NÚMERO 299

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The Accident of Birth: Effect of Birthweight on Educational Attainment and Parent's Compensations Among Siblings

Importante

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Abstract

Despite the importance for public policy design, there is still a lack of evidence in middle income countries regarding children's in-utero health and their later success in life. This study exploits the variation between siblings and explore the effects of birthweight on later health and education outcomes. Findings suggest that low birthweight affects future endowments, including height, health status and cognitive skills, up to the average age of 17. Estimations also suggest an effect on grade repetition in the case of children with highly educated mothers, plausibly because such pupils reach higher educational levels, where differences in health endowments may translate into differences in achievement. Additional exploratory results offer evidence of compensation among richer parents, who invest more money in their less healthy offspring. This evidence is broadly in line with the international literature and suggests that health and education policies should be complemented with early interventions to reduce disparities in birthweight and education outcomes.

Keywords: Fetal origins; Fetal growth; Birthweight; Health Policy
JEL classification: I12, I15, I25, J13

Resumen

Este estudio explota la variación entre los hermanos y explora los efectos del peso al nacer en la salud futura y resultados escolares del individuo. Las estimaciones sugieren que presentar bajo peso al nacer afecta capacidades futuras, incluyendo peso, estatus de salud y habilidades cognoscitivas, a la edad promedio de 17 años. Las estimaciones también sugieren un efecto en la repetición de grados escolares en el caso de los hijos de madres con altos niveles educativos, lo que es convincente dado que tales estudiantes logran altos niveles educativos, donde las diferencias en la salud pueden trasladarse a diferencias en el rendimiento. Resultados exploratorios adicionales ofrecen evidencia de compensación entre los padres más ricos, quienes invierten más dinero en sus hijos menos saludables. Estos resultados se encuentran alineados con la literatura internacional y sugiere que las políticas de salud y educativas deben complementarse con intervenciones tempranas para reducir las disparidades en el peso al nacer y el logro educativo.

Palabras clave: Peso al nacer, Logro escolar, Salud Infantil, Política Educativa

*Introduction**

Birthweight is a potential predictor of future inequality. Mother's health and low nutrition during gestation can raise children's chronic disease risk, limiting their later education outcomes, earnings and general success. Epidemiological research in the US has shown that many children with low birthweight who survive infancy are associated with a higher risk of developing coronary diseases, hypertension, diabetes, cholesterol, cerebral palsy, deafness, blindness, asthma, abnormal bold clotting in later life, lung disease, as well as behavioral problems and lower cognitive development (see, e.g. Barker and Robinson, 1992; Almond, Chay, and Lee, 2004; Gluckman and Hanson, 2006).

This "fetal origins" hypothesis, which asserts that nutrient deprivation in-utero can raise individuals' chronic disease risk and consequently affect other socio-economic outcomes, has gained acceptance among social scientists. It is considered a leading explanation for the correlation between in-utero development (where birthweight is commonly used as a proxy) and future socio-economic outcomes. A discourse that James Heckman, Nobel Prize in economics has broadly summarized in the phrase: "The main source of economic inequality is the accident of birth." Evidence for developing countries and government responses, however has been limited and thus investing in mothers under the notion that this may enhance children's outcomes remains uncommon.[1]

Studies on socioeconomic outcomes have focused on a handful of industrialized countries supporting that many low birthweight infants are indeed prone to suffer cognitive and neurological impairment that limits the returns to human capital investments (Almond and Currie, 2011). Specifically, evidence for the U.S., Canada, Germany, Norway and Denmark has shown that many of the later differences in health, education and labor market achievements start in the first months of fetal life (Case, Fertig, and Paxson, 2005; Almond, 2006; Black, Devereux, and Salvanes, 2007; Oreopoulos, Stabile, Walld, and Roos, 2008; Royer, 2009; Schultz-Nielsen, Tekin, and Greve, 2014). The only study available for a mid-income country confirms a significant negative effect of low birthweight on students' cognitive development and achievement

 I thank the valuable comments of Dr. Pedro Orraca at University of Sussex and my colleagues at CIDE. I am responsible for all remaining errors. Comments are welcome

[1] Despite the potential savings of investing in mother's health rather than mitigating future chronic diseases and lower outcomes (see Almond *et al.*, 2004) governments in Latin America spend three times less in children under the age of 5 compared to those in the age of 6 to 11 (Schady and Berlinski, 2015). Consequently, 200 million children under 5 years of age in developing countries may not reach their developmental potential due to the absence of policies directed to foster their early human capital (Engle, Black, Behrman, De Mello, Gertler, Kapiriri, Martorell, Young, Group *et al.*, 2007; Britto, Engle, and Super, 2013).

(Torche and Echevarría, 2011). [2] Placing this case at the macro level, results suggest that shifting the distribution of birthweight in developing countries to that of the U.S. might potentially reduce world earnings inequality by 1% (Behrman and Rosenzweig, 2004). Researchers have questioned the generalization with other national contexts, but empirical evidence for poorer countries is scarce.

Economists have also recognized, in theory, that finding the effect of a poor in-utero nutrition in a developing country is not the only relevant matter for a correct public policy design. It is important to study family reactions and understand whether parents reinforce or compensate for the plausibly "unexpected" birthweight differences amongst their offspring. This arises because potential health programs targeting vulnerable children may be undone by parents who react in a compensating manner by devoting greater resources to non-participating children and to themselves. In this context, if reinforcement dominates then the effects of birthweight would be overestimated. On the contrary, if compensation dominates such rates would be underestimated (Becker and Tomes, 1976). Consequently, a key policy interest is the effect of improving in-utero development of a child with given genetic endowments and family background, while considering potential parental responses to policy intervention.

This paper seeks to quantify the lasting effects of children's in-utero nutrition on their future health status and their education outcomes. Specifically, it studies in-utero growth per week and birthweight using retrospective measures for a sample of individuals between 5 and 15 years in 2002 extracted from three rounds of the Mexican Family and Life Survey (MxFLS). The main specifications explore the effects of in-utero nutrition on children's height, health status and Raven's test scores, which are used as a proxy of the intelligence quotient (IQ). Effects of birthweight on educational attainment are also analyzed using years of schooling, school attendance and grade repetition as outcomes. Secondly, the analysis tests if parents with different levels of education take compensating actions to attenuate harmful effects arising from discrepancies in their offspring's health, for example by devoting more money to unhealthier children. The analysis is conducted in three different years which allows capturing differential effects over time. To the best of my knowledge, this is the first study that measures birthweight effects and family responses in Mexico and one of the few in a mid-income country.[3]

[2] Torche and Echevarría(2011) merge information on birthweight with standardized Mathematics and Spanish test scores for all fourth graders in Chile. The authors observe that a 400 grams increase in birth weight results in a 15.0% standard deviation (SD) increase in Mathematics scores. Moreover, the effect is statistically strong among disadvantaged families, but nearly disappears among advantaged ones. This evidence on compensating mechanisms among richer families differs from previous empirical studies on parental resource allocation that tend to favor a reinforcement mechanism in the U.S. and in some developing contexts (see, e.g. Datar, Kilburn, and Loughran, 2010; Rosenzweig and Zhang, 2009).

