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Working Paper

Roots of opportunity: Influences of early-life health on intergenerational mobility in a developing country

WIDER Working Paper, No. 76/25

Provided in Cooperation with:

United Nations University (UNU), World Institute for Development Economics Research (WIDER)

Suggested Citation: Quintão, Giovanna Pavlovic; Scorzaface, Luiz Guilherme (2025) : Roots of opportunity: Influences of early-life health on intergenerational mobility in a developing country, WIDER Working Paper, No. 76/25, ISBN 978-92-9267-635-7, The United Nations University World Institute for Development Economics Research (UNU-WIDER), Helsinki, <https://doi.org/10.35188/UNU-WIDER/2025/635-3>

This Version is available at:

<https://hdl.handle.net/10419/339084>

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Roots of opportunity

Influences of early-life health on intergenerational mobility
in a developing country

Giovanna Pavlovic Quintão¹ and Luiz Guilherme Scorzafave²

October 2025

Abstract: This study investigates the long-term effects of early-life health on intergenerational mobility in Brazil. Using the first cohort in Brazil, conducted in Ribeirão Preto city in 1978–79, linked to administrative income records, we study the effects of low birth weight on upward mobility and income inequality, conditional on several confounding factors. We find that individuals born with low birth weight have 13.5 percentage point chance to surpass their parents' income by at least 10 percentiles. The penalty for having poor early health remains if we use other measures of early health. Additionally, children with poor early health have less chance to complete higher education. Educational attainment partially mediates the effect of low birth weight on upward mobility. The inclusion of maternal smoking and insufficient prenatal care in our models does not significantly alter the estimated effect of low birth weight on upward mobility, suggesting that other prenatal and early-life factors contribute to the long-term disadvantages associated with low birth weight.

Key words: intergenerational mobility, early-life health, low birth weight, income inequality, education inequality

JEL classification: C21, I14, I24, J62,

Acknowledgements: We would like to thank the Child and Adolescent Health Study Center (NESCA/FMRP/USP) for providing the data essential to this research.

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This study is prepared within the UNU-WIDER project **Inequality over the life course**, which is part of the **Reducing inequalities across and within countries research area**.

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ISSN 1798-7237 ISBN 978-92-9256-635-3

<https://doi.org/10.35188/UNU-WIDER/2025/635-3>

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The Institute is funded through income from an endowment fund with additional contributions to its work programme from Finland and Sweden, as well as earmarked contributions for specific projects from a variety of donors.

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The views expressed in this paper are those of the author(s), and do not necessarily reflect the views of the Institute or the United Nations University, nor the programme/project donors.

1 Introduction

Why are some individuals able to move up the economic ladder while others remain in the same or worse position compared to their parents? One explanation is the differences in early investments in health and education, which reflect the accumulation of human capital. This human capital is related to long-term outcomes (Heckman 2007), and the prenatal environment is one of the earliest investments in human capital accumulation.

While the literature on intergenerational mobility has documented the importance of factors such as neighbourhood conditions and race (Chetty et al. 2014, 2019), the specific role of early-life health remains largely unexplored, particularly in developing countries. Most research on early-life health examines its impact on adult wages or health status, but a direct link to intergenerational mobility is seldom established. The few studies that do address this connection are limited to developed countries and often rely on aggregated data rather than individual-level longitudinal follow-up (Heinonen et al. 2013; Robertson and O'Brien 2018).

In this paper, our primary metric is upward mobility, which we define, following Corak et al. (2014), as the probability that an individual achieves an adult wage rank exceeding that of their parents by a specified margin. Our main indicator of early-life health is low birth weight (LBW), defined as a birth weight below 2,500 grams (World Health Organization 1961). LBW often results from adverse prenatal conditions (inadequate nutrition, maternal stress, smoking, or poor prenatal care) that hinder fetal development (Johnson and Schoeni 2011). As an early marker of human capital, we confirm the hypothesis that LBW has a lasting association with individual life outcomes.

We use the first birth cohort in Brazil, conducted in Ribeirão Preto (1978–79), a city located in the state of São Paulo. We link the cohort data to administrative records on income and employment in adulthood, enabling us to track individuals from birth into their thirties and forties while controlling for a comprehensive set of socioeconomic and family background characteristics at birth. Our final main sample includes 2,902 individuals, with information on parental household income, wages in adulthood, and measures of early health. At the time of data collection, Ribeirão Preto was a mid-sized city with a population of 318,544. Educational attainment was low—only one-third of the population aged 15 and older had completed the equivalent of primary education (IBGE 1982). The fertility rate was 2.6 live births per woman, and the infant mortality rate was 36.9 per 1,000 live births (Carvalho et al. 2020), which is comparable to those observed today in low-income countries.

Our empirical strategy relies on a selection-on-observables approach, estimating probit and OLS models of educational attainment, adult income rank, and upward mobility as a function of early-life health. We include as control the parental income rank and family background char-

acteristics to isolate the association between birth weight and mobility. We conduct robustness checks to address potential concerns relative to sample selection and measurement of adult outcomes.

We find that poor early-life health reduces both wages in adulthood and upward mobility. Being born with LBW decreases the probability of surpassing one's parental income rank by any margin by 11.8 percentage points (p.p.), corresponding to a 31.3% decrease in the baseline. In terms of absolute position in the distribution, LBW results in a 6 percentile decrease in adult wage rank. We also show that LBW has an effect on higher education attainment; however, the effect of LBW on upward mobility is not mediated solely by educational attainment. We also show that LBW increases the mortality risk by 75% relative to the baseline, and reduces the probability of formal labour market participation by 21% compared to the baseline rate.

Our contribution is to provide the first evidence linking early-life health to upward mobility in a developing country. Studying this relationship in such contexts is crucial, as early health shocks may have more severe long-term effects due to a weaker institutional capacity to buffer early disadvantages.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the data and empirical strategy. Section 4 presents the results. Section 5 discusses the mechanisms and drivers. Section 6 presents other results. Section 7 presents the robustness tests. Section 8 discusses the results, and Section 9 concludes.

2 Related literature

The literature on the long-term effects of early health traditionally distinguishes between the effects of nature and nurture. Nature refers to genetic effects, while nurture pertains to environmental influences. However, the field of epigenetics demonstrates that genetic factors often manifest only under specific environmental conditions, and then nature and nurture are interconnected (Heckman 2007).

The economics literature that employs twin fixed-effects models to measure the effects of LBW on adult outcomes aims to isolate the impact of nurture. In these studies, LBW is not treated as a proxy for early health but rather as a direct condition in itself. The results of twin studies are consistent in finding effects on educational medium-term outcomes such as high school completion in Norway, the United States, and Canada (Behrman and Rosenzweig 2004; Black et al. 2007; Oreopoulos et al. 2008), academic achievement at 15 years of age in Japan (Nakamuro et al. 2013), and school grades at 15 years of age in Taiwan (Lin and Liu 2009).

The evidence on the effects of LBW on earnings is less consistent. Nakamuro et al. (2013) find

no significant impact of LBW on wages using twin fixed-effects estimations. However, the authors caution against concluding that LBW has no long-term effects, since their earnings variable is self-reported and therefore subject to measurement error. Similarly, Miller et al. (2005) find no effect of LBW on educational attainment and a limited impact on earnings in the Australian twins sample—each additional ounce (28.4 g) of birth weight is associated with a 0.4% increase in wages. In contrast, Black et al. (2007) suggest a more substantial relationship: both OLS and twin fixed effects estimate that a 10% increase in birth weight leads to an approximately 1% increase in full-time earnings.

Since these effects are identified using twin fixed effects, they do not account for the broader effect of prenatal environmental factors, such as maternal stress or smoking during pregnancy, on later outcomes. Studies that employ sibling fixed effects or cohorts controlling for observable characteristics are better suited to capturing the overall effects of early health, rather than isolating the impact of LBW alone. Our paper aligns more closely with this literature, specifically studies using cohorts.

Fletcher (2011) uses sibling comparisons in the United States and finds negative effects of LBW on educational outcomes. However, they do not find significant effects on long-term outcomes, contrasting with Johnson and Schoeni (2011), who also employ sibling fixed effects and identify a substantial negative impact on the labour market: LBW reduces earnings by 15%. Two cohort studies using the 1958 British cohort find negative effects of LBW on educational outcomes (Case et al. 2005; Currie and Hyson 1999). However, they reach different conclusions regarding earnings in adulthood. Currie and Hyson (1999) do not find statistically significant effects of LBW on adult earnings. In contrast, Case et al. (2005) find that adverse prenatal conditions—such as maternal smoking and LBW—are associated with worse employment and earnings outcomes in adulthood, though the effects are modest.

