Trends in child labor and the impact on health in adulthood in Brazil from 1998 to 2008

Evolução e impacto do trabalho infantil na saúde de indivíduos adultos no Brasil entre 1998 e 2008

Evolución e impacto del trabajo infantil en la salud de los individuos adultos en Brasil entre 1998 y 2008

Marislei Nishijima [1,2]
André Portela Fernandes de Souza [3]
Flávia Mori Sarti [1]

[1] Universidade de São Paulo, São Paulo, Brasil.
[2] Department of Economics, Boston University, Boston, U.S.A.
[3] Escola de Economia de São Paulo, Fundação Getúlio Vargas, São Paulo, Brasil.

Correspondence
F. M. Sarti
Escola de Artes, Ciências e Humanidades, Universidade de São Paulo.
Av. Arlindo Bettio 1000, sala 302-A, São Paulo, SP 03828-000, Brasil.
flamori@usp.br

Abstract

There is little evidence in Brazil on the impact of child labor on health status in adulthood. This study aimed to investigate trends in child labor in Brazil and estimate the long-term effects of child labor on the health of Brazilian adults, using nationally representative databases (Brazilian National Household Sample Survey) *from three different years (1998, 2003, and 2008). The models were based on a two-stage linear equation and Generalized Method of Moments (GMM). The results suggest that child labor has declined in Brazil, although the data still show patterns of early entry into the country's labor market. Regardless of the type of work, child labor adversely affected health outcomes in adulthood, both directly (impacts on health outcomes) and indirectly (losses in educational attainment). Child labor places a long-term burden on Brazilians, jeopardizing the formation of human capital through negative impacts on health outcomes in adulthood.*

Child Labor; Adult Health; Health Promotion; Education

Resumo

Há escassez de evidências quanto ao impacto do trabalho infantil na saúde do adulto no Brasil. O objetivo do presente artigo é analisar a evolução do trabalho infantil no Brasil e estimar seus efeitos de longo prazo no estado de saúde dos brasileiros em idade adulta, utilizando bases de dados representativas da população nacional (Pesquisa Nacional por Amostra de Domicílios) *em três períodos (1998, 2003 e 2008). Os modelos estimados foram baseados em equações lineares em dois estágios e método dos momentos generalizado (GMM). Os resultados obtidos indicam declínio da prevalência de trabalho infantil no Brasil, embora os dados analisados ainda apresentem padrões de ingresso precoce no mercado de trabalho brasileiro. O trabalho infantil, independentemente da atividade, teve influência negativa em indicadores de saúde de adultos, direta (impacto em saúde) e indiretamente (perda de anos de estudos). Assim, o trabalho infantil impõe um prejuízo em longo prazo à população no Brasil, influenciando adversamente a formação de capital humano via impactos negativos em saúde na fase adulta.*

Trabalho de Menores; Saúde do Adulto; Promoção da Saúde; Educação

Introduction

The International Labor Organization (ILO) defines child labor as "*work that deprives children of their childhood, their potential and their dignity, and that is harmful to physical and mental development. It refers to work that* (…) *interferes with their schooling: by depriving them of the opportunity to attend school; by obliging them to leave school prematurely; or by requiring them to attempt to combine school attendance with excessively long and heavy work*" [1] (p. 16).

At first considered a regional issue, child labor raised increasing international concern due to its negative association with economic growth and human development, as evidenced by growing interest in the literature [2], especially regarding the influence of trade liberalization [3,4], globalization [5], technological progress [6], development of financial and credit markets [7,8,9,10], and income inequality [11,12,13] on child labor.

Several studies established the negative impacts of child labor on the educational attainment of working children, demonstrating adverse effects on quantitative and qualitative aspects of children's education and a substantial association with grade repetition, a common trend in Latin America [11,14,15].

In addition to the immediate impacts on children's education, recent studies in developing countries have shown evidence on the burden of child labor in adulthood, particularly related to health outcomes [16,17,18].

Roggero et al. [19] analyzed cross-sectional data from 83 countries gathered in different databases to investigate the health effects of child labor. The authors showed a significant relationship between indicators of population health (adolescent mortality, nutritional level, and infectious diseases) and child labor, indicating the need for longitudinal studies to investigate the short and long-term health effects of child labor.

Long-term impacts of child labor on health and education are difficult to measure and are thus generally under-evaluated [20]. Therefore, the empirical analysis of health outcomes from child labor requires a temporal approach, dealing with short-term effects (immediate outcomes on children's health) and long-term effects (health outcomes in adulthood).

According to the ILO, certain work activities are acceptable for children, especially in poor families in developing countries, given the importance in household income. That is, the definition of child labor refers to unsafe work activities imposed on children from 5 to 17 years of age and that should be targeted for elimination, such as hazardous work performed in informal sectors [1].

Statistics on the prevalence of child labor vary widely across countries and regions. Recent ILO data indicated that nearly 17% of children from 5 of 14 years of age worldwide were in the labor market in 2000, but with significant regional differences, ranging from 15% in the Middle East and North Africa to 29% in Sub-Saharan Africa [21].

Approximately 7% of Brazilian children 7 to 15 years of age were working in 2009, despite the creation of government programs to eradicate child labor in the formal sectors in recent decades [22].

Banning child labor has been considered a Brazilian government priority since the mid-1990s, as stated in the country's Program to Eradicate Child Labor. The main targets of national policies against child labor have been domestic child labor, sexual exploitation, drug cultivation and traffic, family farm work, and informal urban work [22].

Although ILO Convention 138 set the minimum age for admission to employment in 1973, ILO Convention 182, which defines the worst forms of child labor as priorities for eradication, was not approved until 1999. Brazil ratified the two conventions in 2001 and 2000, respectively [23,24].

The main determinants of child labor in Brazil include: significant social inequalities between families [25], regional differences in labor market conditions [26,27], household members' employment [28]; and household composition [29], especially regarding gender [30].

There is little evidence in Brazil on the long-term impacts of child labor on health status in adulthood [31,32]. The existing studies have focused mostly on the determinants of child labor [16,22,23,24,25,26,28] and the immediate impacts on educational attainment or later impacts on income [33,34,35,36].