[3] Mexico offers a unique setup to test the effects of low in-utero growth as according to the he National Institute of Public Health (INSP, for its abbreviation in Spanish) two thirds of the country are two to three points above the official target of reducing low birthweight incidence (below 2500 grams) to a 7% despite the presence of policies directed to enhance mother's health during pregnancy and the puerperium period such as "Arranque parejo en la vida". This is reported in detail in the documents on children's health coming from the National Survey of Health and Nutrition (ENSANUT 2012, for its abbreviation in Spanish).

There are difficulties in identifying causal relationships between early childhood health and later age outcomes, even when working with a rich and detailed dataset such as the one provided by the MxFLS.[4] Unobserved factors, like early-life experiences or genetic endowments, may drive both early health and academic achievement over time. While low health endowments at birth are likely to be correlated with a range of socio-economic and genetic factors contained in both parents' and children's characteristics, so that a policy increasing birthweight would have little effect on later achievements. Consequently, in this study the identification of the effects of fetal nutrition relies on birthweight variation among brothers and sisters by using a sibling fixed-effects model.[5] This method allows keeping household's unobserved variables such as parents' characteristics and genetic factors, affecting children's health and educational outcomes, as fixed.

The last part of this study is framed in the theoretical models of human capital investment with multiple offspring coming from Becker and Tomes (1976). This proposition argues that parents invest to maximize returns, so that the marginal return to their investment equals the cost of capital, i.e. the market rate of return, so that parents' would invest more in children with "better" endowments. Any reinforced income inequalities amongst children are offset via transfers or non-human capital investments. Alternatively, this prediction is sensitive to the exact formulation of parents' preferences (Pollak, 1988). For example, if parents integrate children's years of education in their utility function and not only their offspring future income, then richer and more educated parents may compensate for differences among siblings endowments, while poorer credit-constrained parents may focus on those with the higher chances of succeeding at school. On the other hand, as (Hussain, 2010) discusses, in more deprived contexts parents may not differentiate their investments as siblings with different health or cognitive endowments will end up having the same low levels of education that are common to poorer individuals. In summary, paternalistic preferences may only be tested empirically.

This paper provides evidence of a significant effect of birthweight on future physical endowments, health and cognitive abilities. Effects on education show an increasing chance of grade repetition for children whose mothers are above the mean of education, plausibly because "richer" offspring get higher educational levels in which lower health endowments start playing a detrimental role. Further exploratory work provides evidence of higher investments in low birthweight children in richer households to compensate differences among siblings. On the contrary, there are no noticeable effects of differentiated investments in budget-constrained families. This is in line with the formulations implying that in such contexts, children share the same low level of education for which there is no incentive for parents to differentiate their investments.

[4] More details on this survey will be presented in Section 3.

[5] Examples of studies using sibling and twin methods, which aim to control for genetic characteristics as well as family fixed-effects, include evaluations of the returns to education (Griliches, 1979; Ashenfelter and Zimmerman, 1997), the returns to school quality (Altonji and Dunn, 1996), the effects of teenage childbearing (Rosenzweig and Wolpin, 1995), and more recently IQ effects on schooling in Mexico (Hussain, 2010), among others.

The contribution of the present study is threefold. First, to the best of my knowledge, it is the first to estimate the effects of in-utero development on future health and educational achievement for a cohort of children in Mexico. Second, it contributes to the scarce literature of birthweight effects in a middle-income country with high economic inequality and thus offers a useful setting to test the generalization of the effect of birthweight. Thirdly, it offers evidence on reinforcement or compensating mechanisms in families with different socio-economic status, a topic that is highly relevant to shape public interventions and is often unexplored in developing countries.

The study proceeds as follows. Section 2 discusses the empirical strategy. Section 3 presents the details of the MxFLS as well as some descriptive statistics. Section 4 presents the main results of in-utero growth and birth weight measures on later health and educational outcomes. Section 5 explores parents' responses to offspring with different health endowments. Section 6 concludes and draws some policy recommendations.

Empirical Strategy

Finding the causal effects of in-utero nutrition presents a serious challenge, because children with low birthweight are more likely to be born in poorer families and poverty may be related to parent's genetics. Therefore, disentangling the effects of a poor nutrition during pregnancy from the socioeconomic and genetic factors is not possible using a simple OLS regression that would be comparing poorer and richer children with different physical endowments that impact both, their birthweight and their future success. An option thus, is to exploit differences in birthweight between siblings and compare their future outcomes. The intuition is that despite siblings do not share all their genes, they have the same parents, context and socioeconomic conditions allowing to control for a broad variety of observed and unobserved factors.[6] Formally, this method is explained as follows

A linearized two-sibling relationship may be estimated:

$$Y_{ijt} = \alpha_1 X_{jt} + \alpha_2 X_i + \beta_1 H_{ij} + \beta_2 H_{kj} + \mu_{ijt} \qquad (1)$$

where Y_{ijt} is child's i outcome in family j in time t = 2002, 2005, 2009; X_{jt} denotes a detailed set of family j covariates such as parents' education and income in t; X_i

[6] Specialist argue that siblings only share between 50% and 80% of their genetic material, so that there are still some genetic characteristics that vary across them that may be correlated with birthweight and future outcomes that cannot be accounted by a sibling fixed-effects model (see, e.g. Black *et al.*, 2007). For this reason, research in developed economies has used monozygotic twins to assert the effects of low birthweight. However, it is worth mentioning that when genetics is fully 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), for which the findings provided in this research may be considered a lower bound.

represents a vector of child's i specific controls including age and gender;[7] H_{ij} denotes child's i health endowment at birth; H_{kj} represents the same measure for sibling k in family j, i.e. fetal growth, relative size at birth or birth weight. Finally, μ_{ijt} consists of all unobserved factors affecting outcome Y_{ijt}.

In the specification of Eq. (1), β_1 and β_2 would represent the causal effects of fetal development only if H_{ij} and H_{kj} are orthogonal to μ_{ijt}. In other words, the usual concern with this setup is that μ_{ijt} and H_{ij}, as well as μ_{ijt} and H_{kj}, are likely to be correlated. Hence, ordinary least squares (OLS) estimates of β_1 and β_2 would be biased. For example, this may occur if healthy parents producing healthy children also happen to be richer, have better access to funds for education and inculcate a greater desire for education and better health. Something rather plausible.

