Inequality in the household: neonatal health effects on education outcomes and parents' compensations among siblings.

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Abstract

This study estimates neonatal health associations with future health and education outcomes and explores parents' reactions to low health endowments using a 9-year panel of Mexican siblings. We contribute to the literature by providing results on different aspects of the uterine environment in poorer settings and offering a more dynamic picture of how initial health influences education and parents' compensations among siblings, from childhood to adulthood. Our results are robust to different family fixed-effects models suggesting that unhealthy children at birth have worse adult health, a lower height, and fewer years of schooling at any age between 5 and 22. We offer evidence of reinforcing and compensating patterns among siblings: less-educated parents spend on average 15% fewer economic resources on their less-healthy children's education, while wealthier parents invest 14% more. Notably, the compensating pattern in richer settings starts early in life and remains consistent across all ages.

Keywords: Fetal Origins; Birth Weight; Early Health; Early Childhood; Parent's Compensations
JEL classification: I12, I15, I25, J13

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1 Introduction

Mother's health and habits, nutrition, environmental factors, and stress during gestation can raise children's disease risk, limiting their later health, education, and labor market outcomes. Research has shown that many children with poor neonatal health, who survive infancy, experience a higher risk of developing chronic diseases, as well as behavioral problems and lower cognitive development that limit the returns to human capital investments (Barker and Robinson, 1992; Almond et al., 2004; Gluckman and Hanson, 2006; Almond and Currie, 2011; Schieve et al., 2016; Aurino and Burchi, 2017). These effects could be more detrimental in developing countries, where mothers are more likely to be exposed to adverse environmental factors such as pollution, malnutrition, and economic crises.[1] Furthermore, information on healthy habits and early childhood compensating policies are, on average, less common in poorer settings (Gebresilassie et al., 2021).[2]

In this context, parents' responses to low early health endowments in poorer settings may play an essential role in reinforcing or compensating differences between siblings. For example, parents may exacerbate early health differences when they direct limited resources to the child with more chances to thrive in life (Becker and Tomes, 1976; Pollak, 1988; Conley, 2008). On the one hand, if reinforcement dominates, and this differentiates children's outcomes, the effects of neonatal health on later outcomes would be overestimated. On the other hand, if there is a compensating mechanism, the potential effects would be underestimated. Understanding these mechanisms is of interest for policy design because any increase in inequality of outcomes due to parents' actions should be tackled by public interventions aiming to equalize opportunities. Therefore, a key policy interest in poorer settings is improving childrens' outcomes while considering parental responses.

This paper contributes to the growing evidence on the relationship between initial health endowments and later outcomes by exploring the lasting effects of birth health measures on future children's health and education, from childhood to adolescence, using a 9-year panel of Mexican siblings. We contribute to the literature, which has primarily focused on birth weight and height as a proxy for health,[3] by including results on low birth weight, small-for-gestational-age (SGA), and low fetal growth per week. This is relevant as prenatal events, captured by weight-by-birth-length measures, can influence postnatal development and later outcomes without clearly affecting birth weight (Conti et al., 2020). For example, in our sample, 24% of SGA-children are not born with a low birth weight (or under 2500 grams).

We also contribute to the literature on parents' preferences by offering evidence on parents' compen-

[1] For example, Behrman and Rosenzweig (2004) suggest that shifting the distribution of birth weight in developing countries to that of the US might potentially reduce world earnings inequality by 1%.

[2] Despite the potential economic gains of investing in the most vulnerable children (Doyle et al., 2009), Mexico invests three times less in policies directed to children under the age of 5 compared to those between the ages of 6 to 11 (Schady and Berlinski, 2015). This situation is similar in the rest of Latin America, where 200 million children below the age of 5 may not reach their potential (Engle et al., 2007; Britto et al., 2013).

[3] See, for example, (Behrman and Rosenzweig, 2004; Almond, 2006; Black et al., 2007; Oreopoulos et al., 2008; Royer, 2009; Schultz-Nielsen et al., 2014; Bharadwaj et al., 2018b) on birth weight, and for height as a measure of early health see (Case et al., 2005; Vogl, 2014). We present a detailed review of the papers related to our work in Section 2

sating or reinforcing responses contingent on discrepancies among siblings, in poorer settings and across time.[4] While the relationship between initial health endowments and later outcomes has been studied regularly in the literature, in both developed and more recently in developing countries, the evolution of this relationship across time and how parents' investments in human capital adjust in response, has been less explored in poorer settings with limited institutional support.[5]

We first analyze our neonatal health measures on children's health status, height, and IQ test scores. We estimate the effects on educational attainment using years of schooling, school attendance, and grade repetition as outcomes for a sample of individuals 5 to 22 years old followed through three rounds of the Mexican Family Life Survey (MxFLS) between 2002 and 2009-2011. In the second part of our analysis, we explore if parents devote more or less money to unhealthy children's school expenses and differences in parents' school-related time allocations on their children. This analysis allows us to provide a more complete picture of how initial health interacts with parents' decisions on human capital accumulation at different ages and in poorer settings.

There are methodological challenges in identifying the effects between early health and later age outcomes. Unobserved factors such as genetic endowments, environmental factors, and mother's habits may simultaneously drive low fetal development, early health endowments, and later academic achievement. This study aims to identify some of the effects of intrauterine development by exploiting neonatal health variations among siblings using family fixed-effect models.[6] These models allow controlling for household's unobserved characteristics that remain fixed for all siblings, including some of the socioeconomic and cultural context, common environmental factors, some parental norms and habits and some genetic endowments affecting children's neonatal health and later outcomes.[7]

Nevertheless, some causes of intrauterine development, neonatal health and future outcome differences across siblings are still determined by endogenous parents' responses that vary across time. For example, mothers with low birth weight children can adjust their behavior in subsequent pregnancies to avoid this outcome. Prenatal events such as medical attention received during pregnancy and postpartum mother's health can also influence postnatal development even without affecting birth outcomes (Conti et al., 2020; Gebresilassie et al., 2021). While we do not have an exogenous shifter for birth conditions, we address some of the changes in mothers' responses during pregnancy and during children's first moments

[4]For evidence on reinforcing mechanisms see (Rosenzweig and Zhang, 2009; Datar et al., 2010; Adhvaryu and Nyshadham, 2016), and for evidence on (conditional) preferences for equality see (Torche and Echevarría, 2011; Hsin, 2012; Breining et al., 2015; Yi et al., 2015; Akee et al., 2018; Bharadwaj et al., 2018a).

[5]In this regard, Mexico offers a unique setup to test the effects of low in-utero growth. According to the National Institute of Public Health (INSP, for its abbreviation in Spanish), approximately 9% of children are born below 2500 grams despite low mortality rates.

[6]Examples of studies using siblings and twin methods, which aim to control for genetic characteristics as well as family fixed-effects, include evaluations of the returns to education (Ashenfelter and Zimmerman, 1997), the returns to school quality (Altonji and Dunn, 1996), the effects of teenage childbearing (Rosenzweig and Wolpin, 1995), and the seasonality of birth health (Currie and Schwandt, 2013).

[7]One disadvantage of these models is, that they do not control for all genetic factors that may determine differences in birth weight between siblings because they only share between 50-80% of all genetic traits (see Black et al., 2007). For recent research in developed and developing countries using twins to assert the effects of low birth weight net of genetic variations and with the use of administrative data, see e.g.Bharadwaj et al. (2018a,b).

of life, that are key for their future development (see Hirvonen, 2014; Heckman et al., 2013). We do so by controlling for key variables provided in the MxFLS for different pregnancies such as medic visitations, the week of the first medical appointment, an index of mother's health during gestation and at birth, and vitamins and calcium intake. Additionally, to account for changing circumstances between siblings during the early stages after birth, we control for variables such as breastfeeding status, breastfeeding duration in months, and vitamin intake during breastfeeding.

With this setting we cannot claim causality of early health on future outcomes, because siblings potentially experience very different household environments at other key developmental stages.[8] Yet, given the richness of our data regarding mother's behavior during different pregnancies, after controlling for some parental and children characteristics, and a set of family fixed co-factors, our results are much stronger than simple correlations. Furthermore, we are also able to explicitly model some of the evolving heterogeneous responses by exploring parents' monetary investments in children with different health endowments and time-allocations across time.

Our results show a significant negative association between low neonatal health, future height, and self-reported health. These effects remain up to the age 16 to 22, suggesting that some of the consequences of a bad intrauterine development are seemingly not undone by parents' behavioral responses and public interventions. Effects on education show that unhealthy newborns have fewer years of schooling when they are adults (up to one year less by age 16 to 22).