Brazil also lacks databases to allow empirical analysis of long-term health outcomes of child labor. Despite the limitations of available databases, some studies using self-rated health status have attempted to assess the health impacts of child labor in Brazil, indicating negative effects on health status in adulthood [31,32]. An additional study included models with instrumental variables, demonstrating limited effects of child labor, indirectly affecting health through constraints on educational attainment [37].

Still, the studies have failed to address problems of endogeneity caused by the omission of relevant variables from the models. According to Basu [38] (p. 1114), "*The literature on child labor is an illustration of abundance and anarchy. Theoretical writings on the subject are relatively few* (…). *The empirical writings on child labor are nu-*

merous but they are usually not founded on any theory" . Cigno & Rosati [16] emphasize that studies on the health effects of child labor should also address the issue of two-way causality in order to avoid statistical inconsistencies and underestimation of child labor's impacts [39].

The above-mentioned studies also excluded key health determinants in adulthood that play an important role in the mechanisms of human capital formation during childhood, i.e. the supply of pediatric health care.

The current article thus analyzes the evolution of child labor in Brazil and proposes a robust empirical model to assess long-term health impacts of child labor in Brazil, based on the theory of human capital investment, using representative national databases from three years (1998, 2003, and 2008), thereby contributing to the analysis of the dynamics of child labor and its long-term health impacts.

Materials and methods

Databases

The databases were three *Brazilian National Household Sample Surveys* (PNAD) conducted by the Brazilian Institute of Geography and Statistics (IBGE), in 1998, 2003, and 2008.

PNAD databases are household and individual-based surveys conducted annually by IBGE. Household samples for the survey are nationally representative, since sample size is based on population projections from the *National Census*. PNAD samples are based on three-stage probabilistic sampling: (1) city; (2) census tract; and (3) household. PNAD databases also include supplementary data on specific themes, with health status and child labor as the themes in 1998, 2003, and 2008.

Particularly in the PNAD-2008, there was a substantial change in the number of social programs underway in Brazil since 2003, which may have influenced labor market conditions, employment, and educational attainment. There is evidence that conditional cash transfer programs result in significant increases in school enrollment and attendance [40,41,42], but the results for child labor are conflicting in relation to potential positive [43] or negative effects [42]. Some studies have also shown higher prevalence of child labor during growth periods in Brazil, due to the transition from formal to informal employment for heads of households [28,43].

PNAD-1998 includes data on 344,975 individuals from 90,913 households, PNAD-2003 on 384,834 individuals from 107,846 households, and PNAD-2008 on 391,868 individuals from 118,138 households. Only adults were included in the sample, using information on age at entry into the labor market to estimate the effects of child labor. Young adults whose information indicated a difference of less than 10 years between their current age and the age when they began their first job were excluded from the sample in order to avoid capturing the effects of current work, since the study was designed to analyze long-term effects.

The sample thus included individuals 18 to 55 years of age who provided information on age at their first job, resulting in 106,322 individuals in 1998, 123,567 in 2003, and 132,287 in 2008. Importantly, it is not possible to identify children working in their family business in the PNAD databases, so child labor may have been underestimated in the sample.

Variables

The following variables available from PNAD were selected for the analysis: age (according to birth date in relation to interview date), age at first job (according to the first work performed), child labor (according to self-reported age at first job: yes/no), sex (self-reported sex: male/female), health status (self-rated health status: good/less than good) [44], physical limitation (self-reported difficulty with mobility: yes/no), chronic disease (twelve variables reporting presence or absence of chronic conditions diagnosed and/or perceived and one additional variable summarizing chronic diseases in general: yes/no), race (self-reported in two categories: white/non-white), educational attainment (years of schooling), migration (individuals living in the State of birth: yes/no), and income per adult-equivalent in the household [44] (expressed in US dollars, deflated to the reference period, 2012).

Human capital formation, defined as the accumulation of health, knowledge, and skills from childhood to adulthood, potentially contributing to the enhancement of workforce productivity, can be analyzed as a set of the following characteristics [45]: (a) initial health conditions at birth; (b) parents' choices on expenditures in health and education for their children; (c) parents' wealth and income; (d) individual choices on health and education expenditures during adulthood; and (e) individual income during adulthood.

The PNAD databases thus provide a readily available set of variables to estimate human capital formation, while other variables are unavailable and thus need to be inferred indirectly using proxy variables. Other variables are determined simultaneously, such as wages (which influence

the decision to seek employment) and educational attainment (influenced by the time available for school and expectations of higher income in the future); thus, information on educational attainment also provides information on income.

The PNAD databases were thus complemented by a set of instrumental and control variables necessary to avoid endogeneity and capture long-term impacts of childhood conditions. The additional information gathered to generate instrumental and control variables were designed to capture unobservable past effects from childhood (7 years of age), that is, the potential human capital accomplishment in early childhood and its later health effects in adulthood, and also to avoid the potential bias from omission of relevant variables and causality across time.

Instrumental and control variables were constructed for each individual selected in the PNAD databases, according to a cohort of State of birth, birth year, and sex, using the census and historical datasets from the IBGE, known as 20th Century Statistics, covering the years 1940 to 2000.

The collected data included wealth, health care, education, and infrastructure from the State of birth during school age: (i) control variables: local Gross Domestic Product (variable expressed in USD per capita, deflated to the reference period of 2012), number of hospitals, number of hospital beds, and number of physicians (per 10,000 inhabitants); (ii) instrumental variables: number of elementary schools, enrollment at the beginning of the year, and number of teachers (per 10,000 children up to 14 years of age).

Changes in State of birth's borders were considered during the database assembly (e.g., division or aggregation of States) in order to allow the inclusion of instrumental childhood variables for adults in the PNAD databases (from 1943 to 2000). That is, during the period covered by the instrumental variables, the State of Ponta Porã was added to the State of Mato Grosso do Sul (1946), Iguaçu to the State of Paraná (1946), and the Federal District of Guanabara to the State of Rio de Janeiro (1960); meanwhile, the Federal District was created (separated from Goiás in 1960), followed by the States of Mato Grosso do Sul (separated from Mato Grosso in 1979) and Tocantins (separated from Goiás in 1988).

