixed effects model; each column represents a separate regression. Standard errors, clustered at the family level, are in parentheses. The sample includes families with 2–4 children. The omitted category is birth order 1. All regressions include dummies for year by month of conception and gender of the child. Prematurity is defined as gestational age less than 37 weeks. Head circumference is in cm and reported since 1997. Perinatal condition indicates the diagnosis of a condition originating in the perinatal period and is based on the ICD-10 codes P00–P96. We exclude the codes P05–P08 since these indicate birth weight and gestational age and we look at these outcomes already separately. Perinatal death is defined as fetal deaths occurring with a stated or presumed gestation of 28 weeks or more or deaths occurring within the first 7 days of life. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3
Quantile Regression, OLS, and Fixed Effects Estimates for Health Index

	Quantile							OLS	Family FE
	0.05	0.1	0.25	0.5	0.75	0.9	0.95		
Birth Order 2	0.998*** (0.036)	0.061*** (0.001)	0.060*** (0.001)	0.062*** (0.000)	0.067*** (0.001)	0.055*** (0.001)	0.048*** (0.001)	0.105*** (0.001)	0.142*** (0.002)
Birth Order 3	1.013*** (0.062)	0.074*** (0.001)	0.074*** (0.001)	0.080*** (0.001)	0.088*** (0.001)	0.071*** (0.001)	0.060*** (0.001)	0.126*** (0.002)	0.207*** (0.004)
Birth Order 4	1.038*** (0.142)	0.081*** (0.003)	0.083*** (0.002)	0.093*** (0.002)	0.102*** (0.002)	0.085*** (0.002)	0.072*** (0.003)	0.142*** (0.004)	0.262*** (0.007)
N	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007

Notes: Column (1)–(7) show the quantile regression estimates. Column (8) shows the result of a pooled OLS model and column (9) that of a family fixed effects model. Each column represents a separate regression. The sample includes families with 2–4 children. The omitted category is birth order 1. Dependent variable is the health index at birth. The sample includes families with 2–4 children. The omitted category is birth order 1. All regressions include month and year of conception trend, squared and cubic; dummies for month of conception, and gender of the child. Column (1)–(8) additionally control for family size effects, maternal age at first birth, and mother’s highest education. Standard errors, clustered at the family level, are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A4

Mechanisms of the Birth Order Relationship in Health at Birth

	Health Index	Health Index	Health Index	Health Index	Health Index	Health Index
Birth Order 2	0.142*** (0.002)	0.143*** (0.002)	0.144*** (0.002)	0.143*** (0.002)	0.145*** (0.002)	0.140*** (0.002)
Birth Order 3	0.208*** (0.004)	0.210*** (0.004)	0.212*** (0.004)	0.210*** (0.004)	0.215*** (0.004)	0.209*** (0.004)
Birth Order 4	0.262*** (0.007)	0.264*** (0.007)	0.266*** (0.007)	0.264*** (0.007)	0.271*** (0.007)	0.264*** (0.007)
Maternal Age at Birth						
Maternal Age < 18		0.005 (0.018)	-0.001 (0.018)	-0.003 (0.018)	0.000 (0.018)	0.002 (0.018)
Maternal Age 18–21		-0.002 (0.005)	-0.003 (0.005)	-0.004 (0.005)	-0.002 (0.005)	-0.001 (0.005)
Maternal Age 22–25		0.003 (0.002)	0.003 (0.002)	0.003 (0.002)	0.004 (0.002)	0.004* (0.002)
Maternal Age 30–33		-0.001 (0.002)	-0.001 (0.002)	-0.001 (0.002)	-0.001 (0.002)	-0.002 (0.002)
Maternal Age 34–37		0.004 (0.004)	0.003 (0.004)	0.003 (0.004)	0.002 (0.004)	0.003 (0.004)
Maternal Age > 37		0.016** (0.007)	0.014** (0.007)	0.013* (0.007)	0.013* (0.007)	0.014** (0.007)
Socio-Economic Characteristics						
Student			0.002 (0.003)	0.002 (0.003)	0.003 (0.003)	0.003 (0.003)
Unemployed			-0.009* (0.005)	-0.009* (0.005)	-0.008* (0.005)	-0.008* (0.005)
Out of the Labor Force			-0.006* (0.003)	-0.006* (0.003)	-0.005 (0.003)	-0.005 (0.003)
Mother's Income			-0.025*** (0.005)	-0.025*** (0.005)	-0.026*** (0.005)	-0.025*** (0.005)
Father's Income			-0.006* (0.003)	-0.007* (0.003)	-0.007** (0.003)	-0.007* (0.003)
Maternal Behavior						
Smoking				-0.028*** (0.003)	-0.028*** (0.003)	-0.028*** (0.003)