Our results also suggest that conditional on schooling years, differences in outcomes can be partially explained by more educated mothers spending 14% more on their less healthy children's education, an endowment-compensating mechanism. These results align with the international evidence for poorer settings (Torche and Echevarría, 2011; Hsin, 2012; Yi et al., 2015). On the contrary, less educated mothers invest 15% fewer economic resources. Notably, the reinforcement of health attributes is significant only from age 9 to 11 and is slightly higher for older children, so we suggest that poorer parents may take more time to understand their offspring's skills (see Dizon-Ross, 2019). Following the literature on human capital accumulation and life-skills formation (see Doyle et al., 2009), our evidence gives additional justification for in utero and early childhood public interventions in more impoverished families, and for interventions to inform parents on the detrimental effects of low health endowments.

The study proceeds as follows. Section 2 reviews the literature related to our study. Section 3 discusses the empirical strategy. Section 4 presents the details of the MxFLS as well as some descriptive statistics. Section 5 presents the main results of neonatal health measures on future health and educational outcomes. Section 6 explores parents' responses to offspring with different health endowments. Section 7 discusses the main results and draws some policy recommendations.

[8] There is also selection on family size. That is, families and mothers with two children are different in observable and unobservable ways from those with only one child which, by definition, we exclude in family-fixed effects models

2 Literature Review

The literature has extensively shown the links between parental socioeconomic status and children's health, and between offspring health and adult education, job status, income, and personality traits, suggesting that health plays a substantial role in the inter-generational transmission of economic status.[9] In general, studies for rich countries trying to disclose the effects of health endowments have focused on two measures, adult height and birth weight, showing that heavier children and taller adults, on average, have better social, cognitive, education and labor outcomes (Case et al., 2005; Almond, 2006; Black et al., 2007; Oreopoulos et al., 2008; Royer, 2009; Schultz-Nielsen et al., 2014; Bharadwaj et al., 2018b).

Studies for developing countries have focused on the effects of varying height instead of birth weight, given the lack of data following individuals from birth into adulthood. In general, the research has suggested that the inputs promoting healthy growth in childhood also foster other physical and cognitive skills that translate into better outcomes. For example, Vogl (2014) uses the MxLFS to explore the effects of height on labor income and finds 2% higher hourly earnings per centimeter of height, a premium that remains statistically and economically significant after adjustment for background characteristics, occupation, gender, and cognitive skills. However, these studies are less effective in establishing the link between early childhood and later health.[10]

A growing body of literature for less developed economies has effectively linked in utero health shocks, later health, and other adulthood outcomes using natural shocks. These have relied on the effects of famines, disease, pollution, and war during pregnancy and early childhood, also finding lasting effects on later health and school outcomes (McEniry and Palloni, 2010; Almond and Mazumder, 2011; Umana-Aponte et al., 2011; Bhalotra and Venkataramani, 2013; Almond et al., 2015; Bharadwaj et al., 2017; Shah and Steinberg, 2017).[11] Nonetheless, there are very few studies that explore which specific aspects of childhood have long-lasting effects on both height and other adult outcomes and the dynamics of family responses to low health endowments (see Almond et al., 2018). Shocks and intra-household resource allocations can interact in complex ways not clearly understood. The incidence of low early health endowments and parental responses may shed light on some key mechanisms for a correct policy design.

In this regard, Venkataramani (2012) uses the MxFLS 2002 to study the effects of early life malaria exposure in the 1950s on cognition in a sample of Mexican adults. The author suggests that for a state in the 90th percentile of the pre-intervention malaria mortality distribution, eradication led to a 0.10-0.21 Standard Deviation (SD) improvement in Raven's cognitive test scores (Raven and De Lemos, 1958).

[9] For an extensive revision of this evidence, see Currie (2009); Currie and Vogl (2013); Almond et al. (2018).

[10] See Currie and Vogl (2013) for a thorough revision of the early literature for developing countries exploiting variations in height.

[11] Similarly, Brown (2018) uses the MxFLS to explore the effects of Mexico's "war on drugs" on birth weight. After controlling for selective migration and fertility, the results suggest that early gestational exposure to violence is associated with a substantial decrease in birth weight; however, the author does not link the effects of birth weight on later children's outcomes.

Moreover, children more intensively exposed to malaria eradication entered school 0.37 years earlier, suggesting a parental endowment-reinforcement mechanism, as parents may delay school entrance for children perceived as less skilled. These results are in line with a body of literature for developed and developing countries suggesting that parents invest more in "higher quality" children (Rosenzweig and Zhang, 2009; Datar et al., 2010; Adhvaryu and Nyshadham, 2016). However, these results do not provide direct evidence of differentiated investments across siblings in Mexico, as we seek to provide in this research.

Preferences for equal outcomes among parents, and thus, compensating reactions, have also been found in varying contexts (Breining et al., 2015; Akee et al., 2018). For example, Bharadwaj et al. (2018a) use administrative birth weight data from Chile linked to academic records from first grade through to college entrance exams. The authors find effects of birth weight on first-grade results that remain significant but fade out in high school and college entrance exams. This study shows that this reduction in the effects across time comes from parents investing more time helping lower birth weight children with their homework.

Despite the mixed evidence on parent's allocations, it does seem that parents are more likely to reinforce differences in low resource settings, suggesting that not only their preferences but also financial and information constraints play a role in differentiating investments between siblings (see Torche and Echevarría, 2011). For instance, Hsin (2012) uses sibling fixed-effects models to show that college-educated mothers in the US compensate low birth weight children, while less educated mothers tend to concentrate resources (such as reading and playing) on higher birth weight babies.[12] More recently, Dizon-Ross (2019) provides similar experimental evidence for Malawi, suggesting that poorer families exacerbate early-life disadvantages while richer ones attenuate them. The study also offers evidence that more impoverished parents are less good at predicting their offspring's actual ability, making their investments less efficient.

3 Empirical Strategy

Birth weight is endogenously determined. Unobserved factors can jointly define children's prenatal and early health endowments, parental responses, and future outcomes. Low birth weight offspring are more likely to be born in poorer families, limiting the opportunities that parents and children can access across life. An alternative to disentangle the effects of uterine development is to exploit differences in neonatal measures between siblings and compare their future outcomes. The intuition is that, despite only sharing between 50 to 80% of their genes, siblings live in the same parental culture, context, and

[12]Although Yi et al. (2015) provide evidence of a compensating mechanism, through higher investments in healthcare for unhealthy Chinese twins, the authors also show a robust reinforcement mechanism in terms of educational investments, suggesting that some parents of low-performers may decide that the returns to spending on education are lower than to spending on health.

socioeconomic conditions, therefore allowing to control for a wide variety of observed and unobserved factors that remain fixed in time.[13]

Formally, a linear two-sibling relationship may be estimated:

$$Y_{ijt} = \alpha_1 Z_{jt} + \alpha_2 X_{ijt} + \beta_1 H_{ij} + \mu_{ijt} \tag{1}$$

where Y_{ijt} is child's i outcome in family j in time t=2002, 2005, 2009-2011; Z_{jt} denotes a detailed set of family j covariates such as parents' education and household's income in t; X_{ijt} is a vector of child's i in family j in time t specific controls such as gender, number of siblings and order of birth;[14] H_{ij} denotes child's i health endowment at birth, that is, low birth weight (under 2500 grams) SGA and low fetal growth. Finally, μ_{ijt} consists of all unobserved factors affecting both outcome Y_{ijt} and siblings' health at birth. In this setup μ_{ijt}, H_{ij} and Y_{ijt}, are likely to be correlated and Ordinary Least Squares (OLS) estimates of β_1 are biased. This circumstance may occur, for example, if healthy parents producing healthy children happen to be richer, have more funds for education, or if they inculcate in their offspring a greater desire for education and better health.

A partial solution is to decompose the error term into a family component and a white noise component, so that $\mu_{ijt} = f_{jt} + v_{ijt}$. In this case, f_{jt} captures observed and unobserved family j factors that are common to all siblings in years t. Under this setup, taking differences across siblings i and k and rearranging terms delivers the following model:

$$Y_{ijt} - Y_{kjt} = \alpha_1 (X_{ijt} - X_{kjt}) + \beta_1 (H_{ij} - H_{kj}) + (v_{ijt} - v_{kjt}) \tag{2}$$

Where we assume that: $\mathrm{E}(v_{ijt} - v_{kjt} \mid Y_{ijt}; Y_{kjt}; X_{ijt}; X_{kjt}; H_{ij}; H_{kj}) = 0$. When there are $n > 2$ siblings in total, Eq. (2) may be generalized for sibling i in family j as follows:

$$Y_{ijt} - \bar{Y}_{jt} = \alpha_1 (X_{ijt} - \bar{X}_{jt}) + \beta_1 (H_i - \bar{H}_j) + (v_{ijt} - \bar{v}_{jt}) \tag{3}$$

In Equation (3) the outcome depends on the sibling's i own health at birth and the sum of all siblings in the family j average health endowments at birth. Therefore, in a fixed-effect regression β_1 provides the effect of low health endowments compared to that of all siblings in family j on the outcomes of interest. Note that this estimation will be independent of $(v_{kjt} - \bar{v}_{jt})$ only if unobserved family characteristics do not change heterogeneously between siblings across time, for example, if mothers' investments between children vary during pregnancy and if there are changes in her behavior during subsequent pregnancies due to the presence of a low birth weight child. To account for some time varying differences, we include

[13] When genetics is accounted by using identical twins, results are 20 to 50% higher than those using OLS or sibling-fixed effects for the same sample (see e.g. Behrman and Rosenzweig, 2004; Black et al., 2007; Torche and Echevarría, 2011). Unfortunately, with the data at hand, it is not possible to identify identical or monozygotic twins.