Models

The results of three empirical models were analyzed for the evolution and long-term effects of child labor on adults' health in Brazil, based on estimates of linear equation modeling through two-stage Ordinary Least Squares (OLS) and Generalized Method of Moments (GMM), using the converged weight matrix in the first stage, considering the complex sampling design of the PNAD databases in Stata software (Stata Corp., College Station, USA).

Under the first model, child labor (C_i) is a dependent variable related (α_n) to the individual's available (X_i) and unavailable (Y_i) characteristics, in addition to the unobservable aspects that influenced choices by individual's parents concerning child labor during his or her childhood (u_{1i}).

The second model assumes that educational attainment (S_i) is a dependent variable related (φ_n) to the individual's available (X_i) and unavailable (Y_i) characteristics, in addition to unobservable aspects that influenced choices by the individual's parents concerning education during his or her childhood (u_{2i}).

According to the third model, current health status (H_i) is a dependent variable related (δ_n) to child labor (C_i), educational attainment (S_i), the individual's available (X_i) and unavailable (Y_i) characteristics and unobservable characteristics of individual health status (u_{3i}).

The instrumental variables in the first stage were child labor (C_i) and schooling (S_i), as proposed by Emerson & Souza [36]. The individual's unavailable characteristics in adulthood (Y_i) and unobservable characteristics from childhood (u) were separated in order to emphasize the use of proxy variables as controls, to reduce the problem of unavailability of potentially observed variables in the PNAD database.

The models describe decisions on the individual's child labor, schooling, and current health status in adulthood and decision of his or her parents during childhood. The individual's available characteristics (X_i) are represented by personal variables extracted from PNAD, and environmental variables are derived from the supply of hospitals, hospital beds, and physicians in order to control for unobservable child health conditions at the time of entry into the labor market (parental decision on child labor). The individual's unavailable characteristics (Y_i) are represented by instrumental variables. The models included a set of instrumental and control variables (Z_i) related to schooling and child labor, but dissociated from the individual's health status.

The models assume that the stock of health in childhood depends on: (i) the individual's initial stock of health at birth, which in turn depends on unobservable genetic characteristics; and (ii) the parents' wealth, income, and preferences in relation to education, work, consumption of goods, and medical care (investment in health), which are potentially observable variables although not directly available in PNAD.

The stock of health in adulthood also depends on: (i) the individual's stock of health during childhood; (ii) their income and preferences on health during adulthood.

Since individual income is determined simultaneously with decisions on schooling and labor market entry, there is a problem of simultaneous determination of variables. Information on schooling is thus assumed to provide information on individual income.

Assuming that linear functions can appropriately describe the models regarding the evolution and long-term effects of child labor on adults' health in Brazil, equations [1], [2], and [3] were designed to describe decisions on child labor, schooling, and stock of health, respectively:

$$C_{ci} = \alpha_0 + X_{ci}\,\alpha_1 + Y_{ci}\,\alpha_2 + u_{1ci} \quad [1]$$
$$S_{ci} = \varphi_0 + X_{ci}\,\varphi_1 + Y_{ci}\,\varphi_2 + u_{2ci} \quad [2]$$
$$H_{Ai} = \delta_0 + C_{ci}\,\delta_1 + X_{ci}\,\delta_3 + Y_{ci}\,\delta_4 + u_{3ci} \quad [3]$$

As previously mentioned, in order to control for potential bias in estimates due to omission of relevant unobservable or unavailable variables, instrumental variables were included in the models. A set of variables (Z_i) correlated with schooling and child labor that does not affect the unexplained component of the individual's stock of health either in childhood or adulthood, such that $E(Z_i\,u_{3i}) = 0$. That is, equations [1], [2], and [3] can be expressed as:

$$C_i = \alpha_0 + X_i / Z_i\,\alpha_1 + Y_i / Z_i\,\alpha_2 + u_{1i} \quad [1']$$
$$S_i = \varphi_0 + X_i / Z_i\,\varphi_1 + Y_i / Z_i\,\varphi_2 + u_{2i} \quad [2'']$$
$$H_{Ai} = \delta_0 + C_i\,\delta_1 + S_i\,\delta_2 + X_i\,\delta_3 + Y_i\,\delta_4 + u_{3i} \quad [3]$$

Results

The mean age at first job increased from 13.11 years in 1998 to 13.36 in 2003 and 13.75 in 2008, although the mean age of individuals reporting date of entry into the labor market also increased (from 36.96 in 1998 to 37.48 in 2003 and 38.22 in 2008). Educational attainment also increased from 1998 to 2008. Household income per adult-equivalent also increased from 1998 to 2008 (USD 504.08 to USD 563.23) (Table 1).

Overall, the proportion of individuals engaged in child labor in Brazil declined during the study period, especially in the 4-14-year age bracket (from 66.5% in 1998 to 57.8% in 2008). However, the results still reflect early entry into the labor market, since fewer than 25% of individuals reported age at first job greater than 16 years in each year, a trend that increased slowly from 1998 (18.9%) to 2008 (23.53%).

Proportionally fewer adults that reported a personal history of child labor in 2008 had a diagnosis of chronic disease, compared to adults that reported a history of child labor in 1998 (Table 2).

The correlation matrix for variables included in the model shows low correlation among instrumental variables and age at first job and gender, while showing high correlation with education and age, corroborating previous studies [9,12,15,43] (Table 3).

Three models were estimated by the robust variance Instrumental Variable Ordinary Least Squares method including occurrence of chronic disease, physical difficulty, and good self-rated health as dependent variables. The models were estimated for each PNAD year (1998, 2003, and 2008) to explore possible changes across time.

The results showed a positive association between child labor and prevalence of chronic diseases and physical difficulty, i.e., early entry into the labor market (child labor) increased the likelihood of chronic disease and physical difficulty in adulthood. There was also a positive association between age at first job and "good" self-rated health, i.e., early labor market entry (child labor) reduced the likelihood of good health status in adulthood.

As expected, higher educational attainment reduced the likelihood of chronic diseases and physical difficulty, but increased the probability of good health status. According to the estimates using two-stage GMM controlled for endogeneity, males and younger individuals were more likely to report better health outcomes (Tables 4 and 5).