Table A4 continued

Prenatal Checkups GP					0.013*** (0.001)	0.013*** (0.001)
Prenatal Checkups Midwife					0.007*** (0.000)	0.006*** (0.000)
Prenatal Checkups Specialist					0.009*** (0.001)	0.009*** (0.001)
Hospitalizations for Medical Pregnancy Complications						
Gestational Diabetes						0.007 (0.007)
Gestational Hypertension						-0.074*** (0.009)
Preeclampsia						-0.167*** (0.006)
Differences in Birth Order Coefficients						
△ Birth Order 2	0.001***	0.001***	-0.001***	0.002***	-0.005***	-0.002***
△ Birth Order 3	0.002***	0.002***	-0.002	0.005***	-0.006***	-0.001***
△ Birth Order 4	0.002***	0.002***	-0.002	0.007***	-0.007***	0.002***
N	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007
Mean	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Joint Test	2148.16	2087.50	2053.57	2030.81	2068.45	1923.58
Prob > F	0.00	0.00	0.00	0.00	0.00	0.00

Notes: The table shows the results of family fixed effects models; each column represents a separate regression. Each column represents a separate regression. The sample includes families with 2–4 children. The omitted category is birth order 1. Dependent variable is the health index at birth. All regressions include year by month of conception dummies and a dummy for gender of the child. Omitted category in column (3)–(6) is working in the year before birth. Mother’s and father’s income in panel a) is based on disposable income in the year before birth (after tax and interest rate) and defined as the percentile of the income distribution in the observed year. Missing observations are mainly due to different reporting schemes over the sample period. To account for any potential underlying systematic scheme, we account for missing values by including indicator variables for missing values. The triangle (△) is the difference between the birth order coefficients in the two enclosed columns for birth order 2, 3 and 4, respectively. The bold differences in the last column compare column (1) with column (6). The test for the differences is based on a Wald test. Standard errors, clustered at the family level, are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A5
The Role of the Pregnancy Interval in the Birth Order Relationship in Health at Birth

	(1) Health Index	(2) Health Index
Birth Order 3	0.077*** (0.004)	0.078*** (0.004)
Birth Order 4	0.139*** (0.007)	0.140*** (0.009)
Pregnancy Interval < 11 Months		0.025*** (0.004)
Pregnancy Interval 12–17 Months		-0.003 (0.004)
Pregnancy Interval 24–29 Months		-0.002 (0.004)
Pregnancy Interval 30–37 Months		-0.003 (0.004)
Pregnancy Interval 38–51 Month		-0.007 (0.004)
Pregnancy Interval >51 Months		0.006 (0.006)
△ Birth Order 3		0.001
△ Birth Order 4		-0.001
N	265,149	265,149
Mean	0.05	0.05
Joint Test	219.85	153.73
Prob > F	0.00	0.00

Notes: The table shows the results of family fixed effects model. Each column represents a separate regression. The sample includes families with 3–4 children. The omitted category is birth order 1. Dependent variable is the health index at birth. All regressions include year by month of conception dummies, a dummy for gender of the child, and dummies for maternal age at birth. The triangle (△) is the difference between the birth order coefficients in the two enclosed columns for birth order 2, 3 and 4, respectively. The bold differences in the last column compare column (1) with column (6). The test for the differences is based on a Wald test (none of the differences are significant). Standard errors, clustered at the family level, are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A6
Quantile Regression, OLS, and Fixed Effects Estimates for Health Index With In Utero Environment Controls

