The Impact of a Primary Health Care Strategy on Educational Outcomes in Brazil: A Cohort Analysis

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Abstract

The Family Health Strategy (FHS) is a primary care initiative of the public health system in Brazil to provide decentralized health access at scale, covering the poorest population in Brazilian municipalities with home visits. Impacts of such a large-scale policy as the FHS might overflow from health outcomes and influence educational outcomes, by improving child development. In this study, we aim to assess the effects of the presence of the FHS in the year of birth and in subsequent years of life on the number of school enrollments when they were aged between 7 and 11. We use the staggered rollout of the program across municipalities to follow eight cohorts of children born between 2000 and 2007 in 5,505 Brazilian municipalities and explore the municipality, cohort and year dimensions of the data to control for different levels of unobserved effects and trends. Our study shows that the average number of enrollments of the cohorts increases with the presence of the FHS in the municipality in the year of birth and with its presence two, four and six years after birth. The cumulative effects of the program imply an average increase of 18 enrollments in the municipalities, which is close to the reduction in the average number of children out of school between 2000 and 2010 in Brazil. Cohorts that have been continuously assisted by the program since birth have had the largest impacts on enrollment. Given the recent challenges posed to the public health system in Brazil, interruptions in the supply of primary care services could generate adverse consequences not only for the health status of the population, but also for the accumulation of human capital and the well-being of generations in the future.

Key words: primary health strategy, school enrollment, child development

Highlights

- The presence of a primary health initiative in the municipality since birth increases school enrollments later in life
- The magnitude of the impact is similar to the reduction in the average number of children that were out of school in Brazil
- Large coverage is necessary to produce significant impacts on school enrollment

1. Introduction

Despite the growing interest of policymakers and researchers on early childhood development, the prevalence of children at risk of not reaching their full development potential in low-income and middle-income countries was still around 43% among children under 5 years of age in 2010 (Black *et al.*, 2017). In Brazil, this share was comparatively lower at 11%, but still represented more than 1.6 million children, more than in most countries in Latin America (Lu, Black and Richter, 2016).

Development is an interactive maturation process, in which there is an orderly progression of cognitive, motor, socioemotional and language skills, which form the foundation that will support skills and learning during later stages of life (Black *et al.*, 2017). Exposure to biological and psychological risk factors associated with poverty since birth and during the first years of life might affect the structure and functioning of the brain and compromises the child's development, preventing them from fully reaching their development potential (Black *et al.*, 2017; Walker *et al.*, 2011). As a result, exposure to those risk factors might impair the incorporation of human capital throughout life, educational outcomes and productivity in adulthood, which results in the perpetuation of poverty in the next generation (Walker *et al.*, 2011; Almond, Currie and Duke, 2018). Early childhood interventions are the most cost-effective and the returns on investments during this phase are substantial (Engle *et al.*, 2011).

Health policies can contribute to child development by promoting and offering supportive services for the health and nutrition of mothers and babies. The public health system in Brazil is one of the largest of its kind in the world, covering about 150 million people with primary care services (Bastos *et al*., 2017).[4] The Family Health Strategy (FHS) was created in 1994 to reorganize the structure and way of functioning of primary care to promote universal access to health services, to coordinate and expand coverage to more complex levels of care, and to implement inter-sectoral actions for health promotion and disease prevention (Paim *et al.*, 2011). The FHS teams are composed of doctors, nurses, nursing technicians and community health agents who provide health care with home visits and care in Basic Health Units, in addition to carrying out educational actions of health promotion. Each team is responsible for a fixed number of families (between 800 and 1,000) and individuals (maximum 4,000) in a defined territory.

The FHS is a large-scale initiative that mainly affects families living in poverty. In 2019, there were around 43,000 teams working in Brazil, in 98.4% of Brazilian municipalities, serving 64% of the population.[5] Data from the National Health Survey (PNS/IBGE) collected in 2013 shows that the coverage of the FHS among the poor was 73%, in rural areas was 81%, and among the poor who lived in rural areas was 85% (IBGE, 2013).