Conclusions

According to Baland & Robinson [46] (p. 678), "*Child labor is inefficient when it is used by parents as a substitute for negative bequests (to transfer income from children to parents) or, because of capital market imperfections, as a substitute for borrowing (to transfer income from the future to the present)*".

Nevertheless, a large proportion of the Brazilian population reported early entry into the labor market, reflecting a pattern of economic inequality and lack of social support that predominated in the country for several decades prior to a major government program designed to ban child labor in the mid-1990s, the Program to Eradicate Child Labor.

Early admission into the labor market, regardless of the type of work, adversely affects health outcomes in adulthood, both directly (influencing the propensity to chronic diseases,

Table 1

Characteristics of Brazilians in childhood (instrumental variables) and adulthood (control and health status variables). Brazil, 1998, 2003, and 2008.

Variables	1998		2003		2008	
	Mean	SD	Mean	SD	Mean	SD
Health status variables						
Good health status (yes/no)	0.77	0.42	0.77	0.42	0.76	0.43
Physical difficulties (yes/no)	0.23	0.42	0.21	0.41	0.23	0.42
Chronic diseases (yes/no)	0.41	0.49	0.36	0.48	0.35	0.48
Arthritis (yes/no)	0.09	0.28	0.06	0.23	0.05	0.21
Asthma (yes/no)	0.03	0.17	0.03	0.18	0.03	0.18
Backache (yes/no)	0.26	0.44	0.18	0.38	0.17	0.37
Cancer (yes/no)	0.00	0.04	0.00	0.06	0.00	0.06
Cirrhosis (yes/no)	0.00	0.05	0.00	0.04	0.00	0.04
Depression (yes/no)	0.07	0.25	0.05	0.22	0.04	0.21
Diabetes (yes/no)	0.02	0.13	0.02	0.14	0.03	0.16
Heart diseases (yes/no)	0.03	0.18	0.03	0.17	0.03	0.16
Hypertension (yes/no)	0.12	0.33	0.13	0.33	0.13	0.34
Renal diseases (yes/no)	0.04	0.19	0.02	0.15	0.01	0.12
Tendinitis (yes/no)	0.03	0.16	0.03	0.18	0.03	0.18
Tuberculosis (yes/no)	0.00	0.03	0.00	0.04	0.00	0.04
Control variables						
Age at first job (years)	13.02	4.15	13.29	4.11	13.75	4.07
Age (years)	36.96	8.93	37.48	8.97	38.33	8.88
Educational attainment (years)	6.41	4.46	7.07	4.44	7.93	4.42
Race (white/other)	0.53	0.50	0.49	0.50	0.45	0.50
Sex (male/female)	0.59	0.49	0.57	0.49	0.56	0.50
Income * (USD)	504.08	862.54	471.97	743.28	563.23	902.21
Migration (yes/no)	0.21	0.41	0.22	0.41	0.21	0.40
Instrumental variables						
GDP per capita ** (USD)	3,537.67	2,646.67	4,225.52	3,024.23	4,950.55	3,331.99
Hospitals *** (per 10,000 inhabitants)	0.42	0.20	0.43	0.19	0.44	0.19
Hospital beds *** (per 10,000 inhabitants)	34.10	16.23	34.41	15.46	34.72	14.72
Physicians *** (per 10,000 inhabitants)	6.23	7.29	7.10	7.21	8.41	9.51
Schools *** (per 10,000 children)	42.00	16.28	44.49	17.52	46.29	18.23
Enrollment *** (per 10,000 children)	3,668.00	1,464.31	4,159.87	1,555.60	4,700.66	1,658.20
Teachers *** (per 10,000 children)	132.90	67.13	156.65	74.10	183.50	83.22

GDP: Gross Domestic Product; SD: standard deviation.

* Variables expressed in USD per adult equivalent in the household in the reference period, 2012;

** Variables expressed as USD per capita in the reference period, 2012;

*** Variables referring to the individual's childhood (7 years of age) in the State of birth.

physical difficulty, and overall health status) and indirectly (affecting educational attainment through the loss of school years), confirming the trend initially observed in recent studies based on the PNAD-1998 database [32].

That is, there are still negative effects from the significant proportion of Brazilian adults that did not benefit from such programs in childhood, resulting in persistent disparities in the population in 2008. The burden of child labor in Brazil was probably mitigated in recent decades by various social programs, but their impact on child labor is still being consolidated.

The study showed lower propensity to chronic diseases in individuals that reported entering the labor market at the transition into adulthood (nearly 18 years old) in all three study years. Predisposition to chronic diseases increased accor-

Table 2

Age of entry into labor market. Brazil, 1998, 2003, and 2008.

Age at first job (years)	1998			2003			2008		
	% population	% cumulative	% chronic disease *	% population	% cumulative	% chronic disease *	% population	% cumulative	% chronic disease *
4	0.05	0.05	0.55	0.04	0.04	0.61	0.02	0.02	0.39
5	0.56	0.61	0.56	0.48	0.53	0.42	0.40	0.42	0.41
6	1.10	1.71	0.53	1.01	1.54	0.43	0.83	1.25	0.43
7	4.52	6.23	0.51	4.28	5.82	0.42	3.38	4.63	0.44
8	7.47	13.70	0.47	6.68	12.50	0.39	5.47	10.10	0.41
9	5.65	19.35	0.45	5.02	17.53	0.38	4.23	14.33	0.41
10	14.56	33.92	0.43	13.15	30.68	0.34	10.74	25.07	0.35
11	3.93	37.84	0.41	3.57	34.25	0.35	3.48	28.56	0.38
12	11.79	49.63	0.42	11.62	45.87	0.35	11.70	40.26	0.34
13	6.73	56.36	0.39	6.73	52.60	0.36	6.85	47.11	0.35
14	10.14	66.50	0.38	10.31	62.91	0.34	10.69	57.80	0.33
15	8.67	75.17	0.37	9.56	72.47	0.33	10.50	68.30	0.32
16	5.93	81.10	0.37	6.86	79.32	0.33	8.17	76.47	0.30
17	4.23	85.33	0.37	4.79	84.11	0.34	5.93	82.40	0.32
18	6.56	91.90	0.37	7.41	91.53	0.34	8.47	90.88	0.31
20	2.35	96.18	0.39	2.58	96.25	0.35	2.68	95.91	0.32
25	0.40	99.19	0.47	0.45	99.26	0.45	0.44	99.19	0.39
30	0.16	99.79	0.52	0.15	99.84	0.56	0.13	99.79	0.49

* Refers to the proportion of individuals reporting chronic diseases.

ding to self-reported age at labor market entry after 25 years of age.