Studies use cohort control for socioeconomic conditions during childhood, as these conditions significantly influence child health and can be a confounding factor. For instance, research in developing countries using quasi-experimental variations from expansions in compulsory schooling demonstrates that increasing years of mandatory education reduces the incidence of very LBW and improves other birth outcomes (Chou et al. 2010; Güneş 2015).¹

In developing countries, most of the empirical evidence on early-life health focuses on the effects of specific interventions or adverse in-utero shocks (nutritional intake, droughts, disease outbreaks, pollution, and conflict) on later-life outcomes. These studies emphasize how prenatal environmental conditions shape long-term human capital formation (for a comprehen-

¹ However, similar studies in European countries have not found significant effects of increased maternal education, through compulsory schooling reforms, on reducing LBW (Arendt et al. 2021; Chevalier and O’Sullivan 2007).

sive overview, see Currie and Vogl 2013). However, fewer studies examine the direct effect of early-life health status on adult socioeconomic outcomes, independently of external shocks or interventions. This leaves a gap in understanding the broader implications of baseline prenatal health conditions on long-term mobility.

Studies that examine long-term consequences of LBW used cohorts from Brazil, Guatemala, India, the Philippines, and South Africa (Victora et al. 2008). Maternal and child under-nutrition, measured by birth weight and early growth, are associated with health outcomes (body mass index, glucose concentrations) and schooling attainment. The income results are available for Guatemala and Brazil: in Guatemala, no significant association was found between birth weight and adult income; in Brazil, a 1 kg increase in birth weight was associated with a 0.12 increase in the log of annual income. The difference in results may be explained by the timing of adult income measurement as it was measured in Brazil at different life stages—ages 21–23 in Brazil and 26–41 in Guatemala. In Guatemala, the analysis was limited to four rural villages. An exception to the cohort-based studies is the work by Rosenzweig and Zhang (2013), which uses a twin fixed-effects strategy in China and finds a causal impact of birth weight on both schooling and earnings, with heterogeneity across gender and occupational sectors.

Our study complements the cohort-based research in Brazil and Guatemala from Victora et al. (2008) by providing broader effects on long-term outcomes (upward mobility), and investigating a broader and more representative population over a longer horizon.

Finally, evidence on the effects of early health on intergenerational mobility is limited and focused on the United States. Evidence suggests that preterm children have lower upward mobility (Heinonen et al. 2013), counties with higher rates of LBW tend to have lower economic mobility (Robertson and O'Brien 2018), and higher cigarette taxes can improve educational mobility by reducing maternal smoking (Settele and Van Ewijk 2018).

We contribute to the intergenerational mobility literature by providing the first evidence of the effects of early health conditions on upward mobility in a developing country, using cohort data that allow individuals to be tracked over time.

3 Methodology and data

3.1 Empirical specification

Our main estimation analyses the effect of early-life health on upward mobility. We adapt the directional upward mobility measure proposed by Corak et al. (2014) and we define upward mobility (UP) as the probability that an individual attains higher rank in adulthood than their

parents by at least τ , conditional on a set of covariates Z :

$$UP_{\tau} = \Pr(Y_1 - Y_0 > \tau | Z) \quad (1)$$

where Y_1 denotes the child's wage rank and Y_0 the parent's household income rank. The vector Z includes our main variable of interest, LBW, as well as family characteristics at birth ($\mathbf{X}$: mother's education, single motherhood, mother's age, and family size at birth), individual characteristics ($\mathbf{H}$: race and sex), and the parental income rank (Y_0).

We estimate a probit model of the latent index Y_i^* given by:

$$Y_i^* = \alpha + \delta \text{LBW}_i + \mathbf{X}_i\beta + \gamma Y_{0i} + \mathbf{H}_i\theta + \varepsilon_i \quad (2)$$

with the observed outcome defined as

$$Y_i = \begin{cases} 1 & \text{if } Y_i^* > 0 \quad (\text{child attains upward mobility}) \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

We estimate three measures of upward mobility: the probability that an individual, in adulthood, surpasses their parental income rank (UP_0); the probability of surpassing it by at least 10 percentiles (UP_{10}); and the probability of surpassing it by at least 20 percentiles (UP_{20}).

We measure income ranks in adulthood and childhood (parental) following Chetty et al. (2014), by calculating the position that each individual or parent i occupies in their respective wage or income distribution. These positions range from 0 to 100, and the ranks are computed within each sample (Table 1).

Table 1: Number of individuals in sample, by birth weight status

Sample	LBW status		Total (n)
	Non-LBW (n)	LBW (n)	
Main sample	2,756	196	2,952
Intermediate outcomes sample	1,919	145	2,064
Robustness sample	1,364	95	1,459

Note: the table reports the number of individuals by sample and LBW status. LBW refers to individuals born with birth weight below 2,500 g, while non-LBW refers to those above this threshold. The main sample consists of individuals linked to administrative labour market and social registry data. The intermediate outcomes sample includes individuals surveyed between ages 22 and 25. The robustness sample corresponds to individuals observed in additional follow-up surveys conducted between ages 35 and 39.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

Parental income is captured at birth (in 1978–79) as the household family income from all sources.² Adult wages refer to the average monthly earnings from all jobs between 2011 and

² The income question in the cohort survey was: 'How much did you and your family members receive last

2020. Since not all individuals are observed in every year, we compute an adult wage as the average of available annual wages. Half of the sample appears in at least 7 out of the 10 years. We show in the robustness checks that our results are not sensitive to how adult wages are defined.

3.2 Data sources

Our sample consists of the cohort born between 1 June 1978 and 31 May 1979 in the hospitals of Ribeirão Preto (Brazil), with mothers who lived in the city. The baseline data collection at birth was executed by the Ribeirão Preto Medical School of the University of São Paulo (FMRP-USP) and aimed to monitor the health of individuals from birth to adulthood. In Brazil, this was the first longitudinal study that followed a cohort from birth (Barbieri et al. 2021).

In the baseline survey, 9,067 interviews were conducted with mothers soon after delivery. These interviews were conducted in the maternity wards themselves and covered 98% of newborns from 1978 to 1979.³ Mothers who did not reside in Ribeirão Preto were excluded from the survey, making the size of the study population 6,973.

In our main estimations we use two administrative databases covering 2011–20 to obtain adulthood wages for the cohort. The first, RAIS (the Annual Social Information Report), is Brazil's formal labour market database, covering all employed individuals in registered jobs. RAIS includes data on education, employment status, and income; these data are reported by employers and used for the social security system.⁴ However, RAIS does not capture individuals in informal employment, who are often at the lower end of the income distribution. To include these individuals, we use Cadastro Único, an administrative registry maintained and regularly updated by the Ministry of Social Development. Cadastro Único tracks the socioeconomic conditions of families with per capita income below half the minimum wage. Of the 5,147 individuals in the cohort with income information in 1978–79 and some form of identifying information (e.g., name, mother's name, or *Cadastro de Pessoas Físicas*⁵), we obtained socioeconomic data in adulthood for 58.6%. We find 2,852 individuals (55.4%) in RAIS and 165 individuals

month?'. Interviewers clarified that income should include all sources, such as wages, investments, rental income, pensions, donations, and any other types of earnings (Aitsi-Selmi et al. 2013). For approximately 15% of the main sample, information on household income was missing. However, data on the mother's age, education (nine categories), and occupation were available. In these cases, we impute household income by predicting it through a linear regression model.

³ Overall, 2.5% of mothers left the hospital before they could be interviewed, and less than 1% refused to be interviewed (Barbieri et al. 2021).

⁴ Data from the National Census 2010 shows that approximately 49.7% of the 1978–79 cohort had formal employment in 2010.

⁵ CPF, the Brazilian individual taxpayer identification number.

(5.8%) only in Cadastro Único. Our baseline sample consists of 2,952 individuals with valid income information at both birth and adulthood. The details of the data construction are given in Figure A2 in the Appendix. Our data set lacks information on people with informal jobs who earn more than half the minimum wage per capita, which represents approximately 28% of the cohort population according to the National Census 2010. We perform robustness estimations to account for sample bias.

The Medical School of the University of São Paulo, which is responsible for the baseline cohort, also conducted follow-up surveys into adulthood. We use two of these follow-up surveys in supplementary analyses. The first, which we refer to as the intermediate outcomes sample, was conducted when participants were aged 22–25 ($n = 2,064$) and provides information on intermediate adult outcomes. The second, which we refer to as the robustness sample, was conducted when individuals were aged 37–39 ($n = 1,775$). We use this sample to replicate the main estimations, relying on cohort data rather than administrative records. Details on these samples are presented in Figure A1 and Table 1.

The main sample includes 2,952 individuals, of which 196 (6.6%) were classified as LBW. The intermediate outcomes sample, observed when individuals were 22–25 years old, consists of 2,064 participants, with 145 (7.0%) LBW. Finally, the robustness sample, collected at ages 37–39, includes 1,459 individuals, of whom 95 (6.5%) were LBW.

3.3 Descriptives

Table 2 reports the descriptive statistics of the birth characteristics collected in 1978–79 and adult outcomes for our main sample. Overall, 28% of mothers reported smoking during pregnancy, which is higher than the current global prevalence of 1.7% (Lange et al. 2018). Mothers in our cohort attended an average of 5.8 prenatal care visits, which exceeds the World Health Organization’s earlier minimum recommendation of four visits, though still below the current guideline of eight. LBW children have, on average, a worse prenatal environment with more mothers who smoked during pregnancy (27% vs 40%) and had fewer prenatal care appointments.