Previous research shows that the FHS impacted several health outcomes. Systematic reviews of the literature highlight the effects of the FHS on conditions sensitive to primary care (PCSC), such as children and adults mortality rates, morbidity, preventable hospitalizations, and use of health and oral health services (Bastos *et al*., 2017). However, no studies so far have assessed the impact of years of exposure to the FHS since birth on long-run educational outcomes.

[4] According to July 2019 data, the coverage of Primary Health Care reaches 154 million in Brazil, and that of the FHS, 133 million. Data obtained from the system e-Gestor – Atenção Básica (https://egestorab.saude.gov.br/paginas/acessoPublico/relatorios/relHistoricoCoberturaAB.xhtml).

[5] Data obtained from the e-Gestor Atenção Básica, referring to the municipalities in July 2019. Available at: <https://egestorab.saude.gov.br/paginas/acessoPublico/relatorios/relHistoricoCoberturaAB.xhtml;jsessionid=2GAYIdoKpA0MS39hfAIwmicG>. Accessed on September 24, 2019.

The aim of this paper is to fill this lacuna by exploring the staggered rollout of the program across municipalities to follow cohorts of children born in municipalities with and without the program at birth to assess its effects in school enrollments. The specification we use controls for a series of confounders, such as municipality fixed-effects that control for pre-existing municipality differences that are fixed over time, flexible state-time effects that capture health shocks at the State level that may vary over time and linear municipality trends across cohorts that control for the number of live births in each municipality, for example. We control for interactions of cohort and year effects and between municipality and year effects that capture educational policies implemented in some municipalities in specific years that can impact enrollments. We also conduct placebo tests examining whether future FHS presence impacts current enrolments. To address the possibility of migration before age seven, we also estimate models using only the children that live in the same municipality where they were born.[6]

Our results show that the presence of a structured primary health program since birth can have robust effects on school attendance years later, even in a context where most children already are at school, by including the most vulnerable children in each municipality. The cumulative effect of the program is an average increase of 18 enrollments, which is close to the reduction in the average number of children out of school between 2000 and 2010 in Brazil. Cohorts that have been continuously assisted by the program since birth have had the largest impacts on enrollment. Previous evidence suggests that the program impacts infant and child mortality, but our calculations imply that this impact is not enough to explain the increase in enrollments, so that our evidence suggests that the

[6] About 50% of the children were born in a municipality different from where they mother lived at time of birth because most municipalities do not have a hospital. Therefore, when we use the sample of children that live in the same municipality that they were born, we are being very conservative.

program also improved child development of surviving children through its effects on child health and mother health and behavior.

Besides this introduction, this article is divided into four sections. In section 2, we show a review of the literature. In section 3, we present the data and the empirical strategy. Section 4 shows the main results and robustness tests, and in section 5, we put some conclusions.

2. Literature Review

The FHS does not have a specific focus on child development, but it has several characteristics that can promote it and, consequently, impact learning at later ages. The FHS focuses on equipping families with time, resources, knowledge and skills so that they can provide integral care for children. In addition, the FHS is linked to municipal health units called Basic Health Units (UBS) and for this reason it is also able to coordinate efforts from different sectors (such as education, well-being, social protection, environmental security and conservation, agriculture, water and sanitation) and with existing organizations in the communities to generate health promotion actions. Actions of the FHS teams include identifying common health problems and health risks for the population covered, carrying out health surveillance and epidemiological surveillance procedures, carrying out specific work with mothers and children (Aquino, Oliveira and Barreto, 2009). The interaction of teams with families within communities allows them to teach best practices and changes in habits, food preparation, hygiene, cleaning, and ways of dealing with less complex health problems (Rocha and Soares, 2010).

The effects of these actions on health indicators have been studied in several previous research, especially on infant mortality. Rocha and Soares (2010) and Bhalotra, Rocha and Soares (2019) examine the effects of the FHS on infant mortality according to the duration of the program in the municipality, using a difference-in-differences strategy and show that the impact increases with the years that the municipality remains in the program, reaching between 20% and 34% eight years after entering the program, compared to a 49% reduction in the infant mortality rate worldwide in the 25-year interval between 1990 and 2015 (Rocha and Soares, Bhalotra, Rocha and Soares, 2019).