The lower likelihood of chronic diseases in individuals that reported their first job in early adulthood poses a problem in the analysis of long-term impacts of child labor, representing a non-linear interference in health outcome patterns, which may compromise the results of statistical analysis in the absence of control for potential bias, as occurred in the conclusions by Lee & Orazem [37], who reported positive long-term health outcomes from child labor. The models estimated with inclusion of instrumental variables related to access to health care in childhood showed a statistically significant positive impact on health outcomes, demonstrating benefits for long-term human capital formation.

Two-stage GMM models allowed identifying the effects of early entry into the labor market (child labor) and educational attainment on health outcomes in adulthood, indicating the existence of direct and indirect impacts on adults' health. This was contrary to the previously published literature [37], which only identified indirect impacts of child labor on health outcomes in adulthood.

Night classes in elementary schools in Brazil may have played a role in mitigating some negative impacts of child labor on educational attainment. The abundance of public schools offering night classes from the fifth grade upwards tends to moderate the lack of opportunities for working children [47].

According to Basu [38] (p. 1115), policy measures to fight child labor may be divided between legal interventions and collaborative interventions, the latter concerned with "*availability of good schools, the provision of free meals, and efforts to bolster adult wages*", especially "*by making schooling compulsory. This is because a child's presence in school is easier to monitor than a child's abstention from work*" .

Furthermore, Edmonds & Pavcnik [48] advocate that programs designed to eradicate child labor should be based on policies targeted at improving educational infrastructure and reduction of school costs, combined with conditional cash transfer programs for families to keep their children in school in developing countries, as observed in Bangladesh (*Food for Education*), Mexico (Progresa – *Programa de Educación, Salud y Alimentación*), and Brazil (*Bolsa Família*).

Table 3

Correlation matrix of variables. Brazil, 1998, 2003, and 2008.

1998	Age		1st job		Sex		Education		Race		School		Enrollment		Teachers		Hospitals		Beds		Physicians	
Age	1.00																					
Age at 1st job	0.11	*	1.00																			
Sex	-0.03	*	-0.14	*	1.00																	
Education	-0.06	*	0.42	*	-0.07	*	1.00															
Race	0.05	*	0.11	*	-0.01	*	0.27	*	1.00													
Schools	-0.39	*	-0.10	*	0.00		-0.08	*	-0.05	*	1.00											
Enrollment	-0.77	*	-0.09	*	0.03	*	0.08	*	0.05	*	0.44	*	1.00									
Teachers	-0.78	*	-0.07	*	0.02	*	0.11	*	0.11	*	0.41	*	0.88	*	1.00							
Hospitals	-0.20	*	-0.04	*	0.01	*	0.11	*	0.21	*	0.13	*	0.55	*	0.45	*	1.00					
Hospital beds	-0.19	*	0.09	*	0.02	*	0.22	*	0.30	*	-0.20	*	0.45	*	0.49	*	0.58	*	1.00			
Physicians	-0.31	*	0.03	*	0.02	*	0.11	*	0.09	*	-0.12	*	0.31	*	0.33	*	0.21	*	0.45	*	1.00	
GDP	-0.59	*	0.01	**	0.03	*	0.22	*	0.23	*	-0.04	*	0.68	*	0.73	*	0.53	*	0.80	*	0.45	*
2003	**Age**		**1st job**		**Sex**		**Education**		**Race**		**School**		**Enrollment**		**Teachers**		**Hospitals**		**Beds**		**Physicians**	
Age	1.00																					
Age at 1st job	0.11	*	1.00																			
Sex	-0.04	*	-0.14	*	1.00																	
Education	-0.08	*	0.40	*	-0.09	*	1.00															
Race	0.06	*	0.11	*	-0.03	*	0.25	*	1.00													
Schools	-0.33	*	-0.11	*	0.01	*	-0.10	*	-0.09	*	1.00											
Enrollment	-0.76	*	-0.10	*	0.03	*	0.09	*	0.02	*	0.40	*	1.00									
Teachers	-0.77	*	-0.09	*	0.03	*	0.11	*	0.10	*	0.38	*	0.87	*	1.00							
Hospitals	-0.20	*	-0.04	*	0.00		0.11	*	0.21	*	0.09	*	0.50	*	0.39	*	1.00					
Hospital beds	-0.16	*	0.09	*	0.00		0.22	*	0.30	*	-0.29	*	0.36	*	0.42	*	0.59	*	1.00			
Physicians	-0.32	*	0.03	*	0.01	*	0.12	*	0.10	*	-0.14	*	0.31	*	0.34	*	0.21	*	0.47	*	1.00	
GDP	-0.60	*	0.02	*	0.02	*	0.23	*	0.22	*	-0.14	*	0.62	*	0.68	*	0.51	*	0.76	*	0.47	*
2008	**Age**		**1st job**		**Sex**		**Education**		**Race**		**School**		**Enrollment**		**Teachers**		**Hospitals**		**Beds**		**Physicians**	
Age	1.00																					
Age at 1st job	0.07	*	1.00																			
Sex	-0.04	*	-0.13	*	1.00																	
Education	-0.11	*	0.39	*	-0.11	*	1.00															
Race	0.06	*	0.10	*	-0.03	*	0.21	*	1.00													
Schools	-0.24	*	-0.08	*	0.01	**	-0.10	*	-0.09	*	1.00											
Enrollment	-0.74	*	-0.05	*	0.02	*	0.11	*	0.02	*	0.33	*	1.00									
Teachers	-0.72	*	-0.03	*	0.02	*	0.13	*	0.10	*	0.32	*	0.86	*	1.00							
Hospitals	-0.21	*	-0.03	*	0.00		0.11	**	0.17	*	0.05	*	0.43	*	0.32	*	1.00					
Hospital beds	-0.11	*	0.10	*	-0.01		0.21	*	0.27	*	-0.38	*	0.28	*	0.35	*	0.54	*				
Physicians	-0.29	*	-0.01	*	0.02	*	0.09	*	0.07	*	-0.15	*	0.26	*	0.29	*	0.18	*	0.37	*	1.00	
GDP	-0.56	*	0.06	*	0.01	*	0.25	*	0.20	*	-0.26	*	0.57	*	0.62	*	0.45	*	0.73	*	0.38	*

GDP: Gross Domestic Product.