The partial solution is offered if the error term is decomposed into a family component and a white noise component, so that $\mu_{ij} = f_j + v_{ij}$ j.[8] Here f_j captures unobserved time-invariant family j factors and it is assumed that $E(v_{ij} / X_{ij}; X_i; H_{ij}; H_{kj}) = 0$. Under this setup, taking differences across siblings and rearranging terms delivers the following model for two siblings i and k in family j:

$$Y_{kj} - Y_{ij} = \alpha_1(X_{kj} - X_{ij}) + (\beta_1 - \beta_2)H_{ij} - H_{kj} + (v_{ij} - v_{kj}) \tag{2}$$

In practice, there may be three or more siblings in the estimation sample. When there are $\mathrm{n} > 2$ siblings in total, Eq. (2) may be generalized for sibling k in family j as follows:

$$Y_{kj} - \bar{Y}_j = (\beta_1 - \beta_2)H_{kj} - \bar{H}_j + (v_{kj} - \bar{v}_j) \tag{3}$$

Eq. (3) states that the outcome depends on own health and on the sum of all siblings in family j average health endowments. Thus, the coefficient H_{kj} in a fixed-effect regression of on H_{kj} will yield an estimate of $(\beta_1 - \beta_2)$ or the effect of low birthweight compared to that of all siblings in family j on the outcomes of interest. Note that this estimation will be independent of $(v_{kj} - \bar{v}_j)$ and thus unbiased only if all unobserved family factors such as parenting style and genetics are fixed for both children. While this is plausible, this approach only conditions out characteristics that are family-specific and unchanging over time during the period of analysis, but is not robust to time- varying unobserved characteristics such as family income at the moment of birth or throughout early childhood.

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7 The variety of outcomes considered in the empirical analysis are explained in detail in Section 3.

8 For simplicity, I do not write the time sub-index *t*.

Furthermore, despite some sibling's genetic characteristics are not captured by a sibling fixed- effects setup, "the incidence" of low birthweight may well be considered exogenous to parents' anticipations, as mother's plausibly ignore what will be the exact weight of their future offspring. Therefore, this setup is arguably more robust to examine family investments among siblings with different birthweight. These considerations are acknowledged in the interpretation of the results presented in Sections 4 and 5.

Data, Sample and Descriptive Statistics

Mexican Family Life Survey (MxFLS)

This study examines 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 includes information on family characteristics such as parents' education, household income and number of children per household, among others. All three waves of the MxFLS include a set of Raven's tests, which are used as a proxy measure of IQ. This is done by testing children's cognitive skills, which are in theory independent of schooling (Raven and De Lemos, 1958). [9]

The MxFLS also includes detailed information on individual members of the family who were between 5 and 15 years old in 2002. The dataset provides their characteristics on current and past schooling and relevant measures at birth such as weight and relative size. Furthermore, given that birthweight may vary due to the weeks of pregnancy, fetal growth is also computed in this research using birthweight and gestational age, which is measured in weeks. This variable is then reported in grams per week. All birth retrospective health measures come from questionnaires applied to mothers who provide such information for their last two pregnancies.[10]

The MxFLS also includes questions on contemporary offspring's health. Categories of health re- ported by parents are used to construct a binary variable denoting children's "bad' and "good health". Additional information contained in the survey is used to study parents' investments meant to compensate or reinforce differences in their offspring birthweight. Specifically, the MxFLS includes information related to expenses in fees, books, uniforms and private tutoring per child incurred during the last academic year.

Finally, it is worth mentioning that a limitation of the dataset is that, unlike some studies measuring the effects of early childhood health on later education and labor outcomes, the three waves of the MxFLS were conducted over a relatively short period of time. Thus, it is not possible to follow individuals from early childhood until they

[9] The results of these tests are then standardized by age and sex with a mean of zero and a SD of one.

[10] According to the first round of the MxFLS, i.e. MxFLS-I, the average number of children per family is 2.4. Therefore, it is plausible to think that the information of two children may be representative of the average Mexican family.

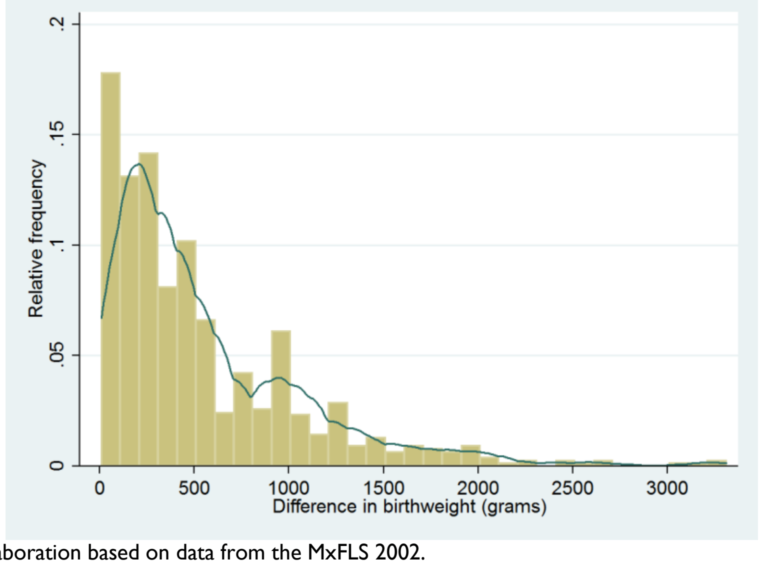
become adults, consequently, this study relies on the use of retrospective questions on birth health. A second shortcoming is that it is not possible to know the characteristics of households when children were born, since this information is only contemporary available. This makes it impossible to control for the effects of socio-economic status during early years on offspring's development which may bias birthweight coefficients.

Sample and Descriptive Statistics

The sample for this study includes all households with at least two siblings between the ages of 5 and 15 years in 2002, who are also observed in the second and third rounds of the MxFLS conducted in 2005 and 2009-2011, respectively. Despite the apparent wide range of ages considered, trimming the sample to study only younger or older siblings would generate problems of efficiency in the estimations. Furthermore, although the potential difference in age between siblings may seem wide, the average age difference between brothers and sisters in our sample is only 2.6 years. Finally, in Mexico it is between the ages of 5 and 15 years when discrepancies in educational results start to emerge.

An important underlying assumption so far is that there exists substantial variation in the birth- weight difference between the most recent pair of siblings of a family. Figure 1 displays the frequency distribution of differences among same sex siblings and shows substantial variation. Specifically, the average weight difference within pairs of same sex siblings is 560 grams, with a Standard Deviation (SD) of 528 grams, where about half of the pairs have differences of up to 500 grams.