Adverse early health outcomes are also concentrated among LBW newborns. While 5% of non-LBW births are preterm, this share rises to 41% among LBW births. Similarly, the prevalence of small-for-gestational-age (SGA) rises from 6% in the non-LBW group to 45% in the LBW group.⁶

⁶ We classify SGA using INTERGROWTH-21st international newborn size standards (Papageorgiou et al. 2018): an infant is SGA if birth weight is below the 10th percentile of the reference for their gestational age (in days) and sex.

Table 2: Descriptive statistics

Variable	LBW status: Mean (SD)		
	Non-LBW	LBW	All
<i>Prenatal environment</i>			
Mother smokes during pregnancy	0.27 (0.44)	0.39 (0.49)	0.28 (0.45)
Prenatal appointments <4	0.15 (0.36)	0.22 (0.42)	0.16 (0.36)
No. prenatal appointments	5.83 (2.00)	5.18 (2.07)	5.79 (2.01)
<i>Early health outcomes</i>			
Preterm birth	0.05 (0.21)	0.41 (0.49)	0.07 (0.25)
SGA	0.06 (0.24)	0.45 (0.50)	0.09 (0.28)
Birth weight (g)	3,329.90 (430.79)	2,199.48 (249.46)	3,255.58 (505.93)
<i>Family characteristics at birth</i>			
Mother exclusively domestic work	0.82 (0.39)	0.83 (0.37)	0.82 (0.39)
Single mother	0.07 (0.25)	0.13 (0.33)	0.07 (0.26)
No. household members	4.42 (2.23)	4.61 (2.23)	4.43 (2.23)
Mother's age	25.81 (5.84)	25.53 (6.42)	25.79 (5.88)
<i>Mother's education at birth</i>			
Complete high school	0.12 (0.32)	0.06 (0.24)	0.11 (0.32)
Complete higher education	0.06 (0.23)	0.01 (0.10)	0.05 (0.23)
Incomplete high school	0.83 (0.38)	0.93 (0.26)	0.83 (0.37)
<i>Income at birth</i>			
Monthly parental household income (min. wage)	4.71 (4.76)	3.47 (3.20)	4.62 (4.68)
Monthly parental household income per cap. (min. wage)	1.13 (1.25)	0.78 (0.88)	1.11 (1.23)
<i>Individual characteristics</i>			
Non-white	0.25 (0.43)	0.32 (0.47)	0.25 (0.44)
Sex = woman	0.48 (0.50)	0.55 (0.50)	0.48 (0.50)
<i>Adult outcomes</i>			
Adult wage (BRL)	2,885.03 (3,581.64)	1,905.29 (1,527.43)	2,820.61 (3,492.29)
Registered at social registry (CadÚnico)	0.18 (0.39)	0.21 (0.41)	0.19 (0.39)
Complete high school (adult)	0.56 (0.50)	0.62 (0.49)	0.57 (0.50)
Complete higher education (adult)	0.27 (0.44)	0.14 (0.34)	0.26 (0.44)
Incomplete high school (adult)	0.17 (0.37)	0.25 (0.43)	0.17 (0.38)

Note: the table presents descriptive statistics for the main sample, separating individuals by LBW (birth weight <2,500 g). Values show means, with standard deviations in parentheses. Preterm births are defined as gestational age under 37 weeks and SGA as birth weight below the 10th percentile of the international reference for gestational age and sex. Non-white individuals are Black, Indigenous, or other racial groups. Monthly parental household income is expressed as the minimum wage at birth and express adult salary in Brazilian reais (BRL), deflated to 2020 values using the INPC index. Registration at the social registry (Cadastro Único) refers to individuals linked to Brazil's national social assistance database, who receive less than half the minimum wage per capita.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

The majority of mothers in our sample are engaged exclusively in domestic work (82%), are not single mothers (single mothers account for only 7.0%), and have incomplete high school education (83%). Additionally, the average family size when the cohort member is born is 4.4. Individuals born with LBW are more likely to come from disadvantaged backgrounds. Mothers of LBW children more frequently had incomplete high school (93%) than mothers of non-LBW children (83%). Average family income at birth among LBW individuals was 3.5 minimum

wages, compared to 4.7 minimum wages among non-LBW, and per capita income averaged 0.78 minimum wages versus 1.13 minimum wages, respectively.

A larger share of individuals born with LBW are non-white (Black, Indigenous, or other racial groups), and the proportion of women is also higher among the LBW group compared to the non-LBW group. In adulthood, individuals born with LBW have worse outcomes than non-LBW adults. Average adult salary is lower among LBW individuals (BRL1,905) compared to non-LBW (BRL2,885). The likelihood of being registered in the government's social registry (Cadastro Único) is slightly higher for LBW individuals (21%) relative to non-LBW (18%), and the likelihood of completing higher education is lower (21% vs 33%).

4 Main results

4.1 Effects of early health on upward mobility

In this section, we examine how early-life health affects upward mobility, which we define as the probability that an individual's adult wage rank is at least 20, 10, or 0 percentiles higher than the parental household income rank (measured at birth). Table 3 shows the average marginal effect of early-life health measures on upward mobility. Across all specifications, we find a consistent and negative association between poor early-life health and the likelihood of upward mobility. Panel A shows that individuals born with LBW are, on average, 8.7 p.p. less likely to move more than 20 percentiles above their parents' rank (UP_{20}), which corresponds to a decrease in 31.3% of the baseline upward probability (27.8%). Individuals born with LBW are 13.5 p.p. less likely to surpass their parents by at least 10 percentiles, and 12.2 p.p. less likely to surpass them by any margin. These effects correspond to reductions of 32.4% and 24.1%, respectively, relative to the baseline probabilities of upward mobility.

LBW can arise as a result of two different factors: shortened gestational length (i.e. preterm birth) or intrauterine growth restriction (IUGR) (Hughes et al. 2017). Shortened gestational length is a result of inadequate prenatal care, but also of genetic predisposition and caesarean delivery, which, in Brazil, is positively correlated with higher socioeconomic status (Silva et al. 1998). On the other hand, IUGR is directly associated with adverse intrauterine environments, including poor maternal nutrition and limited access to prenatal care (Sharma et al. 2016).⁷ A method to measure IUGR is SGA, defined as a birth weight below the 10th percentile of international standards for gestational age and sex.⁸ We estimate the effect of SGA on upward mobility in Panel B of Table 3. Individuals born SGA have 5–7 p.p. less chance of upward mobility

⁷ Although IUGR can also arise because of genetic predisposition (Sharma et al. 2016).

⁸ We used the INTERGROWTH-21st standard score from Papageorgiou et al. (2018).

compared to those with appropriate weight for their gestational age. Although smaller than the LBW effect, this penalty remains sizeable relative to baseline rates of upward mobility, representing a reduction of up to 17.6%.

Table 3: Probit: average marginal effects of early health on upward mobility

	UP_{20}	UP_{10}	UP_0
<i>Panel A: LBW as main regressor</i>			
Low birth weight	−0.087 (0.024)***	−0.135 (0.026)***	−0.122 (0.031)***
Family controls	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes
No. observations	2,902	2,902	2,902
<i>Panel B: SGA as main regressor</i>			
Small for gestational age	−0.049 (0.022)**	−0.052 (0.025)**	−0.070 (0.027)***
Family controls	Yes	Yes	Yes
individual controls	Yes	Yes	Yes
No. observations	2,902	2,902	2,902
<i>Panel C: Log birth weight as main regressor</i>			
Log birth weight	0.099 (0.042)**	0.165 (0.045)***	0.206 (0.050)***
Family controls	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes
No. observations	2,902	2,902	2,902
<i>Panel D: Mean of the dependent variable</i>			
	0.278	0.376	0.506

Note: Panels A–C report results for the average marginal effect from different probit regressions. Panel D shows the mean of the dependent variable. Panel A shows the average marginal effect of LBW (<2,500 g) on upward mobility. Panel B reports estimates using SGA as the main regressor. Panel C presents results using log birth weight as the main regressor. We report robust standard errors in parentheses. UP_{20} , UP_{10} , and UP_0 are indicator variables equal to 1 if the individual's adult wage rank is at least 20, 10, or 0 percentiles higher than the parental household income rank (measured at birth), respectively. All specifications include the following controls: mother's age at birth; parental income rank at birth; mother's education; number of household members at birth; indicator if mother works exclusively in domestic work; single-mother indicator; sex; and race. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

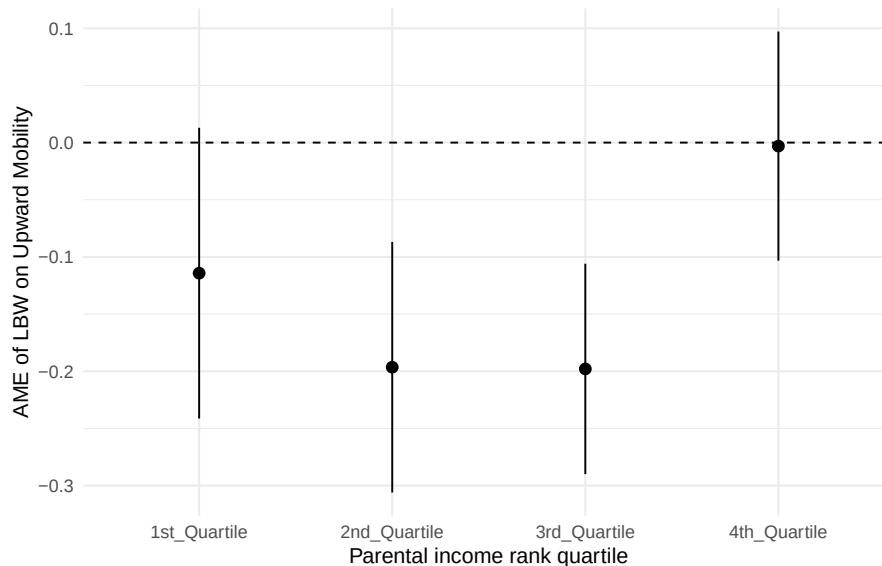
Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

Panel C of Table 3 estimates models using a continuous measure of birth weight (log grams) to avoid relying on the arbitrary 2,500 g cut-off and the manipulation around that threshold. A 10% increase in birth weight raises the probability of upward mobility by about 1–2 p.p., corresponding to a 3.6–4.4% increase relative to the baseline probability.