* Significant at 1%;

** Significant at 5%.

Table 4

Effect of child labor on chronic disease, physical difficulty, and health status in adulthood (second stage of ordinary least square models). Brazil, 1998, 2003, and 2008.

Independent variables	Chronic disease					
	1998		2003		2008	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Educational attainment	-0.0081	0.02	0.0203	0.02	-0.0169	0.02
Child labor	0.2210 *	0.12	0.3790 **	0.10	0.1680 ***	0.08
Migration	-0.0069	0.01	0.0138 **	0.00	0.0059	0.00
Age	0.0144 **	0.00	0.0168 **	0.00	0.0131 **	0.00
Sex	-0.1340 **	0.01	-0.1300**	0.01	-0.1290 **	0.01
Race	-0.0004	0.03	-0.0175	0.02	0.0144	0.02
Hospitals	0.0062	0.01	-0.0378 ***	0.02	0.0123	0.02
Hospital beds	-0.0006 ***	0.00	0.0003	0.00	-0.0008 **	0.00
Physicians	-0.0002	0.00	0.0000	0.00	0.0001	0.00
Income per adult equivalent #	0.0000	0.00	0.0000	0.00	0.0000	0.00
α	-0.1620	0.29	-0.6870 **	0.26	-0.0779	0.24
N	106,322		123,567		132,287	
R2	0.0750		0.0100		0.0580	
Independent variables	**Physical difficulty**					
	1998		2003		2008	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Educational attainment	-0.0384 *	0.02	0.0240	0.02	-0.0106	0.02
Child labor	0.3800 **	0.11	0.5260 **	0.09	0.1660 ***	0.07
Migration	-0.0118 ***	0.00	-0.0106 **	0.00	-0.0088 ***	0.00
Age	0.0103 **	0.00	0.0141 **	0.00	0.0099 **	0.00
Sex	-0.1740 **	0.01	-0.1310 **	0.01	-0.1270 **	0.01
Race	0.0533 ***	0.03	-0.0280	0.02	-0.0021	0.02
Hospitals	-0.0618 **	0.01	-0.0496 **	0.02	0.0140	0.01
Hospital beds	0.0000	0.00	0.0005 *	0.00	-0.0008 **	0.00
Physicians	-0.0002	0.00	-0.0001	0.00	0.0001	0.00
Income per adult equivalent #	0.0001 ***	0.00	0.0000	0.00	0.0000	0.00
α	-0.0965	0.27	-0.8340 **	0.22	-0.0718	0.21
N	106,322		123,567		132,287	
R2	-0.1130		-0.1420		0.0660	

(continues)

One of the main challenges for research on long-term health effects of child labor in Brazil is the absence of appropriate cohort databases including suitable health variables for assessing population health status. The use of self-rated health moderately influences the resulting coefficient estimates, since it is linked to individual health-related behavior.

The study's limitation was thus the lack of appropriate health variables in nationally representative databases. However, the proxy variables included as evidence of unobservable characteristics during childhood were sufficient to perform a statistically valid analysis, accounting for potential distortions related to self-rated health status in order to investigate long-term health effects of child labor.

Table 4 (continued)

Independent variables	Good health status					
	1998		2003		2008	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Educational attainment	0.0477 ***	0.02	0.0235	0.01	0.0042	0.02
Child labor	-0.3410 **	0.11	-0.2410 **	0.09	-0.2240 **	0.07
Migration	-0.0044	0.00	-0.0102 **	0.00	-0.0016	0.00
Age	-0.0078 **	0.00	-0.0079 **	0.00	-0.0092 **	0.00
Sex	0.1410 **	0.01	0.1010 **	0.01	0.0811 **	0.01
Race	-0.0474 *	0.03	0.0014	0.02	0.0251	0.02
Hospitals	0.0349 **	0.01	0.0357 ***	0.01	0.0089	0.01
Hospital beds	0.0004	0.00	0.0002	0.00	0.0005 *	0.00
Physicians	-0.0002	0.00	0.0002	0.00	-0.0002	0.00
Income per adult equivalent #	-0.0001 ***	0.00	0.0000	0.00	0.0000	0.00
α	0.8560 **	0.26	0.9370 **	0.22	1.1640 **	0.21
N	106,322		123,567		132,287	
R2	-0.1260		0.0320		0.0590	

SE: standard error.

* Significant at 10%;

** Significant at 1%;

*** Significant at 5%;

Variables expressed in USD per adult equivalent in the household in the reference period, 2012.

Table 5

Effect of child labor on chronic disease, physical difficulty, and health status in adulthood (GMM models, 2nd-stage regression). Brazil, 1998, 2003, and 2008.

Independent variables	1998					
	Chronic disease		Physical difficulty		Good health status	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Educational attainment	-0.0084	0.02	-0.0388 *	0.02	0.0484 **	0.02
Child labor	0.2190 *	0.12	0.3780 ***	0.11	-0.3390 ***	0.11
Migration	-0.0069	0.01	-0.0117 **	0.00	-0.0046	0.00
Age	0.0144 ***	0.00	0.0103 ***	0.00	-0.0077 ***	0.00
Sex	-0.1340 ***	0.01	-0.1750 ***	0.01	0.1410 ***	0.01
Race	-0.0001	0.03	0.0539 **	0.03	-0.0484 *	0.03
Hospitals	0.0062	0.01	-0.0652 ***	0.01	0.0387 ***	0.01
Hospital beds	-0.0006 **	0.00	0.0000	0.00	0.0004	0.00
Physicians	-0.0002	0.00	-0.0003	0.00	-0.0002	0.00
Income #	0.0000	0.00	0.0001 **	0.00	-0.0001 **	0.00
α	-0.1570	0.29	-0.0903	0.27	0.8460 ***	0.26
N	106,322		106,322		106,322	
R2	0.0760		-0.1150		-0.1290	