[14] Outcomes and controls considered in the empirical analysis are fully explained in Section 4.

in vector X_{ijt} a set of controls aiming to account for differences in mother's behavior during pregnancy, such as weeks of pregnancy before the first medical visitation, the number of medical appointments during pregnancy, an index of mothers' health during pregnancy and at birth, a dummy for c-section, and vitamins/calcium intake. Similarly, to proxy for heterogeneous mother's behavior during the first months after birth, a key period for future children's development, we include controls on breastfeeding status, breastfeeding time in months, and vitamin intake during breastfeeding.

With this setting we cannot claim causality of early health on future outcomes, because a) we do not control for all the genetic variations involved, and b)siblings may still potentially experience very different household environments at other key developmental stages. Yet, we differentiate from the family-fixed effects literature by including a rich set of controls during pregnancy and in the postpartum period, which is key for future childhood development. After controlling for parental and children characteristics and different sets of fixed-effects, we can offer a set of results that are stronger than simple correlations.

We then explore changes across time in parental school-related expenses and time allocation between siblings and across time at ages 5 to 8, 9 to 11, 12 to 15, and 16 to 22 to offer more evidence on the dynamic changes in parental responses. [15] Finally, in some specifications, we include time and gender-by-age, gender-by-age-by-order-of-birth, gender-by-age-by-weeks-of-pregnancy, and gender-by-age-by-breastfeeding-time fixed-effects to compare differences within more similar groups of children.

4 Data and Descriptive Statistics

4.1 Mexican Family Life Survey (MxFLS)

This study uses a panel of households extracted from the 2002, 2005, and 2009-2011 MxFLS. The MxFLS is a nationally representative household survey covering over 8,400 households located in 150 communities throughout Mexico.

The survey provides information on measures of birth weight and the weeks of gestation. We compute SGA as a variable taking the value of one if the child was born at the bottom 10th percentile of birth weight, standardized by weeks of gestation and gender, and zero otherwise. We also define a dichotomous variable for low birth weight children, depicting those newborns whose birth weight was below 2500 grams. Low fetal growth is a dummy taking the value of one if the child is in the 10th percentile of fetal growth per week (this is, birth weight over birth length in weeks).

All birth weight measures come from questionnaires applied to mothers providing this information for their last two pregnancies. Additionally, the MxFLS includes a battery of questions on pregnancy and post-postpartum health, including the week of gestation when the mother visited a medic for the

[15] These groups of age are chosen to represent key moments in children's development while starting school, during teenage years and as young adults, while keeping the balance of observations across groups evenly distributed: that is, 28%, 23%, 25% and 24% of all observations, respectively.

first time, the number of medic consultations during pregnancy, and if they consumed vitamins, iron, or calcium. We also construct two indexes of mother's health, one during pregnancy including 12 variables and another including information on mother's and child's health at birth, and information on breastfeeding, including its frequency and duration in months, and if the mother took vitamins and calcium while breastfeeding. [16]

The survey also includes information on family characteristics such as parents' years of education, household income, and the number of children per household, including their age and sex. It also includes a set of Raven's IQ tests. These test children's and adults' cognitive skills that, in theory, are independent of schooling (Raven and De Lemos, 1958).[17]

We also have detailed information on sons and daughters between ages 5 to 15 in 2002, followed in the next rounds. The data set provides their characteristics on current and past schooling, for which we can compute the age at which they started school if the children have repeated a grade at least once in their current or any previous educational level (primary, secondary or post-secondary) and if they are currently attending school. We use additional information on school expenses to study parents' investments meant to compensate or reinforce differences in their offspring's early health. Specifically, the MxFLS includes information related to expenses in books, tuition fees, uniforms, and private tutoring per child during the last academic year. It also reports on the number of hours per week that parents spend helping their children with school-related tasks.

We use the information on contemporary offspring's health coming from five self-assessed categories going from "bad" to "very good", reported by parents, to construct a binary variable denoting children's "good" and "very good" health. We also compute children's standardized height-by-age and sex as a measure of current health endowments.

One limitation of the MxFLS is that the three waves were conducted over a relatively short period, and thus it is not possible to follow individuals from birth until adulthood. Consequently, we pool our data and use a set of categorical variables to denote effects across different groups of ages 5 to 8, 8 to 11, 12 to 15, and 16 to 22 years, aiming to depict various stages of development while maintaining a balance in the number of observations among these groups. Another shortcoming of the data is that the study relies on retrospective questions of birth health; however, we provide visual evidence of high variance in birth weight and the differences between siblings, offering support to the quality and precision of the mother's responses.

Finally, it is not possible to know the characteristics of the households when the children were born, since this information is only contemporary available. It is thus impossible to control for the effects of

[16]The first index includes information on vaginal bleeding and urine or vaginal infections, swelling skin, high blood pressure, eye infections, frequent headaches, levels of in-blood sugar, kidney infection, abnormal flow, abortion threats, as well as premature contractions. The second index includes mothers' high or low blood pressure; if the child was in an incorrect position; if the umbilical cord was around the neck; and if there was another unspecified complication during labor

[17]IQ is standardized by age and sex with a mean of zero and an SD of one.

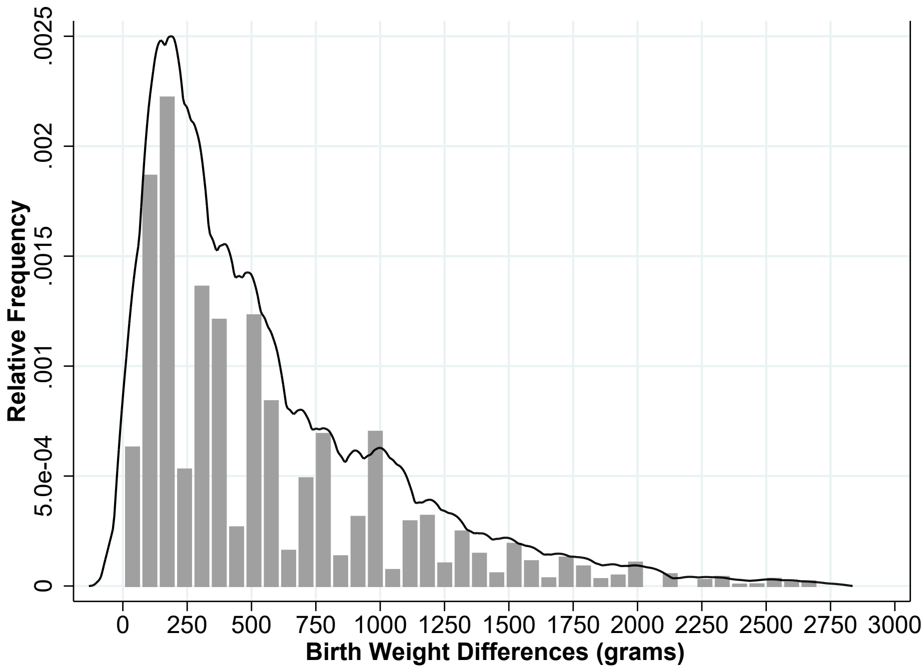
socioeconomic status during early years on offspring's development, which may bias our coefficients (for example, if parents were considerably poorer when their less healthy child was born, our estimates would be upward biased). However, the average age difference between brothers and sisters in our sample is of only 2.6 years; therefore, it is reasonable to assume that the socioeconomic conditions did not vary substantially when each sibling was born.

4.2 Sample and Descriptive Statistics

The sample used includes all siblings between 5 and 22 years, as all our outcomes are measured from age 5, including IQ, weight, height, and school outcomes.

Figure 1 shows the frequency distribution of differences in birth weight among same-sex siblings and shows substantial variation between offspring. Specifically, the average weight difference within pairs of same-sex siblings is 565 grams (SD of 528 grams), and half of the pairs have differences of up to 400 grams. Contextualizing these numbers, Torche and Echevarría (2011) show that a 400 grams increase in birth weight among Chilean twins is associated with a gain of 0.15 SD in standardized tests of mathematics.