FIGURE 1. DIFFERENCES IN BIRTHWEIGHT BETWEEN THE YOUNGEST PAIR OF SIBLINGS WITH THE SAME GENDER



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

Panels A and B in Table 1 show the main descriptive statistics of family context and individual covariates. Descriptive statistics of school outcomes and retrospective birth measures are presented in panels C and D for a sample of children ages 5 to 15 in 2002, 8 to 18 in 2005 and 12 to 22 in 2009, residing in households with at least two kids. The data shows that the averages of the context variables presented in Panel A do not change dramatically over time. In general, context descriptive statistics show stability of mean income, mother's education and average number of siblings. Which gives support to the argument that socioeconomic conditions may have not varied much during offspring's early life.

Regarding individual characteristics of children, it can be seen that they are on average 9 years old in 2002, 12 years of age in 2005 and 17 years old in 2009. Given that IQ and height are standardized with respect to the population, it is observed that children in the sample are slightly above the mean in both measures, where this remains fairly stable across time. Similarly, roughly the same proportion of children is ranked as having "bad health" across time, which stood at 26.1% in 2002, 20.3% in 2005 and 27.2% in 2009-2011.

Concerning the school outcomes shown in Panel C, children exhibit an average of 4.5 years of schooling when they are 9 years old, 6.8 years of schooling when they are age 12, and 9.6 years of schooling when they are 17 years old. In accordance to these numbers, note the significant decrease in the proportion of children attending school, which goes from approximately 93.0% in 2002 to 60.0% when they reach 17 years of age, offering an important variation worth of studying in relation to children's birthweight and later health endowments.

Finally, Panel D gives a description of birth measures. On average, birth weight is 3.3 kilograms and fetal growth per week is of 93 grams. Note that 24.1% of children were reported to be born smaller in comparison to the 76.3% of newborns that were reported as being born average or bigger.[11]

[11] Regarding the comparability of the families included in the sample, i.e. those with at least two children, with all the other households included in the MxFLS, Annex Table A1 shows the average differences between the interest variables in our sample and all households surveyed. The differences are not statistically significant and this is indicative that the sample used in our study remains representative of the Mexican population.

TABLE 1. MAIN DESCRIPTIVE CHARACTERISTICS OF A SAMPLE OF KIDS OF AGE 5 TO 15 IN 2002

	2002			2005			2009		
	Obs.	Mean	SD	Obs.	Mean	SD	Obs.	Mean	SD
A. Family Context									
Log of Income	1,876	10.15	1.06	1,876	10.42	1.00	1,876	10.44	1.11
Mother's schooling (years)	1,771	8.03	3.03	1,771	8.09	3.02	1,771	8.37	3.03
Siblings	2,219	2.22	1.23	2,219	2.30	1.26	2,219	2.02	1.30
B. Individual Characteristics									
Girl	2,219	0.5	0.5	2,219	0.49	0.50	2,219	0.50	0.50
Age	2,219	9.08	2.9	2,219	12.34	2.97	2,219	16.77	3.04
Cognitive Test (IQ)	2,188	0.1	0.97	2,188	0.10	0.96	2,188	0.14	0.96
Standardized Height	2,015	0.17	0.97	2,015	0.09	0.96	2,015	0.14	0.96
Bad Health	2,192	0.26	0.44	2,192	0.20	0.40	2,192	0.27	0.45
C. School Outcomes									
Repeated Grade	1,836	0.14	0.35	1,836	0.16	0.37	1,836	0.18	0.38
Years of Schooling	1,880	4.45	2.54	1,880	6.84	2.80	1,880	9.61	2.28
Attending School	2,219	0.93	0.26	2,219	0.87	0.33	2,219	0.60	0.49
School Expenses	2,219	564.07	1519.69	2,219	663.26	2248.55	2,219	401.70	1165.72
D. Retrospective Health									
Birthweight	2,323	3.32	0.68						
Fetal growth gr. p/week	2,140	93.04	17.99						
Relative Size at Birth (N=2208)	533	0.24							
Smaller									
Normal or bigger	1,675	0.76							

Source: author's elaboration based on the MxFLS 2002 to 2009-2011
Notes: "Children's bad health" is a dummy variable taking the value of 1 if the child was reported as having "very bad" or "bad health" and zero otherwise. IQ is standardized by age and height is standardized by age and sex. School expenses are in Mexican pesos of 2002.

Impacts of birth measures on later health and educational outcomes

Does in-utero growth affect future health?

According to the international evidence, the analysis conducted in this study is based on two substantive points. First, teenager's health relates to their academic performance. Second, later general health and academic achievement are influenced by birthweight. In this regard, Table 2 displays a set of OLS results relating birth measures and later health outcomes, where all regressions include a full set of controls.[12] The relevant explanatory variables are, birthweight in kilograms (and children born at the bottom quartile to observe extreme effects of birthweight) and fetal growth in grams per week. All cross-sectional specifications as well as sibling fixed-effects models were estimated using clustered standard errors at the household level.

The results in panel A show a positive association between birthweight and children's height when they are on average 9, 12 and 17 years old; i.e. in 2002, 2005 and 2009, respectively. Similarly, when children are younger, higher birthweight relates

[12] As it is common in the literature this paper starts showing OLS estimates despite knowing that the estimations are biased in order to understand more about the nature of such biases once sibling-fixed effects are included.

negatively to their probability of reporting bad health in 8.4% points and it weakly relates to a higher IQ. However, effects on health and IQ disappear for later years. Note that results for children at the bottom quartile of birthweight and in Panel B regarding fetal growth per week, reveal a similar pattern than that of birthweight in kilograms, giving support to the general results.

TABLE 2. OLS REGRESSIONS OF CHILDRENS HEALTH OUTCOMES ON FETAL GROWTH AND BIRTH WEIGHT

	2002			2005			2009		
Variable	Height	Bad Health	IQ	Height	Bad Health	IQ	Height	Bad Health	IQ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. Birthweight									
Kilograms	0.176***	−0.064***	0.074*	0.231***	−0.009	0.029	0.323***	−0.003	−0.016
	(0.031)	(0.018)	(0.040)	(0.040)	(0.017)	(0.042)	(0.046)	(0.021)	(0.042)
R-Squared	0.085	0.039	0.088	0.086	0.018	0.06	0.08	0.029	0.111
Bottom Quarter	−0.213***	0.074***	-0.165***	−0.294***	0.009	−0.111*	−0.386***	0.037	−0.021
	(0.040)	(0.028)	(0.059)	(0.057)	(0.025)	(0.062)	(0.064)	(0.031)	(0.063)
R-Squared	0.074	0.035	0.091	0.08	0.018	0.062	0.065	0.03	0.111
B. Fetal Growth									
Grams * 10	0.063***	−0.022***	0.029**	0.085***	−0.001	0.012	0.120***	−0.001	−0.006
	(0.011)	(0.007)	(0.015)	(0.014)	(0.006)	(0.016)	(0.017)	(0.008)	(0.015)
R-Squared	0.084	0.038	0.088	0.086	0.018	0.060	0.081	0.029	0.111
Observations	1826	1826	1826	1826	1826	1826	1826	1826	1826
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors, clustered on households, in parenthesis. Other controls included are household's income, parents' education, children's age, sex and birth order. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The use of sibling fixed-effects represent a good way to capture a variety of heterogeneous effects across households such as socio-economic status, parenting styles, preferences at the moment they are surveyed and part of the genetics inherited to children.[13] Table 3 shows the same outcomes for a set of regressions controlling for household's and parents' fixed characteristics.