(continues)

Table 5 (continued)

Independent variables	2003					
	Chronic disease		Physical difficulty		Good health status	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Educational attainment	0.0212	0.02	0.0248 *	0.02	0.0230	0.01
Child labor	0.3760 ***	0.10	0.5140 ***	0.09	-0.2270 **	0.09
Migration	0.0139 ***	0.00	-0.0103 ***	0.00	-0.0106 ***	0.00
Age	0.0168 ***	0.00	0.0140 ***	0.00	-0.0079 ***	0.00
Sex	-0.1300 ***	0.01	-0.1290 ***	0.01	0.0993 ***	0.01
Race	-0.0188	0.02	-0.0295 *	0.02	0.0027	0.02
Hospitals	-0.0373 **	0.02	-0.0502 ***	0.02	0.0349 **	0.01
Hospital beds	0.0003	0.00	0.0005 *	0.00	0.0002	0.00
Physicians	0.0000	0.00	-0.0001	0.00	0.0002	0.00
Income per capita	0.0000	0.00	0.0000	0.00	0.0000	0.00
α	-0.6920 ***	0.26	-0.8280 ***	0.22	0.9270 ***	0.22
N	123,567		123,567		123,567	
R2	0.0100		-0.1360		0.0380	
Independent variables	**2008**					
	Chronic disease		Physical difficulty		Good health status	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Educational attainment	-0.0184	0.02	-0.0140	0.02	0.0073	0.02
Child labor	0.1550 *	0.08	0.1380 **	0.07	-0.2010 ***	0.07
Migration	0.0063	0.00	-0.0079 **	0.00	-0.0023	0.00
Age	0.0129 ***	0.00	0.0096 ***	0.00	-0.0088 ***	0.00
Sex	-0.1290 ***	0.01	-0.1270 ***	0.01	0.0818 **	0.01
Race	0.0155	0.02	0.0003	0.02	0.0227	0.02
Hospitals	0.0148	0.02	0.0166	0.01	0.0063	0.01
Hospital beds	-0.0008 ***	0.00	-0.0008 ***	0.00	0.0005 **	0.00
Physicians	0.0001	0.00	0.0001	0.00	-0.0002	0.00
Income per capita	0.0000	0.00	0.0000	0.00	0.0000	0.00
α	-0.0522	0.24	-0.0102	0.20	1.1090 ***	0.21
N	132,287		132,287		132,287	
R2	0.0570		0.0690		0.0670	

GMM: Generalized Method of Moments; SE: standard error.

* Significant at 10%;

** Significant at 5%;

*** Significant at 1%;

Variables expressed in USD per adult equivalent in the household in the reference period, 2012.

Resumen

Hay escasez de evidencias en cuanto al impacto del trabajo infantil en la salud del adulto en Brasil. El objetivo del artículo es investigar la evolución del trabajo infantil en Brasil y estimar sus efectos de largo plazo en el estado de salud de los brasileños en edad adulta, utilizando bases de datos representativas de la población nacional (Encuesta Nacional por Muestra de Domicilios) en tres períodos (1998, 2003 y 2008). *Los modelos estimados se basaron en ecuaciones lineales en dos etapas y método de los momentos generalizado (GMM). Los resultados obtenidos indican una reducción de la prevalencia del trabajo infantil en Brasil, aunque los datos analizados aún presenten padrones de ingreso prematuro en el mercado de trabajo brasileño. El trabajo infantil, independientemente de la actividad, presentó efecto negativo en la salud adulta, directa (impacto en salud) y indirectamente (pérdida de años de estudio). Así, impone un prejuicio a largo plazo a la población brasileña, influyendo adversamente en la formación de capital humano por los impactos negativos de salud en la edad adulta.*

Trabajo de Menores; Salud del Adulto; Promoción de la Salud; Educación

Contributors

M. Nishijima participated in the study's conceptualization, data collection, analysis, and interpretation, and writing and approval of the final version for publication. A. P. F. Souza contributed to the study's conceptualization, interpretation of the results, critical revision, and approval of the final version for publication. F. M. Sarti collaborated in the literature review, data analysis, and writing and approval of the final version for publication.

Acknowledgments

The authors wish to thank the São Paulo State Research Foundation (FAPESP) for funding this research project.

References

1. International Labour Organization. Child labour. Geneva: International Labour Organization; 2004.
2. Basu K, Tzannatos Z. The global child labor problem: What do we know and what can we do? World Bank Econ Rev 2003; 17:147-73.
3. Edmonds EV, Pavcnik N. International trade and child labor: cross-country evidence. J Int Econ 2006; 68:115-40.
4. Neumayer E, De Soysa I. Trade openness, foreign direct investment and child labor. World Dev 2005; 33:43-63.
5. Cigno A, Rosati FC. Does globalization increase child labor? World Dev 2002; 30:1579-89.
6. Doepke M, Zilibotti F. The macroeconomics of child labor regulation. Am Econ Rev 2005; 95: 1492-524.
7. Dehejia RH, Gatti R. Child labor: the role of income variability and access to credit across countries. Cambridge: National Bureau of Economic Research; 2002. (NBER Working Paper, 9018).
8. Beegle K, Dehejia RH, Gatti R. Child labor, crop shocks, and credit constraints. Cambridge: National Bureau of Economic Research; 2003. (NBER Working Paper, 10088).
9. Ersado L. Child labor and schooling decisions in urban and rural areas: comparative evidence from Nepal, Peru, and Zimbabwe. World Dev 2005; 33:455-80.
10. Guarcello L, Mealli F, Rosati FC. Household vulnerability and child labor: the effect of shocks, credit rationing, and insurance. J Popul Econ 2010; 23:169-98.
11. Psacharopoulos G. Child labor versus educational attainment: some evidence from Latin America. J Popul Econ 1997; 10:377-86.
12. Ray R. Child labor, child schooling, and their interaction with adult labor: empirical evidence for Peru and Pakistan. World Bank Econ Rev 2000; 14:347-67.
3. Sarkar J, Sarkar D. Why does child labour persist with declining poverty? Brisbane: National Center for Econometric Research; 2012. (NCER Working Paper Series, 84).
14. Heady C. The effect of child labor on learning achievement. World Dev 2003; 31:385-98.
15. Gunnarsson V, Orazem PF, Sánchez MA. Child labor and school achievement in Latin America. World Bank Econ Rev 2006; 20:31-54.
16. Cigno A, Rosati FC. The economics of child labour. New York: Oxford University Press; 2005.
17. Rosati FC, Straub R. Does work during childhood affect adults' health? An analysis for Guatemala. Washington DC: World Bank; 2006. (Understanding Children's Work Project Working Paper Series).
18. O'Donnell O, Rosati FC, van Doorslaer E. Health effects of child work: evidence from rural Vietnam. J Popul Econ 2005; 18:437-67.
19. Roggero P, Mangiaterra V, Bustreo F, Rosati F. The health impact of child labor in developing countries: evidence from cross-country data. Am J Public Health 2007; 97:271-5.