	Quantile							OLS	Family FE
	0.05	0.1	0.25	0.5	0.75	0.9	0.95		
Birth Order 2	0.132*** (0.014)	0.068*** (0.001)	0.064*** (0.001)	0.064*** (0.001)	0.067*** (0.001)	0.055*** (0.001)	0.047*** (0.001)	0.112*** (0.001)	0.140*** (0.002)
Birth Order 3	0.170*** (0.026)	0.090*** (0.002)	0.084*** (0.001)	0.086*** (0.001)	0.089*** (0.001)	0.070*** (0.001)	0.058*** (0.002)	0.148*** (0.002)	0.208*** (0.004)
Birth Order 4	0.207*** (0.049)	0.107*** (0.004)	0.099*** (0.002)	0.102*** (0.002)	0.103*** (0.003)	0.084*** (0.003)	0.068*** (0.003)	0.178*** (0.005)	0.262*** (0.007)
N	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007	1,060,007

Notes: Column (1)–(7) show the quantile regression estimates. Column (8) shows the result of a pooled OLS model and column (9) that of a family fixed effects model. Each column represents a separate regression. The sample includes families with 2–4 children. The omitted category is birth order 1. Dependent variable is the health index at birth. All regressions include month and year of conception trend, squared and cubic; dummies for month of conception, gender of the child, maternal age at birth, mother’s labor force participation in the year before birth, smoking during pregnancy, hospitalizations for gestational diabetes, gestational hypertension, and preeclampsia; controls for mother’s and father’s income in the year before birth; number of prenatal checkups at the GP, the midwife, and the specialist. Column (1)–(8) additionally control for family size effects, maternal age at first birth, and mother’s highest education. Standard errors, clustered at the family level, are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A7
Characteristics of Hospitalization Sample

Variable	Mean	S.D.	N
Number of Children	2.435	0.620	1,089,248
Birth Order 1	0.430	0.495	1,089,248
Birth Order 2	0.434	0.496	1,089,248
Birth Order 3	0.118	0.322	1,089,248
Birth Order 4	0.018	0.133	1,089,248
Child is Male	0.514	0.500	1,089,248
Month of Conception	6.712	3.421	1,089,248
Year of Conception	1995.979	7.637	1,089,248
Any Hospitalization Age 1	0.150	0.357	672,581
Any Hospitalization Age 2	0.097	0.295	673,312
Any Hospitalization Age 3	0.084	0.278	672,827
Any Hospitalization Age 4	0.076	0.265	670,037
Any Hospitalization Age 5	0.070	0.254	665,757
Any Hospitalization Age 6	0.063	0.244	658,217
Any Hospitalization Age 7	0.059	0.236	648,694
Any Hospitalization Age 8	0.057	0.233	638,229
Any Hospitalization Age 9	0.056	0.230	625,828
Any Hospitalization Age 10	0.056	0.229	612,140
Any Hospitalization Age 11	0.057	0.231	594,494
Any Hospitalization Age 12	0.059	0.236	573,594
Any Hospitalization Age 13	0.064	0.245	550,051
Any Hospitalization Age 14	0.075	0.263	505,290
Any Hospitalization Age 15	0.086	0.280	460,077
Any Hospitalization Age 16	0.091	0.288	416,186
Any Hospitalization Age 17	0.099	0.298	370,166

Notes: The top two panels presents summary statistics for the sample used in the hospitalization regressions. The bottom panel shows summary statistics for each age group (17 different samples). Included in the sample are all observations of families with at least two children with non-missing hospitalization information in a given age group. Hospitalization is based on outpatient and inpatient visits (excluding emergency contacts) with an ICD-10 diagnosis from chapters I–XIV