The results presented in Table 3 lead to the same conclusions as those reached in Table 2, and show a significant impact on later health outcomes. In specific, birthweight has a significant effect on height for all years analyzed but it is smaller in comparison to the OLS regressions. For example, in 2009 the effect of one kilogram of difference in birthweight among siblings implies a gain of 0.22 SD (S.E. of 0.06) in height for the heavier

[13] An assumption here is that household's socio-economic conditions, parenting styles and preferences did not change considerably within households from the moment of birth until the date the first round of the MxFLS was conducted. As mentioned before, data presented in Table 1 supports this assumption by offering evidence that, at least in a period of 7 years, income, mother's schooling and the number of siblings remained fairly stable.

sibling, this in comparison to the effect of 0.32 SD (S.E. of 0.04) observed in the OLS regressions. Similar results can be observed for children at the bottom quartile of the birth weight distribution in comparison to siblings in the top three quartiles. The upper bias in the OLS results fits with the description of a positive correlation between socioeconomic unobserved household/family factors and birthweight. Indeed, sibling fixed-effects models help to control for genetic and family background endowments that generate a bias in cross-section estimations. Additionally, it is worth noting that OLS models captured just around 3 to 8% of the total variation in outcomes (as reported by the r-squared), whereas fixed-effects regressions account for up to 80% of the total variation in height, health and IQ.

TABLE 3. SIBLING FIXED-EFFECTS MODELS OF CHILDRENS OUTCOMES ON BIRTH-WEIGHT AND FETAL GROWTH

Variable	Height (1)	2002 Bad Health (2)	IQ (3)	Height (4)	2005 Bad Health (5)	IQ (6)	Height (7)	2009 Bad Health (8)	IQ (9)
A. Birthweight									
Kilograms	0.084**	−0.050*	0.013	0.099*	−0.024	0.100	0.223***	0.005	0.153**
	(0.038)	(0.028)	(0.061)	(0.057)	(0.030)	(0.062)	(0.062)	(0.036)	(0.075)
R-Squared	0.811	0.772	0.783	0.829	0.729	0.807	0.850	0.753	0.784
Bottom Quarter	−0.110**	0.105**	−0.136	−0.219***	0.011	−0.219**	−0.212**	0.037	−0.129
	(0.056)	(0.041)	(0.089)	(0.083)	(0.044)	(0.090)	(0.090)	(0.053)	(0.110)
R-Squared	0.810	0.773	0.783	0.831	0.728	0.808	0.848	0.753	0.782
B. Fetal growth/week									
Grams * 10	0.032**	−0.018*	0.008	0.039*	−0.008	0.041*	0.084***	0.004	0.060**
	(0.014)	(0.010)	(0.022)	(0.021)	(0.011)	(0.023)	(0.023)	(0.013)	(0.028)
R-Squared	0.811	0.772	0.783	0.830	0.728	0.807	0.850	0.753	0.784
Observations	1826	1826	1826	1826	1826	1826	1826	1826	1826
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors, clustered on households, in parenthesis. Other controls included are children's age, sex and birth order. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Sibling fixed-effects models also shows a significant effect of birthweight on children's reported health at the age of 12. For example, in 2002 children who were at the bottom quartile of birthweight are 10.5% points likelier of reporting bad health in comparison to siblings born at the top three quartiles. This effect, as reported in Table 2 also becomes non-significant in time. However, it is worth noting that the measure of birthweight in kilograms does show an effect of 0.15 SD in IQ up to the average age of 17. Moreover, similar results are presented for height, health and IQ using the measure of fetal growth in grams showing that weeks of pregnancy are not driving these results. Furthermore, fixed-effects results confirm a significant and positive effect of fetal growth on IQ, which was not observed in the OLS estimations, at the average ages of 12 and 17 years of 0.041 and 0.060 SD, respectively.

Overall, results regarding in-utero development on later health and cognitive outcomes, although intuitive, are not entirely obvious. The results imply that at the age of

17, a child one kilogram heavier than her brother or sister at birth, would be taller and would possess more cognitive skills on average, independent of family, genetics and context characteristics. More importantly, as the available evidence for developed countries has suggested, such effects may also be translated in other socio-economic and academic results. Next section debates on the effects on school outcomes.

Does in-utero development have an effect on educational outcomes?

This section presents the results of different models using educational outcomes such as years of schooling, attendance rates and grade repetition. Table 4 shows the results of the OLS regressions with the same set of controls used in the models presented in Table 2, where IQ and height standardized by age and sex are added as covariates in order to disentangle the effects of contemporary health and in-utero nutrition on education.

Measures of birthweight in kilograms and quartiles along with fetal growth show a consistent relationship with grade repetition, describing that heavier children at birth are associated with lower chances of repeating a grade. Nonetheless when fixed-effects are included as presented in Table 5 for the same specifications, there are no ostensible impacts of birthweight on years of schooling, school attendance or if the child has repeated a grade by the ages of 9, 12 and 17 years. Indeed, it can be noted in column 6 that children born at the bottom of the birthweight distribution are 9.6% points likelier of failing a grade by the age of 12, nonetheless this is the only significant coefficient and may be just the result of chance, given the many outcomes studied.