We investigate the heterogeneous effect of LBW on upward mobility according to the parental income-rank distribution in childhood. We divide the parental income-rank distribution into quartiles and estimate the upward mobility (UP_{10}) using interactions between LBW and quartiles of parental rank in childhood (Table A1). Figure 1 shows the result. The LBW penalty is largest (in percentage-point terms) for the second and third quartiles, smaller in the first quartile, and weakest in the fourth quartile. The attenuation at the top is consistent with a mechanical ceiling, which individuals starting near the upper tail have limited headroom to move up. A hypothesis for the LBW penalty being lower (in points) at the bottom is that children from the lowest-income families face multiple structural barriers to upward mobility, such as worse schooling opportunities, labour market disadvantages, and limited family resources. In this

context, LBW is one additional constraint among many, so its marginal impact on mobility is comparatively smaller. By contrast, for individuals from the second and third quartiles LBW may be one of fewer barriers, and therefore imposes a sharper penalty.

Figure 1: Average marginal effect of LBW on upward mobility (UP_{10}) by parental income quartile



Note: the figure plots the average marginal effect of being born with LBW (<2,500 g) on the probability of upward mobility defined as UP_{10} (indicator equal to 1 if the individual's adult wage rank is at least 10 percentiles higher than the parental household income rank), estimated separately by quartiles of parental income rank. Points indicate average marginal effects from the probit regression. Vertical bars denote 95% confidence intervals calculated using robust standard errors. The probit regression includes the following controls: quartiles of parental household income rank interacted with LBW, mother's age at birth, mother's education, number of household members at birth, indicators for single motherhood, indicator if mother works exclusively in domestic work, child's sex, and race. The average marginal effects are reported in Table A1.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

4.2 Effects of early health on adult income

We investigate whether early-life health is associated with income in adulthood, complementing the results on upward mobility. Column 1 of Table 4 shows that being born with LBW reduces adult income rank by approximately 6 percentiles. This magnitude is substantial when compared with the intergenerational persistence of income: the effect of LBW is similar to that of having parents positioned 37 percentiles lower in the income distribution. Column 2 reports the results using birth weight as a continuous variable. A 10% increase in birth weight raises wages in adulthood by 2.8%.

Table 4: OLS results: effects of prenatal factors on wage in adulthood

	Wage rank in adulthood (1)	Log wage in adulthood (2)
Low birth weight	−6.091*** (1.801)	
Log birth weight		0.284*** (0.090)
Parental household income rank	0.162*** (0.021)	0.005*** (0.001)
Mother's age	0.127 (0.111)	0.004 (0.003)
Mother: complete high school	11.686*** (1.823)	0.379*** (0.053)
Mother: complete higher education	17.880*** (2.363)	0.659*** (0.082)
No. household members	−1.509*** (0.324)	−0.039*** (0.008)
Mother in domestic work	1.136 (1.432)	0.059 (0.045)
Single mother	−3.083 (2.021)	−0.087 (0.061)
Sex = woman	−11.434*** (0.980)	−0.271*** (0.028)
Race = white	5.317*** (1.169)	0.160*** (0.036)
(Intercept)	44.271*** (3.066)	5.019*** (0.730)
Observations	2,902	2,902
R ²	0.175	0.181
Adjusted R ²	0.172	0.178

Note: this table reports OLS estimates of the effect of prenatal factors on adult wage outcomes. Column 1 uses as the dependent variable the individual's wage rank in adulthood (0–100), while column 2 uses the logarithm of adult wages. Robust standard errors are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: authors' calculations based on the 1978–79 Ribeirão Preto Cohort Study.

5 Mechanisms and drivers

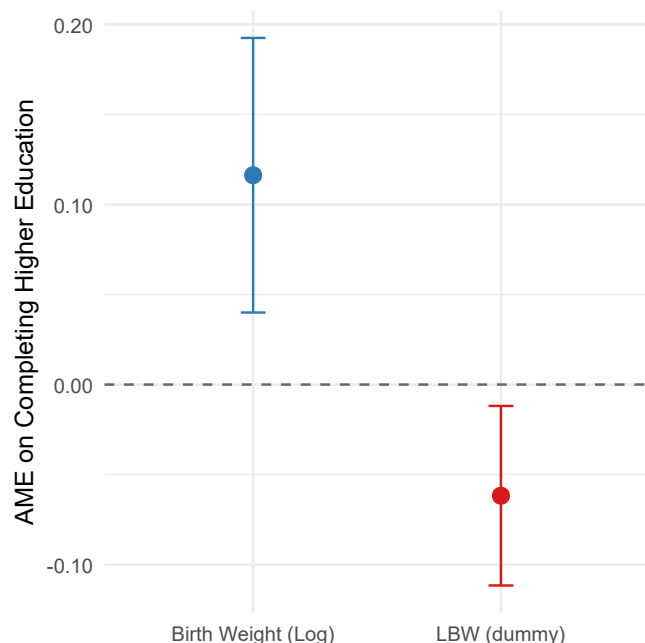
5.1 Mechanisms

In this section we investigate whether education attainment mediates the relationship between early-life health and upward mobility. We estimate the probability of completing higher education⁹ conditioning on birth weight and family and individual characteristics. In Figure 2 we show the average marginal effects of LBW and birth weight on higher education completion, calculated using the estimates in columns 3 and 4 of Table A4. LBW reduces the probability of completing higher education by 6.2 p.p., and a 10% increase in birth weight increases the probability by around 1.2 p.p.

Since educational attainment is strongly correlated with wages in adulthood, it is expected to also be associated with upward mobility. Columns 2, 4, and 6 of Table 5 confirm this relationship. Completing higher education increases the probability of upward mobility by approximately 25–28 p.p. relative to completing only high school. Including the child's education in the specification does not change significantly the LBW effect, indicating that poor early-life health influences upward mobility in adulthood not only through education but also through other mechanisms.

⁹ We measure individuals' educational attainment using the same administrative data source as income, covering the period 2011–20.

Figure 2: Average marginal effects of birth weight on higher education completion



Note: this figure reports the average marginal effects of birth weight on the probability of completing higher education. Estimates are based on columns 3 and 4 of Table A4. The left bar shows the effect of log birth weight, while the right bar shows the effect of an LBW dummy. Confidence intervals are reported at the 10% level. Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

Although we cannot directly link characteristics observed in early adulthood (ages 22–25) to outcomes in late adulthood, we examine whether poor early health is associated with early adulthood outcomes using intermediate outcomes in Table A2. We do not find statistically significant effects of LBW on preschool attendance, working before age 18, early marriage (before age 25), or early childbearing (before age 25). The only significant association appears for college enrolment, where individuals born with LBW are less likely to be enrolled before age 25. This result is consistent with the evidence from our main sample, reinforcing the role of higher education as a channel through which early health disadvantages translate into upward mobility.