20. Organização Internacional do Trabalho. Módulos de auto-aprendizagem sobre saúde e segurança no trabalho infantil e juvenil; 2006. http://white.oit.org.pe/ipec/documentos/modulo_autoaprendizagem.pdf (accessed on 16/Jun/2014).
21. International Labour Organization. Every child counts: new global estimates on child labour. Geneva: International Labour Organization; 2002.
22. Understanding Children's Work Programme. Understanding the Brazilian success in reducing child labour: empirical evidence and policy lessons. Rome: International Labour Organization/United Nations Children's Fund/World Bank; 2011.
23. International Labour Organization. Convention concerning minimum age for admission to employment (C138 – Minimum Age Convention). Geneva: International Labour Organization; 1973.
24. International Labour Organization. Convention concerning the prohibition and immediate action for the elimination of the worst forms of child labour (C182 – Worst Forms of Child Labour Convention). Geneva: International Labour Organization; 1999.
25. Carvalho Filho IE. Household income as a determinant of child labour and school enrollment in Brazil: evidence from a social security reform. Washington DC: International Monetary Fund; 2008. (IMF Working Papers, 08/241).
26. Manacorda M, Rosati FC. Industrial structure and child labor: evidence from Brazil. Rome: International Labour Organization/United Nations Children's Fund/World Bank; 2008.
27. Duryea S, Arends-Kuenning M. School attendance, child labor and local labor market fluctuations in urban Brazil. World Dev 2003; 31:1165-78.
28. Duryea S, Lam D, Levison D. Effects of economic shocks on children's employment and schooling in Brazil. J Dev Econ 2007; 84:188-214.
29. Emerson PM, Souza AP. Birth order, child labor, and school attendance in Brazil. World Dev 2008; 36:1647-64.
30. Emerson PM, Souza AP. Child labor, school attendance and intra-household gender bias in Brazil. World Bank Econ Rev 2007; 21:301-16.
31. Kassouf AL, McKee M, Mossialos E. Early entrance to the job market and its effect on adult health: evidence from Brazil. Health Policy Plan 2001; 16:21-8.
32. Guiffrida A, Iunes RF, Savedoff WD. Health and poverty in Brazil: estimation by structural equation model with latent variables. Washington DC: Inter-American Development Bank; 2005. (Technical Note on Health, 1/2005).
33. Bezerra ME, Kassouf AL, Arends-Kuenning M. The impact of child labour and school quality on academic achievement in Brazil. Bonn: Institute for the Study of Labor; 2009. (IZA Discussion Paper, 4062).
34. Cardoso AR, Verner D. School drop-out and push-out factors in Brazil: the role of early parenthood, child labor, and poverty. Washington DC: World Bank; 2007. (The World Bank Policy Research Working Paper Series, 4178).
35. Emerson PM, Souza AP. Is there a child labor trap? Inter-generational persistence of child labor in Brazil. Econ Dev Cult Change 2003; 51:375-98.
36. Emerson PM, Souza AP. Is child labor harmful? The impact of working earlier in life on adult earnings. Econ Dev Cult Change 2011; 59:345-86.
37. Lee C, Orazem PF. Lifetime health consequences of child labor in Brazil. In: Akee RKQ, Edmonds EV, Tatsiramos K, editors. Child labor and the transition between school and work. Research in labor economics. v. 31. Bingley: Emerald Group Publishing Limited; 2010. p. 99-133.
38. Basu K. Child labor: cause, consequence, and cure, with remarks on International Labor Standards. J Econ Lit 1999; 37:1083-119.
39. Cameron AC, Trivedi PK. Microeconometrics: methods and applications. New York: Cambridge University Press; 2005.
40. Bourguignon F, Ferreira FHG, Leite PG. Conditional cash transfers, schooling, and child labor: micro-simulating Brazil's Bolsa Escola Program. World Bank Econ Rev 2003; 17:229-54.
41. Cardoso E, Souza AP. The impact of cash transfers on child labor and school attendance in Brazil. Nashville: Vanderbilt University; 2004. (Working Paper, 04-W07).
42. Cacciamali MC, Tatei F, Batista NF. Impactos do Programa Bolsa Família federal sobre o trabalho infantil e a frequência escolar. Revista de Economia Contemporânea 2010; 14:269-301.
43. Edmonds EV. Child labor and schooling responses to anticipated income in South Africa. J Dev Econ 2006; 81:386-414.
44. O'Donnell O, van Doorslaer E, Wagstaff A, Lindelow M. Analyzing health equity using household survey data: a guide to techniques and their implementation. Washington DC: World Bank; 2008.
45. Becker GS, Tomes N. Human capital and the rise and fall of families. In: Beckar GS, editor. Human capital: a theoretical and empirical analysis with special reference to education. 3rd Ed. Chicago: University of Chicago Press; 1994. p. 257-98.
46. Baland J-M, Robinson JA. Is child labor inefficient? J Polit Econ 2000; 108:663-79.
47. Guarcello L, Lyon S, Rosati FC. Child labour and education for all: an issue paper. Rome: International Labour Organization/United Nations Children's Fund/World Bank; 2006.
48. Edmonds EV, Pavcnik N. Child labor in the global economy. J Econ Perspect 2005; 19:199-220.

Submitted on 22/Jan/2014
Final version resubmitted on 20/Oct/2014
Approved on 10/Nov/2014