TABLE 4. OLS MODELS OF EDUCATIONAL OUTCOMES ON FETAL GROWTH AND BIRTH WEIGHT

	2002			2005			2009		
VARIABLE	SCHOOLING	ATTENDS	REPEATED	SCHOOLING	ATTENDS	REPEATED	SCHOOLING	ATTENDS	REPEATED
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. Birthweight									
Kilograms	0.028	−0.009	−0.030*	0.066	−0.022	−0.050***	−0.042	−0.02	−0.041*
	(0.053)	(0.009)	(0.017)	(0.060)	(0.014)	(0.016)	(0.107)	(0.021)	(0.022)
R-Squared	0.853	0.068	0.116	0.799	0.163	0.072	0.384	0.401	0.081
Bottom Quarter	−0.040	0.007	0.059**	−0.174**	0.015	0.072***	0.015	0.002	0.052*
	(0.073)	(0.011)	(0.023)	(0.074)	(0.016)	(0.024)	(0.136)	(0.028)	(0.030)
R-Squared	0.853	0.067	0.119	0.799	0.161	0.072	0.384	0.401	0.080
B. Fetal Growth/week									
Grams * 10	0.008	−0.003	−0.010	0.019	−0.008*	−0.018***	−0.015	−0.008	−0.016**
	(0.020)	(0.003)	(0.006)	(0.022)	(0.005)	(0.006)	(0.039)	(0.008)	(0.008)
R-Squared	0.853	0.067	0.116	0.799	0.161	0.067	0.384	0.401	0.081
Observations	1396	1396	1396	1396	1396	1396	1396	1396	1396
Other Controls	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Notes: Robust standard errors, clustered on households, in parenthesis. Other controls included are household's income, parents' education, children's age, sex, birth order, Raven's test scores as a measure of IQ and height standardized by age and sex.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Differences between sibling fixed-effects results and those upwardly biased in the OLS specifications are understandable, if one considers that later educational outcomes also represent a series of parents' 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) and thus, more varying unobserved variables not captured by the fixed-effects may be highly related to children's endowments and educational outcomes. Additionally, the absence of clear effects of birth- weight may be explained because education levels in the context of Mexico are low on average, for which the effects of birthweight on future health and cognitive skills depicted in the previous subsection, may not directly translate into educational effects. Possibly, if children on average continue longer in school, detrimental effects of health would translate into lower education outcomes.

One way to explore this hypothesis is by separating children conditional on their socioeconomic context, which so far has remained fixed. Intuitively, siblings in less deprived families would achieve higher levels of education that may be differentiated by health endowments. In this regard, our data shows that average schooling in 2009 for children whose mothers are below the median of education is of 8.3 years compared to 9.6 years in richer households. Subsection 4.3 elaborates more on this.

TABLE 5. SIBLING FIXED-EFFECTS MODELS OF EDUCATIONAL OUTCOMES ON FETAL GROWTH AND BIRTHWEIGHT

	2002			2005			2009		
Variable	Schooling (1)	Attends (2)	Repeated (3)	Schooling (4)	Attends (5)	Repeated (6)	Schooling (7)	Attends (8)	Repeated (9)
A. Birthweight									
Kilograms	0.074	0.009	−0.002	0.130	0.003	−0.024	0.018	-0.005	-0.018
	(0.073)	(0.014)	(0.025)	(0.090)	(0.020)	(0.026)	(0.149)	(0.034)	(0.032)
R-Squared	0.963	0.706	0.767	0.952	0.793	0.788	0.896	0.886	0.850
Bottom Quarter	0.020	0.017	−0.008	−0.205	−0.006	0.096***	0.029	0.031	0.043
	(0.111)	(0.021)	(0.039)	(0.130)	(0.029)	(0.037)	(0.222)	(0.050)	(0.048)
R-Squared	0.963	0.706	0.767	0.952	0.793	0.789	0.896	0.886	0.850
B. Fetal Growth/week									
Grams * 10	0.027	0.003	−0.004	0.045	−0.001	−0.006	0.012	0.001	-0.007
	(0.027)	(0.005)	(0.009)	(0.033)	(0.007)	(0.009)	(0.056)	(0.013)	(0.012)
R-Squared	0.963	0.706	0.767	0.952	0.793	0.788	0.896	0.886	0.850
Number of Observations	1396	1396	1396	1396	1396	1396	1396	1396	1396
Other Controls	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Notes: Robust standard errors, clustered on households, in parenthesis. Other controls included are household's income, parents' education, children's age, sex, birth order, Raven's test scores as a measure of IQ and height standardized by age and sex.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Heterogeneous effects of in-utero development on future education by socio- economic status

A disadvantage of sibling fixed-effects models is that we cannot observe the separated effects of variables such as family income and parents' education, as these traits remain fixed in each household and for all siblings. However, precisely those financial and cultural characteristics turn out to be of great relevance to understand children's educational outcomes conditional on their fetal development and parental responses.

To explore differences in the effects of birthweight for varying family contexts, Table 6 reports the separated effects on grade repetition conditional on mother's education as a proxy for household's socio-economic and cultural status. Columns 1 to 3 display the effects on the probabilities of repeating a grade for children whose mothers are below the median of education, i.e. seven years of schooling. Columns 4 to 6 reflect the same effects for children whose mothers are above the median of education.[14]

Results in Table 6 show that for children whose mothers are less educated, the low birthweight effects remain non-significant, as presented in columns 1 to 3. Conversely, in the case of families where mothers are more educated, effects of birthweight and similarly, fetal growth on grade repetition are statistically significant when children are

[14] Non-significant effects of fetal growth on schooling and attendance are presented in the Annex Tables A2 and A3.

12 years on average. As stated before, a hypothesis that may explain the effects of birthweight in richer households is that for children who reach higher levels of education on average, detrimental effects of birthweight on health and IQ may indeed translate into differences in achievement.[15]

TABLE 6. SIBLING FIXED-EFFECTS MODELS OF GRADE REPETITION ON FETAL GROWTH AND BIRTHWEIGHT BY MOTHER'S EDUCATION

	Below Median of Education			Above Median of Education		
	2002 (1)	2005 (2)	2009 (3)	2002 (4)	2005 (5)	2009 (6)
A. Birthweight						
Kilograms	0.001	0.027	0.016	−0.002	−0.105**	−0.064
	(0.035)	(0.032)	(0.039)	(0.036)	(0.042)	(0.049)
R squared	0.759	0.816	0.863	0.802	0.772	0.817
Bottom Quarter	0.007	0.014	−0.038	−0.023	0.115**	0.087
	(0.057)	(0.051)	(0.064)	(0.049)	(0.054)	(0.063)
R-squared	0.759	0.815	0.863	0.802	0.770	0.817
B. Fetal Growth/week						
Grams * 10	0.000	0.016	0.007	−0.008	−0.039**	−0.025
	(0.013)	(0.012)	(0.015)	(0.013)	(0.015)	(0.018)
R-squared	0.759	0.816	0.863	0.802	0.772	0.817
Observations	1058	1058	1058	742	742	742
Other Controls	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Notes: Robust standard errors, clustered on households, in parenthesis. Other controls included are children's age, sex, birth order, Raven's test scores as a measure of IQ and height standardized by age and sex.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Still, another plausible explanation may rely on varying parental investments among siblings. For example, less educated mothers in budget-constrained households may be investing more on their children with bad health in order to compensate for early childhood differences, hence reducing their detrimental effects on later educational outcomes. Conversely, more educated mothers in richer house- holds may potentially not being compensating for initial health differences and investing more/equal amount of resources on their healthier offspring, thus maintaining/reinforcing differences in the educational achievement between siblings. The question is now if birthweight has an effect on parents' investments conditional on families' socioeconomic context. Evidence on this is presented below.