Table 5: Average marginal effects of LBW on upward mobility, with and without adult education

	UP_{20}		UP_{10}		UP_0	
Low birth weight	-0.087 (0.024)***	-0.071 (0.024)***	-0.135 (0.026)***	-0.115 (0.027)***	-0.122 (0.031)***	-0.092 (0.032)***
Child: complete HE – complete HS		0.270 (0.017)***		0.274 (0.016)***		0.306 (0.016)***
Child: incomplete HS – complete HS		-0.111 (0.014)***		-0.142 (0.016)***		-0.145 (0.017)***
Family controls	Yes	Yes	Yes	Yes	Yes	Yes
Individual characteristics controls	Yes	Yes	Yes	Yes	Yes	Yes
Mean of dependent variable	0.278	0.278	0.376	0.376	0.506	0.506
No. observations	2,902	2,901	2,902	2,901	2,902	2,901

Note: the table reports average marginal effects from probit models of upward mobility. UP_{20} , UP_{10} , and UP_0 are indicator variables equal to 1 if the individual's adult wage rank is at least 20, 10, or 0 percentiles higher than the parental household income rank (measured at birth), respectively. LBW is defined as birth weight <2,500 g. Complete HE refers to completed higher education, complete HS to completed high school, and incomplete HS to incomplete high school. Coefficients represent average marginal effects with robust standard errors in parentheses. Family controls include mother's age, education, number of household members, indicator if mother is single, and indicator if mother works exclusively in domestic work. Individual controls include sex and race of the child. Adult education controls distinguish complete higher education and incomplete high school relative to complete high school. Means of dependent variable and sample size are reported at the bottom of each column. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

5.2 Drivers

Our findings show that poor early health, measured by LBW, acts as a barrier to upward mobility across the income distribution. The drivers behind the LBW effect on this intergenerational mobility are not fully understood, but Johnson and Schoeni (2011) propose four reasons for the association between birth weight and adult outcomes. First, birth weight may reflect the causal effect of prenatal inputs and fetal environmental conditions, such as the quality of prenatal care, maternal stress levels, and nutritional status, which influence later outcomes. Second, LBW can be linked to postnatal parental investments, as parents can allocate time, education, or resources, either compensating for or penalizing children with poor health. Third, there may be a genetic relationship, where the genetic factors influencing birth weight are positively correlated with those affecting adult outcomes. Fourth, LBW and long-term outcomes can be a result of gene–environment interaction, where genetic predispositions and prenatal environmental conditions jointly contribute to the association.

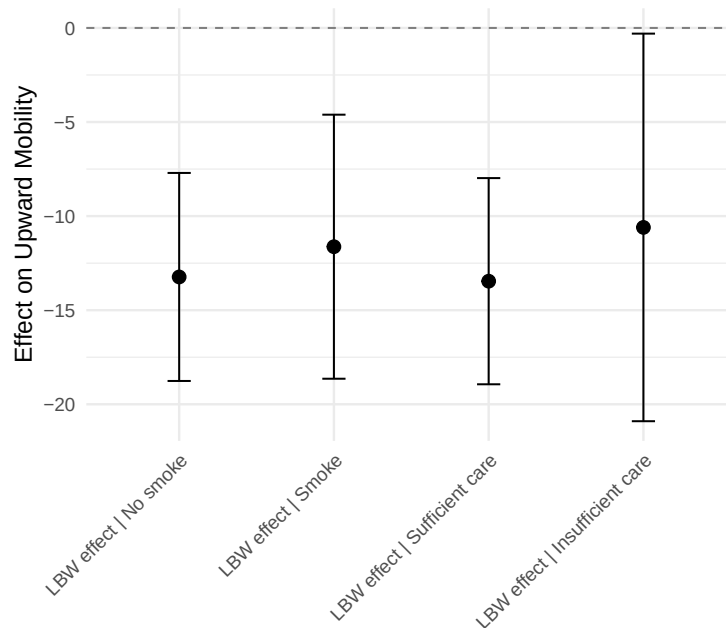
From a policy standpoint, identifying which mechanisms drive the relationship between birth weight and adult outcomes is useful. If prenatal conditions (factor 1) or gene–environment interactions (factor 4) play a major role, then policy-makers can intervene through programmes that improve prenatal care, such as maternal nutrition, stress reduction, and access to medical services. If postnatal parental investment (factor 2) explains a substantial part of the effect, policies supporting early childhood development and parental education can help offset initial health disadvantages. If genetic factors (factor 3) primarily drive the association, then birth weight offers limited guidance for designing effective policy interventions. However, evidence suggests that genetic factors play a minimal role. Black et al. (2011) find that the impact of lower birth weight on adult outcomes being similar for monozygotic (genetically identical) and fraternal twins implies that prenatal environmental and postnatal conditions are the primary drivers of this relationship.

To disentangle which prenatal conditions (factor 1) contribute to upward mobility, we extend our main analysis by incorporating maternal smoking during pregnancy and insufficient prenatal care (defined as fewer than four appointments). Maternal smoking during pregnancy may impair fetal nutrition and expose the fetus to harmful chemicals that disrupt brain development (Lindblad et al. 1988; Shea and Steiner 2008). Prenatal care plays a critical role by providing routine monitoring of maternal and fetal health, nutritional guidance, management of physiological conditions, and the delivery of preventive interventions (World Health Organization 2016). While other prenatal conditions may also contribute to the relationship, we are unable to measure them in our data.

We estimate the effect of LBW on the probability of upward mobility, conditioning on maternal smoking, insufficient prenatal care, and their interactions with LBW. In Figure 3 we show the

average marginal effects of LBW on upward mobility for each group according to their smoking and prenatal care status. The results show no statistically significant differences in the estimated effects between groups, suggesting that the LBW effect on upward mobility is driven by other factors. These other factors can be maternal stress, the overall quality of prenatal care beyond simple appointment counts, or restricted nutrition. Another possible pathway is through parental investment decisions: parents may perceive lower returns to investing in children born with LBW and may allocate fewer resources.

Figure 3: LBW effects on upward mobility (UP_{10}) by maternal smoking and prenatal care



Note: the figure reports average comparisons of LBW (<2,500 g) effect across groups on upward mobility (UP_{10}). The first group includes children whose mothers did not smoke during pregnancy (no smoke), while the second group includes those whose mothers smoked (smoke). The third group refers to children whose mothers attended at least four prenatal care visits (sufficient care) and the fourth group consists of those whose mothers had fewer than four prenatal appointments (insufficient care). The estimated average marginal effects are in Table A7. The models control for: mother's age at birth; parental income rank at birth; mother's education; number of household members at birth; indicator if mother works exclusively in domestic work; single-mother indicator; sex; and race. Vertical bars denote 90% confidence intervals, calculated using robust standard errors. Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

6 Beyond upward mobility

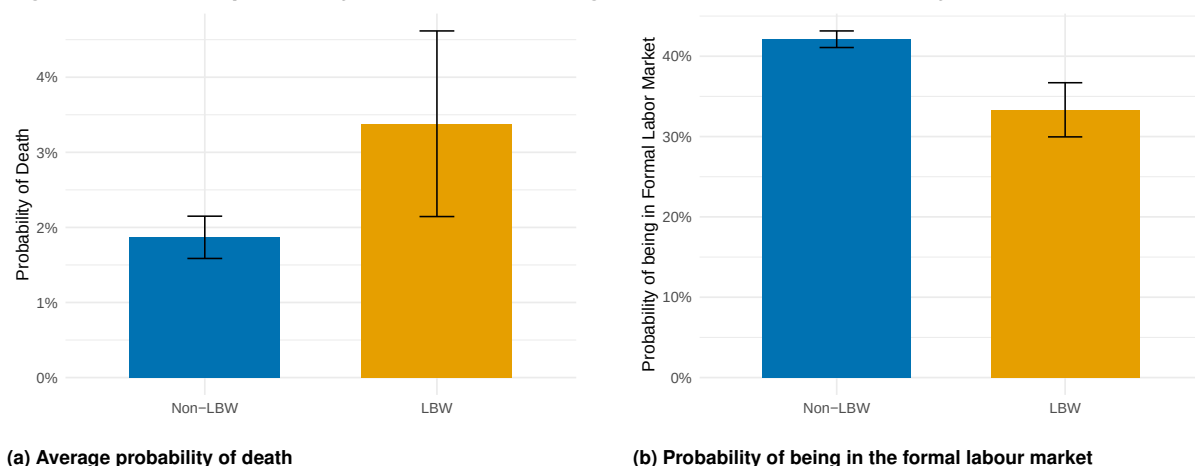
Our analyses of upward mobility necessarily condition on who is observed with earnings, which is individuals who survive to early adulthood and are attached to the labour market. Poor early health can affect both margins, shrinking the set of people who can even enter the mobility sample. Because of this selection, we examine how early-life health is associated with: (1) be-

ing recorded as deceased by age 39,¹⁰ and (2) participation in the formal labour market. For labour market attachment, we proxy participation using presence in formal sector administrative records. Ideally, we would analyse the probability of being out of the labour market, but this outcome is not observable in our data (see Figure A2).

Figure 4 shows that LBW worsens both outcomes. The predicted probability of death in early adulthood is 3.4% for LBW individuals versus 1.9% for non-LBW. Likewise, the predicted probability of formal labour market participation is 33.3% for LBW and 42.1% for non-LBW.

Table A3 quantifies these effects. Being born with LBW increases the probability of mortality by 1.5 p.p., which represents a 75% higher risk of death relative to the baseline mortality rate of about 2%. In addition, LBW reduces the probability of formal employment by 8.8 p.p., corresponding to a 21% decline relative to the baseline participation rate of around 41%.