Figure 1: Differences in Birth Weight Between the Youngest Pair of Siblings with the Same Gender



Source: Authors' own elaboration based on data from the MxFLS 2002.

Panels A and B in Table 1 show the main descriptive statistics of family context and children's covariates. Descriptive statistics of school outcomes and birth measures are presented in panels C and D, while Panel E presents information on mothers' habits and health during pregnancy and postpartum. Columns 1 to 3 present this information for children whose mothers are below the median of education (this is less than nine years), and Columns 4 to 6 do it for mothers above the median. Column 7 depicts differences between the two groups of children and their significance at conventional levels.

Table 1: Main Descriptive Statistics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Below Median			Above Median			
	N	Mean	SD	N	Mean	SD	Diff.
A. Family Context							
Log of Income	4321	10.24	0.99	4239	10.64	0.96	-0.40***
Number of Siblings	4321	2.21	1.47	4239	1.75	1.00	0.46***
B. Individual Characteristics							
Girl	4321	0.50	0.50	4239	0.49	0.50	0.01
Age	4321	12.69	5.63	4239	12.05	5.18	0.65***
Standardized IQ	3614	0.09	0.97	3619	0.25	0.98	-0.16***
Standardized Height	3645	0.02	1.01	3571	0.21	0.97	-0.19***
Bad/Very Bad Health	3935	0.26	0.44	3927	0.18	0.38	0.08***
C. School Variables							
School Starting Age	3320	5.74	0.99	3316	5.58	0.97	0.15***
Repeated Grade	4321	0.13	0.34	4239	0.08	0.27	0.05***
Years of Schooling	3617	6.75	3.38	3453	6.64	3.45	0.11
Currently Attending School	4240	0.73	0.44	4171	0.86	0.35	-0.13***
Log of School Expenses	3314	6.84	0.94	3579	7.26	0.97	-0.42***
Hours Studying w/Parents	4321	0.40	2.20	4239	0.35	1.93	0.05
D. Measures at Birth							
Birth Weight Kg.	4321	3.32	0.68	4239	3.32	0.61	-0.00
Birth Length	3453	39.69	1.41	3311	39.60	1.54	0.09**
Small-for-gestational-age	4321	0.12	0.33	4239	0.10	0.29	0.03***
Under 2500 grams	4321	0.11	0.31	4239	0.09	0.28	0.02***
Low fetal growth	4321	0.12	0.33	4239	0.09	0.29	0.03***
E. Pregnancy and Postpartum							
# of Medical Examinations	4321	7.06	3.17	4239	7.97	3.59	-0.91***
Took Vitamins	4321	0.74	0.44	4239	0.76	0.43	-0.03***
Took Calcium	4321	0.65	0.48	4239	0.74	0.44	-0.08***
Breast-feed	4321	0.90	0.30	4239	0.89	0.32	0.01*
Took Vitamins Breast-feeding	4321	0.03	0.18	4239	0.04	0.19	-0.00
Months Breast-feeding	4321	6.37	7.51	4239	5.65	6.78	0.72***
Mother's Pregnancy Health Index (SD)	4321	-0.03	0.97	4239	-0.06	0.93	0.03
Mother's Birth Health Index (SD)	3350	-0.07	0.85	3243	-0.03	0.94	-0.04*
C-section	3453	0.25	0.43	3311	0.31	0.46	-0.06***

*, **, *** Significant at the 10%, 5%, and 1% levels, respectively.
Notes: Columns (1) to (3) show statistics for children whose mothers are above the median of education. Columns (4) to (6) show the same for children whose mothers are below the median of education.

Descriptive statistics show significant differences in almost all variables. Children with less educated mothers live in poorer households, have more siblings (2.21 vs. 1.75), present a lower IQ (-0.16 SD), are shorter (-0.19 SD), and a higher proportion of them have bad or very bad health (26% vs 18%). While, in our sample, they have slightly more schooling years on average, they are also older. Moreover, poorer children start school when they are older (0.15 years), a lower proportion is currently enrolled in school (73% vs. 86%), and their parents devote fewer resources to school-related expenses. Low birth weight, low fetal growth, and SGA incidence are 2%-3% higher among these children. Finally, in poorer settings, mothers attend 0.9 fewer medical examinations, and a lower proportion of them take vitamins and calcium. Interestingly, less educated mothers breastfeed for more time (0.72 months), possibly, because more educated mothers have a higher opportunity cost of breastfeeding.

5 Neonatal Health, Future Health and Education Outcomes

Table 2 displays the average results relating to neonatal measures and later health outcomes. Column 1 shows OLS estimations, including the set of controls described in Table 1. Column 2 includes family and year fixed-effects. Column 3 includes gender-by-age fixed effects. Columns 4 to 6 add fixed-effects by order-of-birth, birth length, and breastfeeding duration in months. [18]

Panels A,B and C, denote the results for our three health outcomes: Standardized Height, Health Status, and Standardized IQ, respectively. All OLS specifications and sibling fixed-effects models were estimated using robust standard errors clustered at the household level.

Results in Column 1 show a negative and significant relationship between early health and future height and IQ. They also suggest a positive influence on the probability of reporting children's health as bad or very bad at any age between 5 and 22 years old.[19] Notably, these effects remain robust and significant for all of our neonatal measures regressed on future height, once we include different sets of fixed-effects. For example, our preferred specification in Column 6 shows an average negative effect of SGA-children 0.15 SD on standardized height. The effects of low birth weight on the probability of reporting the child's health as bad or very bad remain robust across all specifications denoting an average increase of 8.2 percentage points in our preferred specification. The effects on IQ are not identified at conventional levels once fixed-effects are considered; however, all the estimations show a negative association between bad neonatal health and IQ.

[18]Research has shown that first-born children tend to outperform their younger siblings on measures such as cognitive exams, wages, educational attainment, and employment (see e.g. Pavan, 2016). For a revision on the long-term effects on health and schooling of breastfeeding status and duration, see Horta et al. (2007).

[19]The upper bias in the OLS results fits with the description of a positive correlation between socioeconomic unobserved household/family factors and neonatal health

Table 2: Effects of Neonatal Health on Children's Height, Reported Health and IQ

	(1)	(2)	(3)	(4)	(5)	(6)
A. Standardized Height						
Low birth weight	-0.359***	-0.155**	-0.152**	-0.149**	-0.158**	-0.133**
	(0.041)	(0.066)	(0.066)	(0.067)	(0.067)	(0.066)
Obs.	5680	6040	6040	6040	5321	5361
Low fetal growth	-0.391***	-0.182***	-0.180***	-0.185***	-0.189***	-0.166***
	(0.037)	(0.060)	(0.060)	(0.061)	(0.062)	(0.061)
Obs.	5680	6040	6040	6040	5321	5361
Small-for-gestational-age	-0.383***	-0.159***	-0.157***	-0.172***	-0.147**	-0.150**
	(0.036)	(0.058)	(0.058)	(0.059)	(0.059)	(0.058)
Obs.	5680	6040	6040	6040	5321	5361
B. Bad or Very Bad Health (=1)						
Low birth weight	0.050***	0.083**	0.085**	0.077*	0.083**	0.082**
	(0.019)	(0.040)	(0.040)	(0.041)	(0.041)	(0.040)
Obs.	6199	6589	6589	6589	5933	5968
Low fetal growth	0.058***	0.042	0.044	0.037	0.036	0.040
	(0.018)	(0.037)	(0.037)	(0.038)	(0.038)	(0.037)
Obs.	6199	6589	6589	6589	5933	5968
Small-for-gestational-age	0.051***	0.046	0.046	0.041	0.049	0.044
	(0.017)	(0.035)	(0.035)	(0.036)	(0.036)	(0.036)
Obs.	6199	6589	6589	6589	5933	5968
C. Standardized IQ						
Low birth weight	-0.148***	-0.073	-0.077	-0.081	-0.088	-0.082
	(0.040)	(0.075)	(0.075)	(0.076)	(0.077)	(0.075)
Obs.	5938	6320	6320	6320	5615	5644
Low fetal growth	-0.134***	-0.051	-0.055	-0.052	-0.071	-0.065
	(0.036)	(0.070)	(0.070)	(0.071)	(0.072)	(0.070)
Obs.	5938	6320	6320	6320	5615	5644
Small-for-gestational-age	-0.119***	-0.078	-0.082	-0.062	-0.073	-0.088
	(0.036)	(0.067)	(0.067)	(0.068)	(0.068)	(0.067)
Obs.	5938	6320	6320	6320	5615	5644
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Family and year fixed-effects	No	Yes	Yes	Yes	Yes	Yes
Gender-by-age fixed-effects	No	No	Yes	Yes	Yes	Yes
Gender-by-age-by-order-of-birth f.e.	No	No	No	Yes	No	No
Gender-by-age-by-birth-length f.e.	No	No	No	No	Yes	No
Gender-by-age-by-breast-feeding-time	No	No	No	No	No	Yes