[15] It is worth mentioning that the variable on grade repetition only captures if children failed before they were 12. Most of children in 2009 are 17 years of age on average, for which it is not surprising that there are no effects after 2005.

Parents' responses towards siblings with dissimilar health attributes

Table 7 shows the results of sibling fixed-effects regressions including the logarithm of parents' yearly expenditure per children in school as an outcome (e.g. in books, fees, uniforms and private tutoring) in 2002 and 2005.[16] The estimations show significant differences in expenditures among siblings with a different birthweight in families with more educated mothers. Note that the effects are only present in 2005 when children are on average 12 years old. The estimations suggest 20% less expenses on average on siblings one kilogram heavier. More intuitively, the results provide evidence that when a child is born in the lower quartile of birthweight, richer parents may invest up to 45% more money on her in comparison with other siblings born in the top three quartiles of birthweight.

Considering that the effects on expenses are only present in 2005, results may suggest that once children's health attributes start to translate into lower school outcomes (when they are on average 12 as presented in Table 6) richer parents may react to compensate for endowment differences among siblings. Results on expenses thus fit with the story of richer parents looking for mechanisms to compensate varying health endowments among siblings that may cause different educational outcomes and thus future income differences.

[16] The MxFLS offers information on expenses only for children who are 15 years of age or younger. Because of this, regressions on expenses observed in 2009-2011 are not reported, since in this period more than half of the sample analyzed is already older than 15 years.

TABLE 7. SIBLING FIXED-EFFECTS MODELS OF YEARLY LOG-EXPENDITURE PER CHILD AT SCHOOL ON BIRTHWEIGHT AND FETAL GROWTH BY MOTHER'S EDUCATION

	Below Median of Education		Above Median of Education	
	2002	2005	2002	2005
	(1)	(2)	(3)	(4)
A.Birth Weight				
Kilograms	−0.061	0.017	0.029	−0.231 * *
	(0.065)	(0.063)	(0.106)	(0.099)
R-squared	0.932	0.948	0.916	0.924
Bottom quartile		−0.016	−0.005	0.484***
		(0.086)	(0.158)	(0.134)
R-squared		0.946	0.916	0.936
B.Fetal Growth				
Grams * 10	−0.025	0.002	0.007	−0.038
	(0.024)	(0.024)	(0.038)	(0.043)
R-squared	0.930	0.948	0.917	0.919
Observations	1007	1007	649	649
Other Controls	Yes	Yes	Yes	Yes

Notes: Robust standard errors, clustered on households, in parenthesis. Other controls included are household's income, parent's education, children's age, sex, birth order, Raven's test scores as a measure of IQ, height standardized by age and sex and years of schooling, as naturally, expenses may vary for higher educational levels.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Results are less conclusive for poorer children as no differences in parental investments are noted. As proposed, the higher chance that children from less advantaged backgrounds will anyway reach a low average level of education may discourage parents' compensating mechanisms to help them cope with a deficient in- utero development. Additionally, less educated parents' may as well be less informed about their children's performance or may have a higher preference for equity among their offspring. Another plausible hypothesis may also be that the "incidence" low birthweight may be less disruptive in poorer households causing a less clear parental reaction. In any case, conclusions drawn for poorer households may only be suggestive as there's no clear evidence of what is explaining the absence of apparent compensating mechanisms.

Conclusions and Policy Recommendations

This study examined the effects of low birthweight and fetal growth per week on children's future health and education outcomes. Based on data from three rounds of the MxFLS, a cohort of children between the ages of 5 and 15 years in 2002 was followed until 2009-2011, when most of them had already transited through primary education. In addition, parents' reactions to compensate or reinforce differences in their children's endowments were analyzed using variations in monetary investments among siblings.

The main results show a significant effect of in-utero development on future height, health, cognitive outcomes and in the case of children with more educated mothers, on the probability of repeating a grade. These findings are relevant for the developing world, where intra-uterine growth restrictions are the main determinants of low birthweight, and particularly for Mexico, where two thirds of the country are still up to three points above the official target established in 2001 (i.e. 7% of low birthweight incidence).

Constrains of the data and the methodology may cast a doubt on the size of the coefficients found, given that the variations in birthweight between siblings may in part be explained by genetic differences. However, research analyzing the causal effects of in-utero development has consistently found that once genetic factors are fully considered (for example, by using monozygotic twins) the detrimental effects on children's education and labor market outcomes are actually higher than those found using sibling fixed- effects or simple OLS. (see e.g. Behrman and Rosenzweig, 2004; Black *et al.*, 2007; Torche and Echevarría, 2011). In which case, the findings of this research would represent a lower bound.

Effects of low birthweight on children's height, largely 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 social status (Steckel, 2009; Case and Paxson, 2010). Evidence has shown that adult's height may not only reflect a lower health status that translates into a lower productivity, it may also relate to their self- and social-esteem that have an effect in 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, Nystedt, and Rooth, 2014). Evidence, however, is less certain about the critical windows for nutritional interventions against stunting. The available studies on children's growth show that faltering in developing countries typically begins in the first three months of life and recovery (catch-up growth) after early childhood is difficult to observe (Victora, de Onis, Hallal, Blössner, and Shrimpton, 2010; Prentice, Ward, Goldberg, Jarjou, Moore, Fulford, and Prentice, 2013; Hirvonen, 2013). Therefore, the results presented in this research offer support for public interventions in early stages of life, specifically during gestation in order to reduce the gap in health endowments between more and less deprived individuals.

Similarly, the main findings provided for Mexico also suggest that in-utero growth is significantly related to IQ. These are in line with the evidence found in the literature linking birthweight and cognitive outcomes (Black *et al.*, 2007; Torche and Echevarría, 2011). Moreover, after controlling for IQ and height, this paper provides evidence that a low in-utero development affects later educational outcomes in the case of children born in richer households, plausibly because richer children reach higher education levels where height and cognitive development start playing a role in their achievement despite higher parental investments. Conversely, the non-effects of in-utero nutrition in low-budget households may be explained by the fact that siblings in low socio economic contexts have the same, mostly unvarying, low educational achievement. Their educational level may be heavily influenced by other depriving factors including the educational system, teachers and negative peer effects typically associated with poorer environments, among others. Consequently, low birthweight and parental responses to these factors, may at the end be a weak determinant of their achievement.