Figure 4: Predicted probability of death and of being in the formal labour market by LBW status



(a) Average probability of death

(b) Probability of being in the formal labour market

Note: this figure shows predicted probabilities based on estimates from Table A3. LBW indicates birth weight <2,500 g. Part (a) reports the probability of being recorded as deceased by age 39. The Ribeirão Preto Medical School attempted to trace all cohort members in adulthood and documented deaths for those located; however, some deaths may not be ascertained if individuals could not be contacted. Part (b) reports the probability of participating in the formal labour market, using the presence of individuals in Brazil's formal sector administrative records (RAIS) as a measure.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

7 Robustness tests

We conduct three robustness tests to examine whether our results are sensitive to variations in our baseline sample. First, we estimate the effect of poor early health on upward mobility using the cohort follow-up survey in adulthood (Figure 1). Because our main sample includes only individuals who were either formally employed or registered for social benefits, and since the cohort data captures a broader sample of all individuals located during adulthood, this

¹⁰ The Ribeirão Preto Medical School attempted to trace all cohort members in adulthood and documented deaths for those located; however, some deaths may not be ascertained if individuals could not be contacted.

approach helps mitigate potential selection bias related to relying exclusively on administrative data. Nonetheless, this strategy introduces other limitations, particularly the fact that the cohort follow-up includes only individuals who remained in Ribeirão Preto during adulthood, which may introduce geographic selection bias. Comparing the estimates of Table A5 with the main estimation, we see that the estimated average effects of LBW and birth weight decrease slightly and the coefficients for SGA increase marginally, with standard errors rising due to the reduced sample size. Using self-reported wages, LBW is associated with a decline in the probability of upward mobility ranging from 6.7 to 15.3 p.p. However, we conduct Z-tests comparing the baseline estimates in Table 3 with those from the robustness sample in Table A5 and we do not find statistically significant differences.

Second, we rely on our baseline sample, excluding only individuals who are deceased, and estimate a model using the Heckman selection procedure, which allows us to account for factors influencing sample participation and to correct for selection bias. The results in Table A8 indicate that being born with LBW reduces the likelihood of appearing in the observed sample (selection equation). Moreover, after correcting for selection bias, LBW remains associated with a lower probability of upward mobility, consistent with our previous estimates.

Third, we test the sensitivity of our estimates to the specific years used to measure wages in adulthood. Since our data spans a ten-year period (2011–20), we split the estimation by two-year intervals to assess whether the effect of LBW varies over time on upward mobility (UP_{10}). We show the results in Table A6. We find no meaningful differences between using the ten-year average and the two-year averages.

8 Discussion

Our findings demonstrate that early-life health has a significant impact on adult outcomes in a developing country context. LBW is associated with a reduction of 8.7—13 p.p. in upward mobility, corresponding to a 20–30% decrease in the probability of moving up relative to baseline levels. When educational attainment is included as a control, the LBW effect on upward mobility persists (Table 5), indicating that there are other mechanisms at play beyond education.

We can hypothesize two pathways for the effect of poor early health that may bypass educational attainment and directly affect upward mobility. The first is educational quality. Healthier children have stronger cognitive development (Gonçalves et al. 2025), and so may be better equipped to attend higher-quality (and more academically demanding) schools, which can lead to improved labour market outcomes. Second, we have the role of socioemotional skills. Individuals with poor early health more frequently experience emotional and behavioural problems (Gonçalves et al. 2025), which can be a disadvantage in having higher-paying jobs. For example, children with lower levels of impulse control, difficulty in decision-making, and reduced task

persistence tend to earn lower wages in adulthood (Prevoe and ter Weel 2013).

We also examine whether controlling for maternal smoking and insufficient prenatal care reduces the association between LBW and upward mobility. The inclusion of these prenatal factors does not significantly alter the estimated effect of LBW on adult outcomes, suggesting that other prenatal and early-life conditions contribute to the long-term disadvantages associated with being born with LBW.

Our results on adult wages partially align with evidence from the 1958 British cohort. Case et al. (2005) find that conditions related to the uterine environment are associated with weaker labour market outcomes. However, the magnitude of these effects is small: uterine environment factors account for only 3.9% of the explained variation in employment and 2.2% of the variation in socioeconomic status at age 33. Our results are broadly consistent with the findings from the twin fixed-effects study by Black et al. (2007), though the estimated effect is larger in our context. While Black et al. (2007) report that a 10% increase in birth weight leads to approximately a 1% increase in full-time earnings, we find that the same increase in birth weight is associated with a 2.8% increase in wage in adulthood (Table 4).

Our stronger effects on adult wages may reflect the specific challenges faced in developing countries. In the UK, the quality of schooling and healthcare may help mitigate early disadvantages. By contrast, the Brazilian context of the 1978–79 cohort, born before the creation of the Universal Health System, offered fewer protections against the long-term effects of poor early health. Our findings suggest that, in developing countries, early-life health may play a more critical role in shaping inequality and limiting intergenerational mobility.

We also investigate how LBW can affect factors that determine inclusion in the upward mobility sample. Being born with LBW raises the probability of death before age 39 by 75% higher mortality risk relative to the 2% baseline rate. In addition, LBW reduces the likelihood of formal labour market participation by 21% compared to the baseline participation rate of 41%.

Unobservable factors associated with poor early health, which are also linked to upward mobility and wages in adulthood, can be a source of bias in our results. However, conceptualizing such factors is challenging. One plausible factor is the quality of neighbourhood characteristics and public services, independent of income. For example, certain neighbourhoods with limited access to public services may have worse health outcomes (such as LBW) and worse education, which reduces the chances of mobility. However, in Brazil, it is challenging to consider this relationship between public services and the neighbourhood as entirely independent of income, which is controlled in our models. Higher-income individuals frequently rely on private healthcare and education systems, which generally offer higher quality.¹¹ Since the quality of

¹¹ For example, in 1998, only 7.2% of Brazilians with a family income per capita up to one minimum wage had

public services is closely related to income in Brazil, it is hard to conceive a factor that affects upward mobility that is not mediated by income. Since we control for several socioeconomic characteristics and we track the same individuals over time, our estimates likely capture the effect of poor early health, net of observable socioeconomic factors.

9 Concluding remarks

This paper provides evidence on the long-term effects of early-life health on intergenerational mobility in a developing country. We show that LBW significantly reduces the likelihood of upward mobility, reduces adult wages, and decreases the probability of completing higher education. Our results are robust across different model specifications, including those that account for sample selection. Our results suggest that poor early-life health is a structural mechanism that perpetuates intergenerational inequality.

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health insurance, whereas 83.2% of those earning nine or more minimum wages per capita were covered by health insurance (Kilsztajn et al. 2002). A similar pattern emerges in education: in 2018, only 7% of students enrolled in private primary and lower secondary schools came from the poorest 20% of households, while 40% were from the wealthiest 20%.

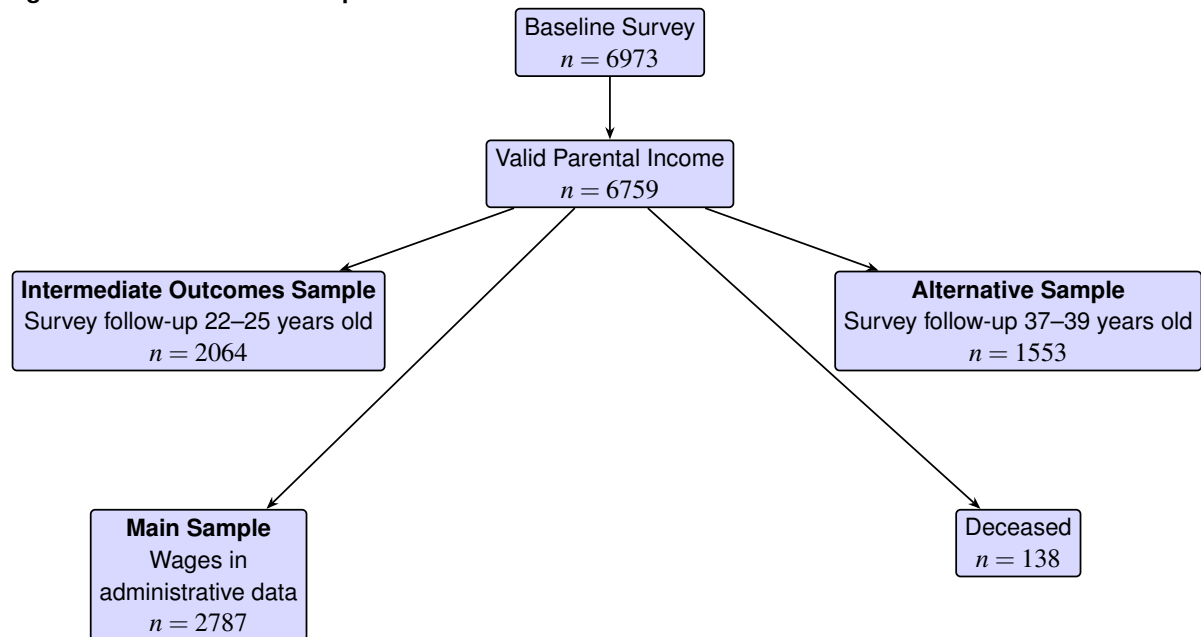
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Appendix