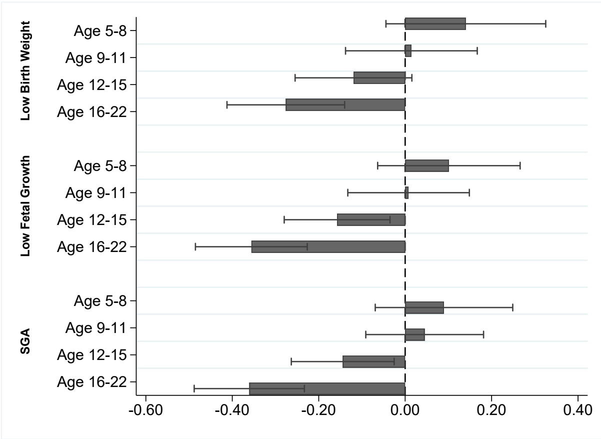
*, **, *** Significant at the 10%, 5%, and 1% levels, respectively.
Notes: Each column in each panel represents a different regression. Robust standard errors, clustered on households, in parenthesis. Other controls included are household's logarithm of income, number of siblings, child's age, sex, and school starting age, a set of dummies denoting the order of birth, a set of dummies denoting birth length in weeks, number of medical examinations during pregnancy, mothers' vitamin and calcium intake, breastfeeding status and duration in months, vitamin intake during breastfeeding, an index of mother's health during pregnancy, an index of mothers health when giving birth, and a dummy denoting cesarean section.

To explore the relationship between early health and later outcomes across different ages, Figure 2 shows the results of our preferred specification in Column 6 when interacting each of our neonatal measures with an indicator variable for groups of age: 5 to 8, 9 to 11, 12 to 15 and 16 to 22 years old. Regardless of the neonatal measure, results for height in Panel (a) show that less healthy newborns are not shorter when children are younger (ages 5 to 8 and 9 to 11). However, lighter and smaller newborns start to differentiate when they grow older. For example, our SGA indicator shows that by age 16 to 22, these children will be around 0.35 SD shorter than their non-SGA peers. Low birth weight seems to relate to a higher probability of reporting bad health from age 9 to 11. Finally, the effects on IQ are not clearly identified for any group of age, but a possible negative effect might appear across time.

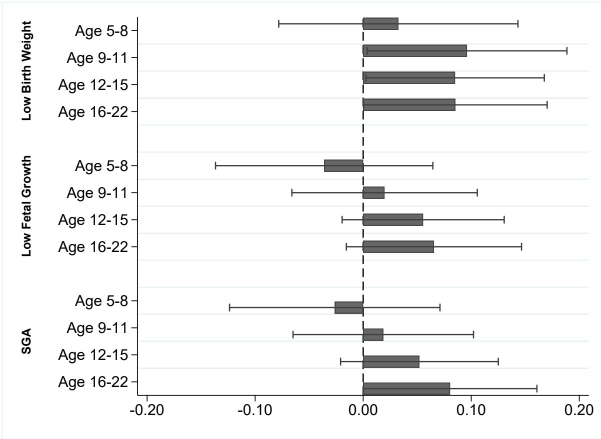
Overall, results regarding uterine development on later health outcomes imply that children born with better health endowments would be taller and healthier, on average, independent of family, some genetics, and context characteristics. As previous evidence suggests, health endowments in adulthood may translate into other socioeconomic and academic results. For example, a back-of-the-envelope computation using the results in Vogl (2014) for the Mexican labor market, at the age of 22, the monthly earnings of an SGE individual (average height of 158 cm in our sample, SD of 9 cm), compared to a non-SGE individual (roughly 0.35 SD taller, or about 162 cm tall), would be around 8% lower.

Figure 2: Effects of neonatal health on future health and IQ by children's age.

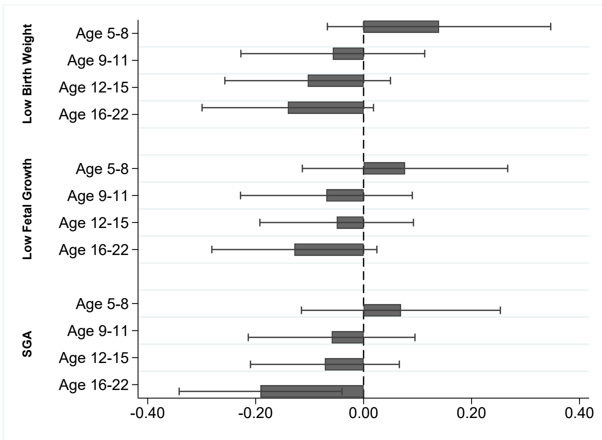
(a) Height



(b) Bad Health



(c) IQ



Notes: Each group of coefficients, for each neonatal health measure, comes from a different regression. These are computed as in our preferred specification in column 6 of Table 2, plus a set of variables interacting the neonatal measure of interest with a dummy denoting each group of age. Robust 95% confidence intervals, clustered at the household level, are depicted by the horizontal lines.

Bad neonatal health can affect both future health and the returns to human capital investments. In this regard, Table 3 shows the results of the same set of regressions in Table 2 for education outcomes. Panels A, B, and C show the average results of our neonatal measures on years of schooling, if the child is attending school, and grade repetition. Once we introduce different sets of fixed-effects the results are not clearly identified. The signs of the coefficients are also not consistent across neonatal measures.

Table 3: Effects of Neonatal Health on Children's Years of Schooling, Attendance and Grade Repetition.