In conclusion, the overall results presented this research for a mid-income country, in line with the international evidence, offer further insights relevant for policy design. They largely support interventions to improve in-utero nutrition that may foster children's height and cognitive skills that will potentially translate into future returns in the education and labor markets. Governments should then focus on interventions for mothers with a higher risk of a low in-utero nutrition specially in income-constrained households given that lower health outcomes may translate into differences in success among individuals and this can have an effect on the future distribution of income. More specifically, for the Mexican case, programs related to pregnant women's and children's health during their first years of live such as "Arranque parejo en la vida' and "Programa Nacional para la Reducción de la Mortalidad Infantil", should take more relevance.

Despite the main findings in this research regarding offspring's education are concentrated in richer households, this does not imply in any way that policies should not consider intervening in poorer families. If the public intention and tendency is to increase the average years of education among the population, governments should consider that poorer households will eventually start reaching higher educational levels where differences in health endowments may translate into differences in achievement, reducing the effectiveness of other education policies. It should also be considered that in such circumstances, poorer households may be limited to find mechanisms to compensate children's varying endowments as richer parent's seem to be doing. Good in-utero nutrition may not be enough to offset the variety of depriving educational circumstances that poorer households encounter in Mexico but it may complement further educational reforms seeking to transform such circumstances.

Finally, these findings also suggest that despite richer parents invest more on children with lower birthweight and thus lower health endowments, the detrimental effects of a low in-utero nutrition on grade repetition are still present. Potentially, parents' investments start late, possibly, when the detrimental effects of health start to be evident. Therefore, earlier government interventions may reduce potential negative effects of a low in-utero development also in less income-constrained households.

Appendix

TABLE A1. AVERAGE COMPARISON OF SAMPLE HOUSEHOLDS WITH ALL THOSE SURVEYED IN 2002

	At least two children			All households			
	OBS	**MEAN**	**SD**	**OBS**	**MEAN**	**SD**	**DIFF.**
Log of Income	1,876	10.15	1.06	2575	10.19	1.06	-0.04
Mother's schooling (years)	1,771	8.03	3.03	2397	8.07	3.01	-0.04
Siblings	2,219	2.22	1.23	3020	1.93	1.25	0.29
Girl	2,219	0.50	0.50	3020	0.50	0.50	0.00
Age	2,219	9.08	2.90	3020	9.33	3.07	-0.25
IQ	2,188	0.10	0.97	2970	0.12	0.97	-0.02
Standardized Height	2,015	0.17	0.67	2732	0.20	0.70	-0.03
Repeated Grade	1,836	0.14	0.35	2376	0.14	0.34	0.00
Years of Schooling	1,880	4.45	2.54	2435	4.74	2.69	-0.29
Attended Secondary	2,219	0.93	0.26	3018	0.93	0.26	0.00
School Expenses	2,219	564.07	1519.69	3020	594.20	1402.23	-30.13
Health Status	2,192	0.26	0.44	2985	0.25	0.44	0.01
Birthweight	2,219	3.32	0.68	3020	3.33	0.67	-0.01
Fetal growth gr. p/week	2,140	93.04	17.99	2916	93.40	17.76	-0.36
Relative Size at Birth (N=2208)							
Smaller	533	24.14		766	25.47		-1.33
Normal and Bigger	1675	75.86		1,820	74.53		

Source: author's elaboration based on the MxFLS 2002 to 2009.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Relative size at birth takes the values of 1 if the child is relative smaller or zero otherwise. "Children's bad health" is a dummy variable indicating with 1 if the child was rated as very bad or bad health or zero otherwise. IQ is standardized by age, height and weight by age and sex. School expenses are in Mexican pesos of 2002.

TABLE A2. SIBLING FIXED-EFFECTS MODELS OF CHILDREN'S YEARS OF SCHOOLING ON BIRTH WEIGHT AND FETAL GROWTH BY MOTHER'S EDUCATION

	MOTHER BELOW MEDIAN OF EDUCATION			MOTHER ABOVE MEDIAN OF EDUCATION		
	2002	2005	2009	2002	2005	2009
	(1)	(2)	(3)	(4)	(5)	(6)
A. Birthweight						
Kilograms	0.119	0.078	−0.241	−0.040	0.204	0.109
	(0.094)	(0.123)	(0.189)	(0.116)	(0.131)	(0.243)
R squared	0.963	0.946	0.923	0.966	0.962	0.907
Bottom Quartile	−0.001	−0.151	0.487	0.065	−0.260	−0.238
	(0.154)	(0.195)	(0.310)	(0.158)	(0.168)	(0.315)
R-sq	0.962	0.946	0.923	0.966	0.962	0.907
B. Fetal Growth						
Grams * 10	0.041	0.032	−0.081	−0.010	0.059	0.045
	(0.035)	(0.046)	(0.070)	(0.043)	(0.048)	(0.090)
R-sq	0.962	0.946	0.923	0.966	0.962	0.907
N	1058	1058	1058	742	742	742
Other Controls	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Standard errors clustered on households in parenthesis.
Children's "health" is a dummy variable indicating if the child was rated as very bad or bad health by her parents and zero otherwise. Other controls included are household's income, parents' education, children's age, sex, birth order and Raven's tests scores.

TABLE A3. SIBLING FIXED-EFFECTS MODELS OF ATTENDANCE RATES ON BIRTH-WEIGHT AND FETAL GROWTH BY MOTHER'S EDUCATION

	Mother Below Median of Education			Mother Above Median of Education		
	2002	2005	2009	2002	2005	2009
	(1)	(2)	(3)	(4)	(5)	(6)
A Birthweight						
Kilograms	0.010	0.001	−0.007	0.005	0.014	−0.037
	(0.019)	(0.028)	(0.043)	(0.021)	(0.027)	(0.050)
R squared	0.729	0.798	0.884	0.658	0.792	0.861
Botton Quartile	0.008	−0.009	0.109	0.022	−0.005	−0.028
	(0.031)	(0.045)	(0.071)	(0.028)	(0.035)	(0.065)
R squared	0.729	0.798	0.886	0.659	0.792	0.861
B. Fetal Growth						
Grams*10	0.004	0.000	−0.001	0.002	0.002	−0.014
	(0.007)	(0.010)	(0.016)	(0.008)	(0.010)	(0.018)
R-sq	0.729	0.798	0.884	0.658	0.792	0.861
N	1058	1058	1058	742	742	742
Other Controls	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Standard errors clustered on households in parenthesis.
Children's "health" is a dummy variable indicating if the child was rated as very bad or bad health by her parents and zero otherwise. Other controls included are households' income, parents' education, children's age, sex, birth order and Raven's tests scores.

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