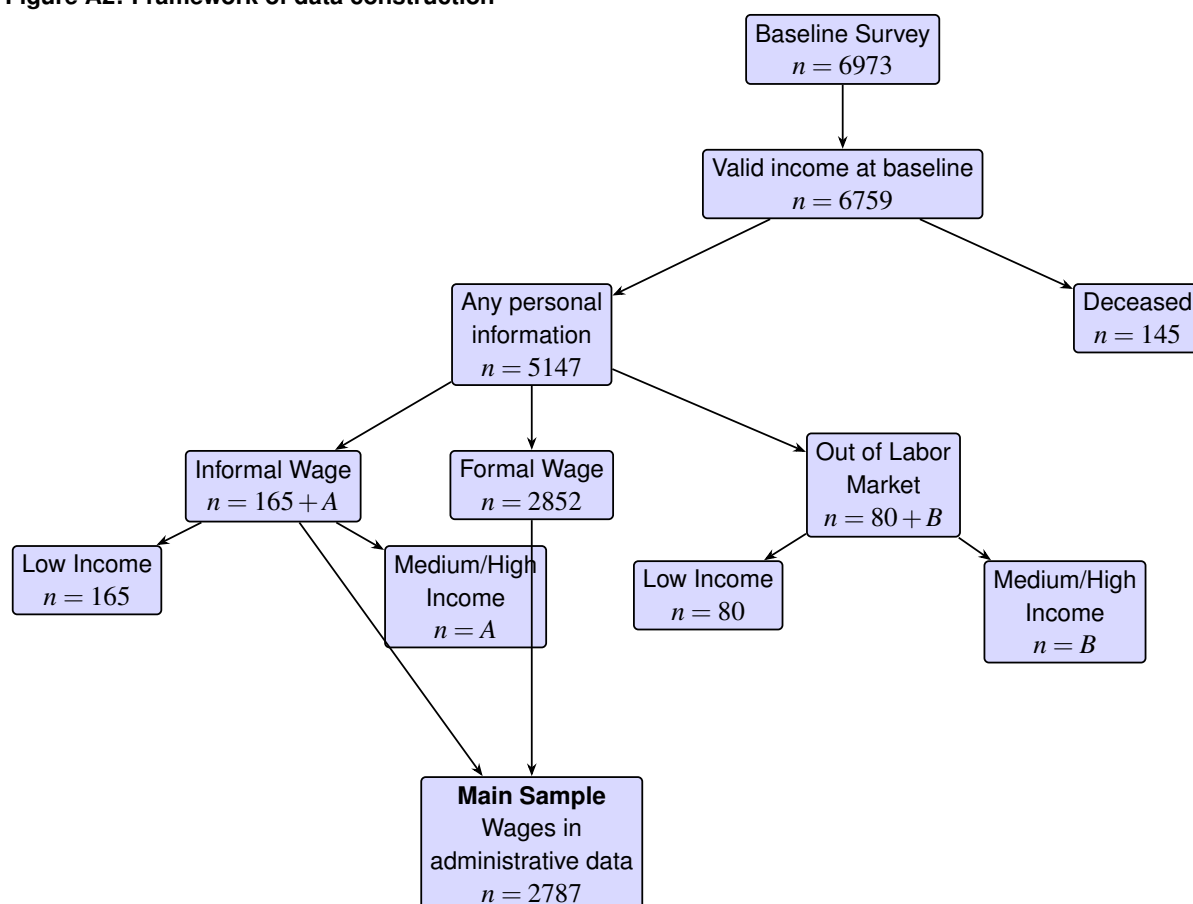
Figure A1: Framework of samples



Note: the figure illustrates the construction of the analytical samples. The baseline survey, the alternative sample, and the intermediate outcomes sample were conducted by the Medical School of the University of São Paulo. The main sample consists of individuals who were successfully linked to the formal labour market database (RAIS) and to the social registry network (Cadastro Único).

Source: authors' construction.

Figure A2: Framework of data construction



Note: the figure illustrates the construction of the analytical samples. Low-income individuals are those enrolled in the social registry network (Cadastro Único) with a reported household per capita income of up to half the minimum wage. Informal jobs correspond to individuals who reported some income in Cadastro Único but were not identified in the Annual Social Information Report (RAIS). Formal jobs are those recorded in RAIS, which covers all registered employment in Brazil. 'Deceased' refers to individuals who were confirmed as deceased during attempts to contact them for the adult follow-up surveys (up to 39 years old). The terms A and B represent individuals with medium or high income: A corresponds to those with informal wages and B to those out of the labour market. Although A and B cannot be separately observed, their total is known: $A + B = 2,050$ individuals. Source: authors' construction.

Table A1: Probit: average marginal effects determinants of upward mobility

Variable	Average marginal effects (probit)		
	P(Up > 20 pp)	P(Up > 10 pp)	P(Up > 0 pp)
Low birth weight	−0.085 (0.024)***	−0.129 (0.028)***	−0.113 (0.035)***
2nd quartile – 1st quartile	−0.228 (0.024)***	−0.216 (0.024)***	−0.249 (0.021)***
3rd quartile – 1st quartile	−0.444 (0.023)***	−0.454 (0.023)***	−0.445 (0.022)***
4th quartile – 1st quartile	−0.615 (0.019)***	−0.675 (0.020)***	−0.663 (0.022)***
Mother in domestic work	−0.036 (0.022)	−0.020 (0.022)	−0.006 (0.022)
Mother's age	0.001 (0.002)	0.000 (0.002)	−0.001 (0.002)
Mother: complete HE – complete HS	−0.017 (0.062)	−0.139 (0.043)***	0.042 (0.039)
Mother: incomplete HS – complete HS	−0.122 (0.036)***	−0.115 (0.030)***	−0.097 (0.028)***
No. household members	−0.015 (0.006)**	−0.019 (0.007)***	−0.020 (0.006)***
Race: white – non-white	0.053 (0.015)***	0.062 (0.017)***	0.049 (0.019)**
Sex = woman	−0.142 (0.014)***	−0.154 (0.015)***	−0.146 (0.016)***
Single mother	−0.047 (0.025)*	−0.057 (0.028)**	−0.028 (0.034)
Mean of dependent variable	0.278	0.376	0.506
No. observations	2,902	2,902	2,902

Note: the table reports marginal effects from probit models of upward mobility. UP_{20} , UP_{10} , and UP_0 are indicator variables equal to 1 if the individual's adult wage rank is at least 20, 10, or 0 percentiles higher than the parental household income rank (measured at birth), respectively. LBW indicates birth weight <2,500 g. Complete HE refers to completed higher education, complete HS to completed high school, and incomplete HS to incomplete high school. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

Table A2: Probit results: marginal Effects of poor early health on intermediate outcomes (22–25 years old)

	Attended preschool		Worked before age 18		Married by age 25		Had a child by age 25		Enrolled in college by age 25	
Low birth weight	0.063	(0.042)	0.045	(0.036)	−0.041	(0.037)	0.002	(0.036)	−0.069*	(0.036)
Mother in domestic work	−0.096***	(0.030)	−0.033	(0.026)	−0.016	(0.028)	−0.008	(0.027)	−0.016	(0.023)
Mother's age	−0.005*	(0.002)	−0.010***	(0.002)	−0.013***	(0.002)	−0.008***	(0.002)	0.008***	(0.002)
Mother: complete HE – complete HS	0.171***	(0.047)	−0.056	(0.039)	−0.045	(0.043)	−0.092***	(0.036)	0.142***	(0.054)
Mother: incomplete HS – complete HS	−0.236***	(0.036)	0.062**	(0.028)	0.137***	(0.030)	0.125***	(0.030)	−0.216***	(0.034)
No. household members	−0.015*	(0.009)	0.032***	(0.007)	0.034***	(0.008)	0.029***	(0.007)	−0.043***	(0.008)
Parental household income rank	−0.0001	(0.0005)	−0.002***	(0.0004)	−0.001***	(0.0004)	−0.002***	(0.0004)	0.004***	(0.0003)
Sex = woman	−0.019	(0.021)	−0.113***	(0.018)	0.113***	(0.020)	0.123***	(0.019)	0.056***	(0.017)
Single mother	0.076	(0.053)	0.054	(0.045)	0.053	(0.048)	0.083*	(0.047)	−0.110***	(0.035)
Mean dependent variable	0.412		0.224		0.318		0.272		0.34	
No. observations	1,977		2,062		2,062		2,062		2,062	

Note: the table reports average marginal effects from probit models of intermediate outcomes observed between ages 22 and 25. LBW indicates birth weight <2,500 g. Complete HE refers to completed higher education, complete HS to completed high school, and incomplete HS to incomplete high school. The number of household members is measured at birth. Parental household income rank is expressed in percentiles of the cohort-specific income distribution. Robust standard errors are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

Table A3: Average marginal effects of poor early health on death and labour market attachment

	Death		Formal labour market participation	
	Estimate	SE	Estimate	SE
Low birth weight	0.015**	0.008	−0.088***	0.021
Mother in domestic work	−0.019***	0.007	0.008	0.017
Mother's age	−0.0004	0.0003	0.003***	0.001
Mother: complete HE – complete HS	−0.003	0.008	−0.053*	0.028
Mother: incomplete HS – complete HS	0.005	0.006	0.033	0.021
No. of household members	0.001**	0.0005	−0.010***	0.004
Parental household income rank	−0.0003***	0.0001	−0.0001	0.0003
Sex = woman	−0.018***	0.003	−0.008	0.012
Single mother	−0.013***	0.004	0.012	0.025
Mean dependent variable	0.02		0.413	
No. observations	6719		6719	