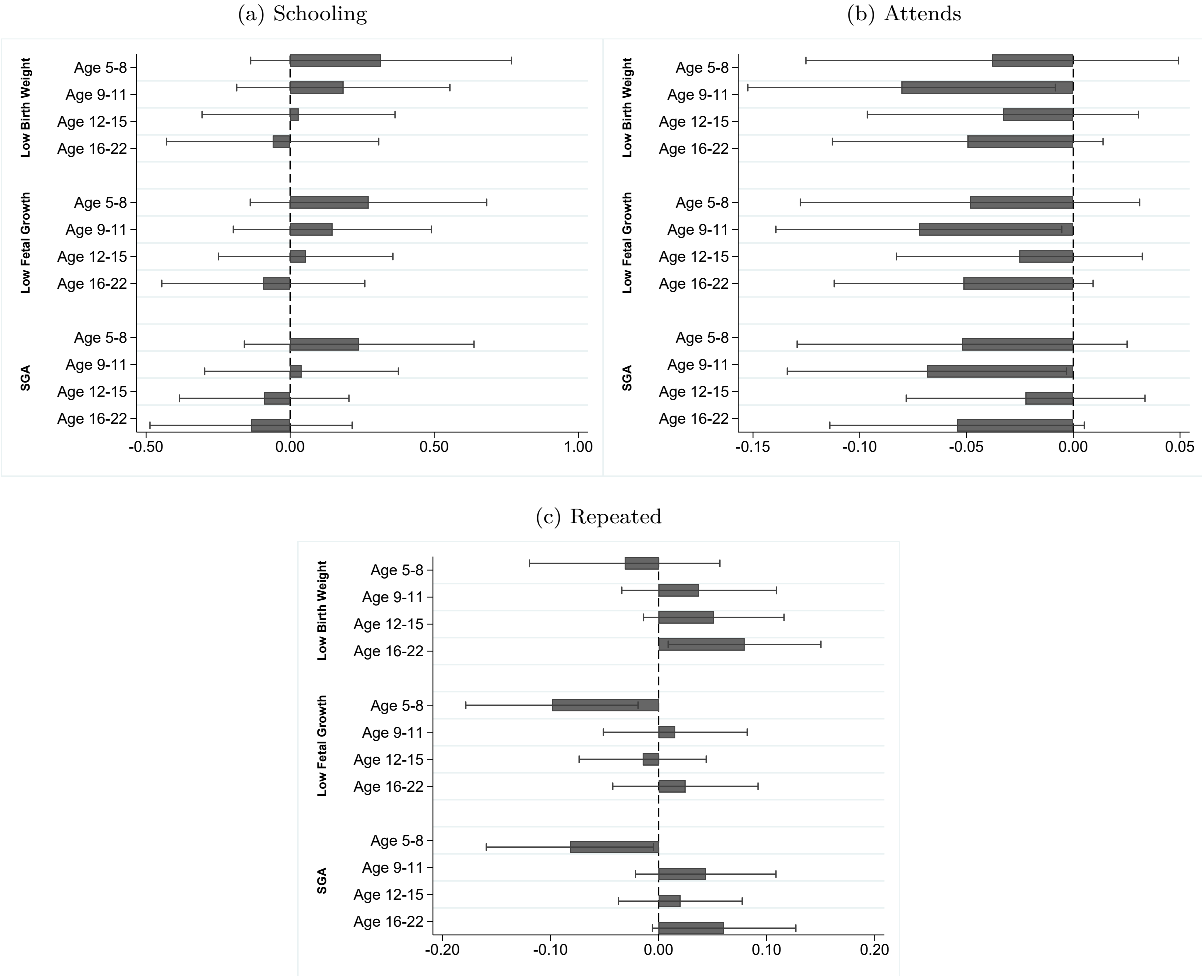
	(1)	(2)	(3)	(4)	(5)	(6)
A. Schooling (years)						
Low birth weight	-0.163**	-0.009	0.001	-0.026	-0.031	0.023
	(0.074)	(0.153)	(0.154)	(0.156)	(0.158)	(0.155)
Obs.	5768	6134	6134	6134	5427	5468
Low fetal growth	-0.165**	0.037	0.039	0.020	0.026	0.028
	(0.068)	(0.141)	(0.141)	(0.142)	(0.145)	(0.142)
Obs.	5768	6134	6134	6134	5427	5468
Small-for-gestational-age	-0.147**	-0.013	-0.014	-0.021	-0.027	-0.034
	(0.066)	(0.136)	(0.136)	(0.137)	(0.139)	(0.137)
Obs.	5768	6134	6134	6134	5427	5468
B. Attends (=1)						
Low birth weight	-0.011	-0.040	-0.043	-0.043	-0.045	-0.042
	(0.014)	(0.029)	(0.029)	(0.030)	(0.030)	(0.029)
Obs.	6440	6852	6852	6852	6245	6280
Low fetal growth	-0.012	-0.030	-0.033	-0.032	-0.033	-0.033
	(0.013)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
Obs.	6440	6852	6852	6852	6245	6280
Small-for-gestational-age	-0.010	-0.035	-0.036	-0.033	-0.037	-0.037
	(0.013)	(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
Obs.	6440	6852	6852	6852	6245	6280
C. Repeated grade (=1)						
Low birth weight	0.081***	0.023	0.027	0.022	0.020	0.026
	(0.017)	(0.030)	(0.030)	(0.031)	(0.031)	(0.030)
Obs.	5740	6092	6092	6092	5334	5368
Low fetal growth	0.077***	-0.027	-0.023	-0.023	-0.031	-0.023
	(0.016)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
Obs.	5740	6092	6092	6092	5334	5368
Small-for-gestational-age	0.075***	-0.002	0.002	-0.003	-0.010	0.005
	(0.015)	(0.026)	(0.026)	(0.027)	(0.027)	(0.026)
Obs.	5740	6092	6092	6092	5334	5368
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Family and year fixed-effects	No	Yes	Yes	Yes	Yes	Yes
Gender-by-age fixed-effects	No	No	Yes	Yes	Yes	Yes
Gender-by-age-by-order-of-birth f.e.	No	No	No	Yes	No	No
Gender-by-age-by-birth-length f.e.	No	No	No	No	Yes	No
Gender-by-age-by-breast-feeding-time	No	No	No	No	No	Yes

*, **, *** Significant at the 10%, 5%, and 1% levels, respectively.
Notes: Each column in each panel represents a different regression. Robust standard errors, clustered on households, in parenthesis. Other controls included are household's logarithm of income, number of siblings, child's age, sex, and school starting age, a set of dummies denoting the order of birth, a set of dummies denoting birth length in weeks, number of medical examinations during pregnancy, mothers' vitamin and calcium intake, breastfeeding status and duration in months, vitamin intake during breastfeeding, an index of mother's health during pregnancy, an index of mothers health when giving birth, and a dummy denoting cesarean section.

Given the nonlinear relationship between school outcomes and age, early health effects could be better identified across different ages. In this regard, Figure 3 shows the effects on education outcomes by groups of age. The results show that negative but not well-identified effects on attendance persist across all ages. While generally non-significant, the results also suggest a heterogeneous pattern for schooling and grade repetition. After controlling for starting school age, younger unhealthy children seem to have spent more time at school than their healthier siblings; however, this reverses across time. Results on grade repetition show a similar pattern.

Our non-significant results could indicate that, on average, Mexican parents can compensate school outcomes between siblings, in comparison to health outcomes. In this case, variables related to parents' characteristics, fixed in our specifications, could interact with children's endowments, educational investments, and outcomes in a more determinant way than those observed for future health. Indeed, evidence has shown that educational outcomes represent a series of heterogeneous parental investments in the form of time and money during childhood, as well as parenting styles and a series of transitions in a given educational system (see, e.g. Cunha and Heckman, 2007). In other words, parents' compensation or reinforcing actions could explain the absence of sharp effects on school outcomes. To analyze heterogeneous parental responses, in the following subsection, we explore the effects on school outcomes, conditional on mother education, which so far has remained fixed, and by groups of age.

Figure 3: Effects of neonatal health on future school outcomes by children's age.



Notes: Each group of coefficients, for each neonatal health measure, comes from a different regression. These are computed as in our preferred specification in column 6 of Table 2, plus a set of variables interacting the neonatal measure of interest with a dummy denoting each group of age. Robust 95% confidence intervals, clustered at the household level, are depicted by the horizontal lines.

5.1 Heterogeneous Effects by Mother's Education.

Table 4 displays in Columns 1, 3, and 5, the average effects on school outcomes for children whose mothers are below or above the median of education (that is 7 years of schooling) and, in columns 2, 4, and 6, the difference between the two groups of mothers. Panels A, B, and C show the effects for our key neonatal measures, respectively. Results show that conditional on mothers' education, controlling for school starting age, and regardless of the neonatal measure, there are no significant and consistent differences between more and less healthy children on attendance and grade repetition. Nonetheless, in families where mothers are more educated, less healthy children have more years of schooling on average. These effects are significant for low fetal growth and SGA children. For example, SGA children with a low educated mother would have 0.67 fewer years of education on average.

Specific estimations of our neonatal health measures on years of schooling, by groups of age, are depicted in Figure 4. The point estimators suggest that older children mainly drive the average effect. For example, controlling for school starting age, SGA children aged 15 and older and with low educated mothers, show a significant reduction in their schooling (close to one year by age 16 to 22), at the same time, SGA children with more educated mothers show higher levels of schooling respect to non-SGA children. Therefore, there seems to be a dynamic process of disadvantages from birth, seemingly undone in more affluent settings but reinforced by poorer parents. These different responses would widen the gap between advantaged and disadvantaged children.

The question at hand is if neonatal health affects parents' investments contingent on varying socio-economic contexts. We explore this in the following subsection.

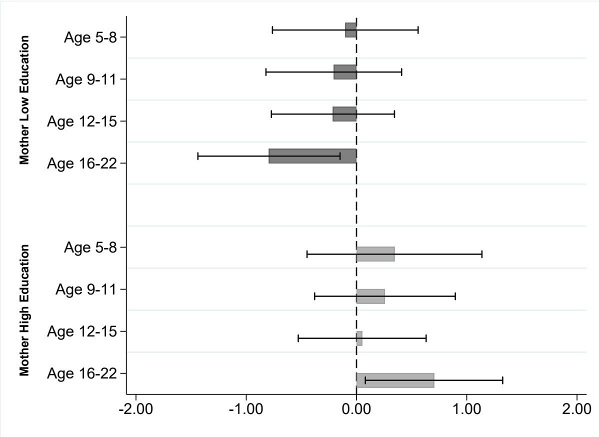
Table 4: Effects of Neonatal Health on School Outcomes by Mothers' Education.

	(1)	(2)	(3)	(4)	(5)	(6)
	Schooling		Attends (=1)		Repetition (=1)	
A. Low Birth Weight						
Mother High Education(average)	0.266		-0.058		0.068*	
	(0.226)		(0.040)		(0.039)	
Mother Low Education (average)	-0.056		-0.018		0.030	
	(0.221)		(0.039)		(0.039)	
Mother Low Education (difference)		-0.322		0.040		-0.039
		(0.305)		(0.054)		(0.053)
Obs.	4398	4398	5017	5017	4337	4337
B. Low Fetal Growth						
Mother High Education (average)	0.502**		-0.027		-0.020	
	(0.225)		(0.040)		(0.039)	
Mother Low Education (average)	-0.226		-0.030		0.023	
	(0.216)		(0.039)		(0.038)	
Mother Low Education (difference)		-0.728**		-0.003		0.043
		(0.298)		(0.053)		(0.052)
Obs.	4398	4398	5017	5017	4337	4337
C. Small-for-Gestational-Age						
Mother High Education (average)	0.385*		-0.032		-0.019	
	(0.216)		(0.039)		(0.038)	
Mother Low Education (average)	-0.283		-0.028		0.054	
	(0.214)		(0.038)		(0.037)	
Mother Low Education (difference)		-0.669**		0.004		0.073
		(0.291)		(0.052)		(0.051)
Obs.	4398	4398	5017	5017	4337	4337
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes
Family and year fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes
Gender-by-age-by-breast-feeding-time	Yes	Yes	Yes	Yes	Yes	Yes

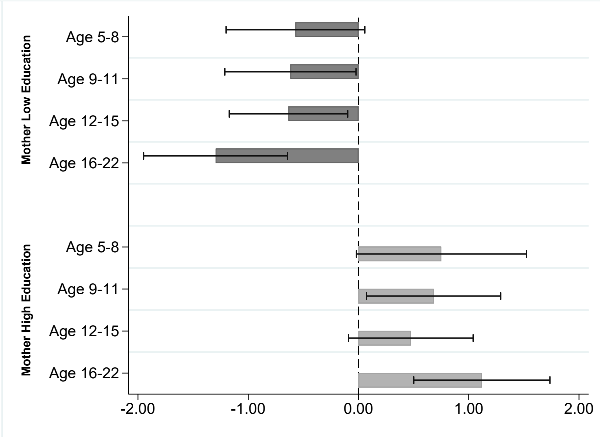
, **, * Significant at the 10%, 5%, and 1% levels, respectively.
Notes: Each column in each panel represents a different regression. Robust standard errors, clustered on households, in parenthesis. Other controls included are household's logarithm of income, number of siblings, child's age, sex, and school starting age, a set of dummies denoting the order of birth, a set of dummies denoting birth length in weeks, number of medical examinations during pregnancy, mothers' vitamin and calcium intake, breastfeeding status, and duration in months, vitamin intake during breastfeeding, an index of mother's health during pregnancy, an index of mothers health when giving birth, and a dummy denoting cesarean section.

Figure 4: Effects of Neonatal Health on Years of Schooling by Child's Age and Mother's Education.

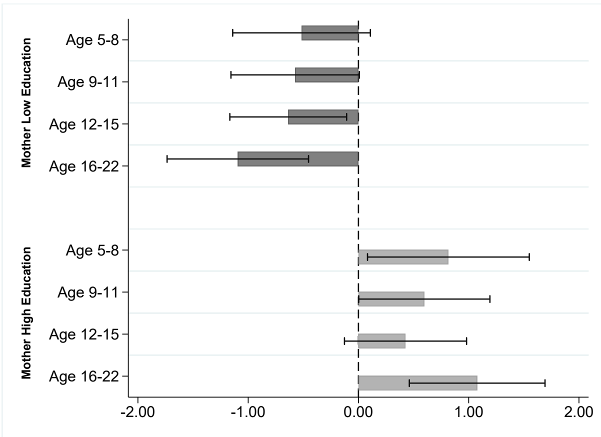
(a) Low Birth Weight



(b) Low Fetal Growth



(c) Small-for-Gestational-Age



Notes: Each group of coefficients, for each neonatal health measure, comes from a different regression. These are computed as in our preferred specification in column 6 of Table 2, adding a triple interaction between the neonatal measure of interest, a dummy denoting each group of age, and a dummy variable denoting mothers' education (above or below the median). Robust 95% confidence intervals, clustered at the household level, are depicted by the horizontal lines.

6 Parents' Compensations Among Siblings

Column (1) in Table 5 shows the average results of our preferred specification plus years-of-schooling fixed-effects, where we regress school-year log-expenses (for example, in books, tuition fees, uniforms, and private tutoring) on our neonatal health indicators, interacted with mothers education. Column (2) shows the difference between children with more and less educated mothers. Columns (3) and (4) denote the average effect and the difference in the hours parents spend per week helping their children with school tasks. We argue that school expenses and time allocations among siblings with different health endowments reflect parental preferences for equity, conditional on their budget constraints.

Estimations do not show well-identified effects for time allocations but suggest significant differences in expenditures among siblings with low fetal growth and SGA children. For example, more educated mothers invest 14% more resources in SGA offspring than in non-SGA, while less educated mothers invest 15% fewer economic resources. A significant difference between more and less educated mothers of 29%. As presented before, SGA and low fetal growth were also more clearly related to children's years of schooling. The evidence on expenses suggests a reinforcement pattern among less-educated mothers and a compensating action among more educated ones. This is consistent with the latest evidence for poorer countries (see Dizon-Ross, 2019).

Finally, it is worth mentioning that in the case of schooling outcomes and parent's investments in education, weight-by-birth-length measures such as low fetal growth and SGA have a more defined explanatory effect than low birth weight. These results align with the evidence suggesting that birth weight is a short-term indicator mainly reflecting the uterine environment in the last trimester, with a higher predictive power on future height and body mass index (BMI), and that, measures including birth length are stronger predictors of child growth and cognition (Conti et al., 2020).

Table 5: Effects of Neonatal Health on School Expenses and Parent's time allocations

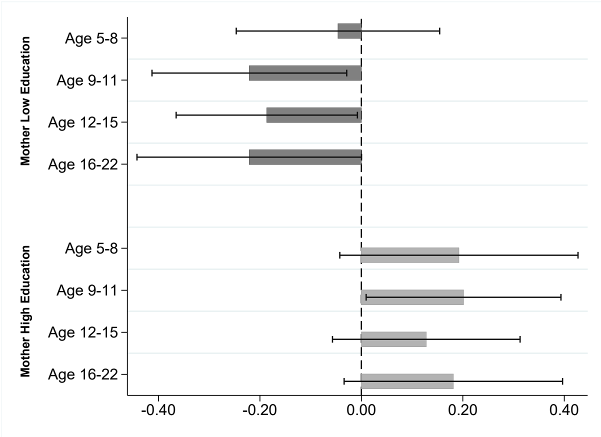
	(1)	(2)	(3)	(4)
	Expenses		Time (hrs/week)	
A. Low Birth Weight				
Mother High Education(average)	0.008		0.456**	
	(0.071)		(0.198)	
Mother Low Education (average)	-0.102		0.031	
	(0.076)		(0.197)	
Mother Low Education (difference)		-0.110		-0.426
		(0.098)		(0.269)
R-sq.	0.903	0.903	0.790	0.790
Obs.	3,601	3,601	4,147	4,147
B. Low Fetal Growth				
Mother High Education (average)	0.129*		0.228	
	(0.069)		(0.196)	
Mother Low Education (average)	-0.150**		-0.132	
	(0.071)		(0.195)	
Mother Low Education (difference)		-0.279***		-0.360
		(0.092)		(0.262)
R-sq.	0.903	0.903	0.790	0.790
Obs.	3,601	3,601	4,147	4,147
C. Small-for-Gestational-Age				
Mother High Education (average)	0.143**		0.024	
	(0.066)		(0.189)	
Mother Low Education (average)	-0.153**		-0.139	
	(0.071)		(0.193)	
Mother Low Education (difference)		-0.296***		-0.163
		(0.090)		(0.255)
R-sq.	0.903	0.903	0.790	0.790
Obs.	3,601	3,601	4,147	4,147
Other Controls	Yes	Yes	Yes	Yes
Family and year fixed-effects	Yes	Yes	Yes	Yes
Years-of-schooling fixed-effects	Yes	Yes	Yes	Yes
Gender-by-age-by-breast-feeding-time	Yes	Yes	Yes	Yes

, **, * Significant at the 10%, 5%, and 1% levels, respectively.
Notes: Each column in each panel represents a different regression. Robust standard errors, clustered on households, in parenthesis. Other controls included are household's logarithm of income, number of siblings, child's age, sex, and school starting age, a set of dummies denoting the order of birth, a set of dummies denoting birth length in weeks, number of medical examinations during pregnancy, mothers' vitamin and calcium intake, breastfeeding status, and duration in months, vitamin intake during breastfeeding, an index of mother's health during pregnancy, an index of mothers health when giving birth, and a dummy denoting cesarean section.