Note: in this table we show the average marginal effects from probit models. The dependent variables are (1) death by age 39 and (2) participation in the formal labour market (measured through administrative records). Covariates include mother's age, mother's education (reference: complete high school), number of household members at birth, single-mother indicator, mother exclusively in domestic work, parental household income rank at birth, sex, and race. Robust standard errors (SE) are reported in parentheses in columns 2 and 4. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

Table A4: Probit: average marginal effects of high-school completion

	Higher education completion		Higher education completion	
	Model 1		Model 2	
Low birth weight	−0.062**	(0.030)		
Log birth weight			0.116**	(0.046)
Complete high school – incomplete high school	0.260***	(0.031)	0.259***	(0.031)
Complete higher education – incomplete high school	0.457***	(0.046)	0.456***	(0.047)
Mother in domestic work	0.033*	(0.019)	0.033*	(0.019)
Mother's age	0.008***	(0.002)	0.007***	(0.002)
No. Household Members	−0.030***	(0.006)	−0.030***	(0.007)
Parental Household Income Rank	0.002***	(0.0003)	0.002***	(0.0003)
Race: white – non-white	0.054***	(0.017)	0.053***	(0.017)
Sex = woman	0.062***	(0.014)	0.065***	(0.014)
Single mother	−0.064**	(0.028)	−0.062**	(0.029)
No. observations	2,901		2,901	

Note: the table reports average marginal effects from probit models of high school completion. LBW indicates birth weight <2,500 g. Complete HE refers to completed higher education, complete HS to completed high school, and incomplete HS to incomplete high school. The number of household members is measured at birth. Parental household income rank is expressed in percentiles of the cohort-specific income distribution. Robust standard errors are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

Table A5: Probit: average marginal effects of early health on upward mobility—robustness

	UP_{20}	UP_{10}	UP_0
<i>Panel A: LBW as main regressor</i>			
Low birth weight	−0.067 (0.039)*	−0.101 (0.042)**	−0.153 (0.046)***
Family controls	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes
No. observations	1,161	1,161	1,161
<i>Panel B: SGA as main regressor</i>			
Small for gestational age	−0.077 (0.034)**	−0.031 (0.042)	−0.063 (0.044)
Family controls	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes
No. observations	1,161	1,161	1,161
<i>Panel C: Log birth weight as main regressor</i>			
Log birth weight	0.017 (0.062)	0.094 (0.068)	0.194 (0.074)***
Family controls	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes
No. observations	1,161	1,161	1,161
<i>Panel D: Mean of the dependent variable</i>			
	0.277	0.376	0.498

Note: Panels A–C report results from different probit models. Panel A shows the average marginal effect of LBW on upward mobility. Panel B reports estimates using SGA as the main regressor. Panel C presents results using log birth weight as the main regressor. Panel D shows the mean of the dependent variable. Robust standard errors are reported in parentheses. UP_{20} , UP_{10} , and UP_0 are indicator variables equal to 1 if the individual's adult wage rank is at least 20, 10, or 0 percentiles higher than the parental household income rank (measured at birth), respectively. All specifications include the following controls: mother's age at birth; parental income rank at birth (percentile); mother's education; number of household members at birth; indicator if mother works exclusively in domestic work; single-mother indicator; sex; and race. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

Table A6: Probit: average marginal effects of early health on upward mobility—robustness

Variable	Dependent variable: probability of upward mobility (UP_10)				
	2011–12	2013–14	2015–16	2017–18	2019–20
Low birth weight	−0.138 (0.029)***	−0.136 (0.028)***	−0.134 (0.030)***	−0.133 (0.030)***	−0.152 (0.030)***
Mother in domestic work	−0.020 (0.022)	−0.032 (0.023)	−0.018 (0.024)	−0.028 (0.024)	−0.028 (0.025)
Mother's age	0.001 (0.002)	0.001 (0.002)	0.002 (0.002)	0.002 (0.002)	0.001 (0.002)
Mother: complete HE – complete HS	−0.095 (0.042)**	−0.129 (0.043)***	−0.129 (0.045)***	−0.110 (0.046)**	−0.096 (0.046)**
Mother: incomplete HS – complete HS	−0.107 (0.027)***	−0.100 (0.029)***	−0.126 (0.029)***	−0.106 (0.030)***	−0.124 (0.032)***
No. household members	−0.021 (0.008)***	−0.018 (0.007)**	−0.020 (0.008)**	−0.019 (0.008)**	−0.017 (0.008)**
Parental household income rank	−0.009 (0.000)***	−0.009 (0.000)***	−0.009 (0.000)***	−0.009 (0.000)***	−0.008 (0.000)***
Race: white – non-white	0.073 (0.018)***	0.092 (0.018)***	0.092 (0.019)***	0.099 (0.019)***	0.082 (0.020)***
Sex = woman	−0.166 (0.016)***	−0.172 (0.016)***	−0.170 (0.017)***	−0.181 (0.017)***	−0.176 (0.018)***
Single mother	−0.064 (0.029)**	−0.080 (0.029)***	−0.077 (0.031)**	−0.081 (0.030)***	−0.062 (0.033)*
Mean of dependent variable	0.378	0.375	0.380	0.365	0.358
No. observations	2,669	2,520	2,387	2,271	2,011

Note: the table reports average marginal effects from probit models of upward mobility (UP_{10}), defined as attaining in adulthood an income rank at least 10 percentiles higher than the parental household income rank. LBW is defined as birth weight <2,500 g. Complete HE refers to completed higher education, complete HS to completed high school, and incomplete HS to incomplete high school. The number of household members is measured at birth. Parental household income rank is expressed in percentiles of the cohort-specific distribution. Estimates are presented separately for two-year periods between 2011 and 2020 to assess the sensitivity of the results to the specific years used to measure adult wages. We find no meaningful differences between the ten-year pooled estimates and the two-year interval estimates. Robust standard errors are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

Table A7: Probit: average marginal effects of upward mobility (UP_{10}) with prenatal environmental variables

	Dependent Variable: Probability of Upward Mobility (UP_{10})			
	Model 1		Model 2	
Low birth weight	−0.128***	(0.027)	−0.130***	(0.030)
Insufficient prenatal care			0.001	(0.023)
Maternal smoking during pregnancy	−0.064***	(0.017)		
Mother in domestic work	−0.022	(0.021)	−0.026	(0.023)
Mother's age	0.002	(0.002)	0.002	(0.002)
Mother: complete HE – complete HS	−0.133***	(0.040)	−0.156***	(0.043)
Mother: incomplete HS – complete HS	−0.099***	(0.026)	−0.086***	(0.028)
No. household members	−0.026***	(0.005)	−0.029***	(0.006)
Parental household income rank	−0.009***	(0.0002)	−0.009***	(0.0002)
Race: white – non-white	0.064***	(0.017)	0.065***	(0.019)
Sex = woman	−0.149***	(0.015)	−0.127***	(0.016)
Single mother	−0.075***	(0.027)	−0.085***	(0.032)
No. observations	2,896		2,410	

Note: the table reports average marginal effects from probit models of high school completion. LBW indicates birth weight <2,500 g. Complete HE refers to completed higher education, complete HS to completed high school, and incomplete HS to incomplete high school. The number of household members is measured at birth. Parental household income rank is expressed in percentiles of the cohort-specific income distribution. Robust standard errors are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.

Table A8: Heckman probit estimates on upward mobility

Outcome equation: UP_{10}		
Low birth weight	−0.527***	(0.106)
Parental household income rank	−0.029***	(0.002)
Mother's age	0.007	(0.006)
Mother: incomplete HS	0.000	(.)
Mother: complete HS	−0.360**	(0.145)
Mother: complete HE	−0.309***	(0.092)
Mother in domestic work	−0.030	(0.070)
Race = non-white	−0.648***	(0.148)
Sex = woman	−0.526***	(0.053)
Constant	1.603***	(0.229)
Selection equation: participation in the sample		
Low birth weight	−0.125*	(0.064)
Parental household income rank	−0.004***	(0.001)
Mother's age	0.001	(0.004)
Mother: incomplete HS	0.000	(.)
Mother: complete HS	−0.107	(0.082)
Mother: complete HE	0.143**	(0.059)
Single mother	0.183**	(0.072)
Mother in domestic work (yes)	−0.006	(0.047)
Mother in domestic work (no)	0.000	(.)
Race = non-white	−1.413***	(0.035)
Sex = woman	−0.077**	(0.034)
Constant	0.620***	(0.113)
Observations	6,585	
Log likelihood	−5,095.78	
Rho	0.484	
Selected	2,898	
Non-selected	3,687	

Note: the table reports estimates from a Heckman probit model of upward mobility (UP_{10}), defined as attaining in adulthood an income rank above at least 10 percentiles parental household income rank. The outcome equation includes covariates measured at birth, including LBW (<2,500 g), mother's age, maternal education (incomplete high school (HS), complete HS, complete higher education (HE)), parental household income rank (in percentiles of the cohort-specific distribution), family size, mother in domestic work, single motherhood, child's sex, and race. The selection equation accounts for participation in the observed adult sample, with the same set of covariates. Robust standard errors are reported in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: authors' calculations based on data from the 1978–79 Ribeirão Preto Cohort Study.