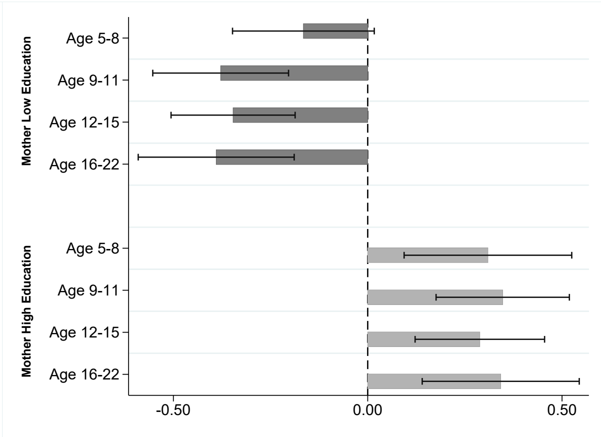
Lastly, we explore the dynamics of parents' responses among their offspring. Figure 5 shows the effects of low-neonatal health on related school expenses for our different groups of ages. After adding years-of-schooling fixed-effects, our results show that less-educated parents do not seem to invest less in their children with low health endowments when they are younger; however, marked differences appear by the age 9-11 onward, plausibly when parents have more information on their children's skills. Contrarily, more educated parents invest more in their less healthy offspring regardless of age. Similarly, time allocations seem to show this same pattern for low birth weight and low fetal growth children, but the effects are not statistically significant at conventional levels.

Figure 5: Effects of Neonatal health on Expenses by Child's Age and Mother's Education

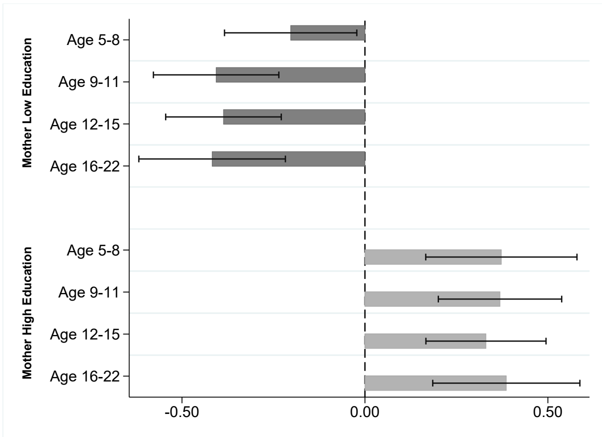
(a) Low Birth Weight



(b) Low Fetal Growth



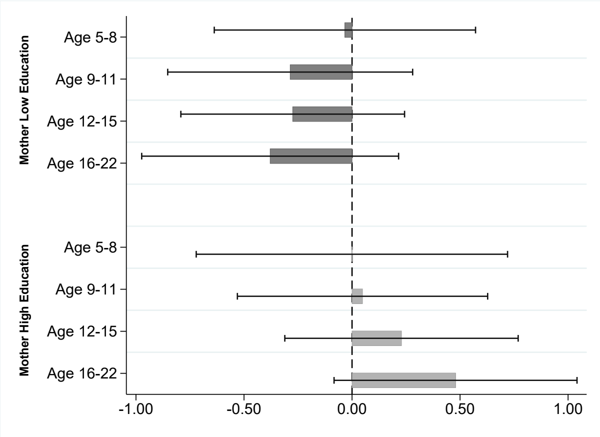
(c) Small-for-Gestational-Age



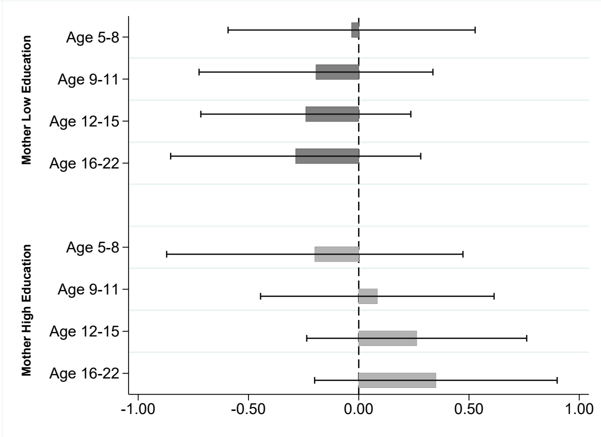
Notes: Each group of coefficients, for each neonatal health measure, comes from a different regression. These are computed as in our preferred specification in column 6 of Table 2, adding a triple interaction between our neonatal measure of interest, a dummy denoting each group of age, and a dummy variable denoting mothers' education (above or below the median). Robust 95% confidence intervals, clustered at the household level, are depicted by the horizontal lines.

Figure 6: Heterogenous effects on Time Allocations by Child's Age and Mother's Education

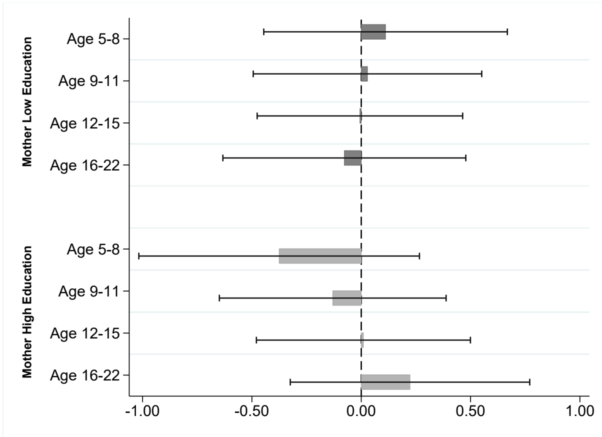
(a) Low Birth Weight



(b) Low Fetal Growth



(c) Small-for-Gestational-Age



Notes: Each group of coefficients, for each neonatal health measure, comes from a different regression. These are computed as in our preferred specification in column 6 of Table 2, adding a triple interaction between our neonatal measure of interest, a dummy denoting each group of age, and a dummy variable denoting mothers' education (above or below the median). Robust 95% confidence intervals, clustered at the household level, are depicted by the horizontal lines.

7 Discussion of results

This study examined the relationship between low birth weight, low fetal growth, small-for-gestational-age, and children's future health, cognition and education outcomes. Using data from three rounds of the MxFLS, we studied children aged 5 to 22 to have a clearer picture of how these effects occur across time. In addition, we analyzed variations in parental monetary and time investments to explore their reactions to compensate or reinforce differences in their offspring's endowments.

Our main results show a significant negative effect of bad neonatal health endowments on future height and health and, once mothers' education separates the effects, we also report a negative effect on more impoverished children's years of schooling. These findings are relevant for the developing world, where uterine development restrictions are still common. For example, in Mexico, the poorer states in the country's south are still up to three percentage points above the official low birth weight target of 7%.

The lasting effects of low neonatal health on children's future height, partially independent of genetics and socio-economic status in their teenage years, relate to one of the most consistent findings in the social sciences, the positive association between height and individuals' social status (Steckel, 2009; Case and Paxson, 2010; Vogl, 2014). Evidence has shown that adult's height may not only reflect a lower health status that translates into lower productivity, it may also relate to their self- and social-esteem that have an effect on both their objective and subjective performance (i.e., how they are conceived and evaluated) (Heineck, 2005; Judge and Cable, 2004). Moreover, research has also documented a relationship between height and cognitive and non-cognitive skills (see e.g. Lundborg et al., 2014). Our back-of-the-envelope computation suggests that by age 22, the estimated association between low neonatal health and height would translate into roughly 8% lower monthly wages.

The findings also suggest that our measures on low fetal growth and SGA children have an average negative effect on years of schooling, specifically in children born in poorer households. This disadvantage does not seem to arise early in life but when children are 12 to 15 years and older. These results relate to the recent evidence in Conti et al. (2020) denoting that uterine development rather than birth weight alone is more related to cognitive development, and possibly cognitive skills are more demanded in higher levels of education, making individuals with bad neonatal health reach lower levels of education.

The evidence we provide on poorer parents possibly reinforcing early health endowments by investing up to 29% fewer economic resources in their less healthy offspring (compared with richer parents) directly relates to the differences in schooling we document. These results also remain in line with other findings in developing countries, suggesting that lower parents allocations sum to the systemic restrictions that many children in less advantaged settings face (see e.g. Hsin, 2012; Yi et al., 2015; Dizon-Ross, 2019). Furthermore, our evidence for more-educated parents denoting a compensating mechanism and a higher preference for equity signifies that parental responses increase differences between siblings and overall inequality in the outcomes between poorer and wealthier children.

Another relevant finding we present, informing on the dynamics of capital accumulation and parental responses across life, is that less-educated Mexican parents do not seem to react to their children's early health endowments immediately. This aligns with the evidence suggesting that in poorer settings, parents are less effective predicting their true offspring's ability (see e.g. Dizon-Ross, 2019). Suggestively, they start reinforcing once they have more evidence about their children's skills.

Our results broadly support interventions aiming to improve uterine development and foster children's health from the first moments in life, especially in poorer settings where parents are more likely to reinforce differences in favor of the child with better health endowments, increasing inequality from the household.

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