Other studies show that the intensity of the effects on infant mortality varies between Brazilian regions, being stronger in the North and Northeast (Rocha and Soares, 2010; Macinko *et al*., 2007; Guanais and Macinko, 2009). The FHS effects also increase with the number of teams in the municipalities (Macinko *et al*., 2007; Guanais and Macinko, 2009; Aquino, Oliveira e Barreto, 2009; Macinko, Guanais and Souza, 2006).

There are several mechanisms through which the FHS affects infant mortality, according to previous research. Firstly, FHS increases the probability of mothers attending seven or more prenatal visits (especially among those with less education) and the number of births that take place in hospitals (Bhalotra, Rocha and Soares, 2019), which leads to better prevention and faster detection of problems in pregnancy that could lead to complications in the child's health even after birth. In this sense, mortality rates due to diseases of the perinatal period (ranging from 22 weeks of gestation to 10 days after delivery) decrease, which largely explains the reduction in the infant mortality rate (Rocha and Soares, 2010). Post-neonatal deaths (between 28 days and 1 year of life) are strongly impacted by the FHS, as they are more related to family care (Macinko *et al*., 2007). Maternal mortality rates are reduced by 53% eight years after of the program starts in a municipality, while mortality among women of reproductive age (10 to 49 years) decreases by 41.2% (Bhalotra, rocha and Soares, 2019).

In addition, FHS teams also prevent infectious diseases among families and children, by providing them with information on basic health care and hygiene practices at home.

Research shows that the program reduces infectious and parasitic diseases (including diarrhea), endocrine, nutritional or metabolic and respiratory diseases (Rocha and Soares, 2010; Macinko *et al*., 2007) and increases vaccination coverage against polio, measles and the triple bacterial vaccine (against diphtheria, tetanus and whooping cough) in children (Aquino, Oliveira and Barreto, 2009).

FHS also improves the health of other adult family members, in addition to mothers and children, as evidenced by the reduction in adult mortality rates and hospitalizations related to cardiovascular diseases (Rocha and Soares, 2010; Cavalcante *et al*. 2018, Nishijima, Sarti and Schor, 2020; Rasella *et al*., 2014), recurrence of strokes, myocardial infarctions (Cabral *et al*., 2012) and increasing resolution of tuberculosis cases (Durovni *et al*., 2017).

Previous studies have also sought to differentiate the effects of the FHS from the largest federal income transfer program in Brazil, the Bolsa Família program (PBF), since the families served by both programs may coincide. In addition, the PBF has health conditionalities that could confound the effects of the FHS. Studies show that the FHS impacts health indicators independently of the PBF presence and that both programs seem to be complementary due to the combination of increased demand for health services by the families served by PBF and the increased supply of those services through the FHS ((Rasella *et al*., 2013; Bastos *et al*., 2017, Guanais, 2015).

Moreover, a comparison between siblings shows that those who were exposed to the FHS at birth (especially those who were born when the FHS had been in the municipality for at least 6 months) have better health than those who were born when there was no program yet (Reis, 2014). This comparison allows the effects due to the program to be clearly separated from the family specific effects on the children's health outcomes.

Rocha and Soares (2010) is the only study that we are aware of that examines the contemporaneous effects of the FHS on education, finding that the program increases school attendance increased by 4.5%, with relatively larger effects for adolescents. Our paper contributes to the literature by examining the long-term effects of the presence of a large-scale primary health program from birth on educational outcomes using a cohort approach and examining the cumulative effects of the program in school enrollments.

3. Data and Econometric Methodology

This paper uses a panel of municipality cohorts born in several years, and explores the staggered rollout of the FHS program and its coverage across municipalities in the first years of life of each cohort to examine its effects on the number school enrollments later in their life cycle. We follow eight birth cohorts born between 2000 and 2007 in each of the 5,505 municipalities combining information on the number of children enrolled in school between 7 and 11 years of age who live in a municipality with the presence of FHS in that municipality in the cohort year of birth and also two, four and six years after birth. We construct a binary indicator of FHS presence and other FHS measures, such as the proportion of the municipality population that is served by the FHS teams in each of these periods and indicators for coverage above critical thresholds.

The information on the number of teams and FHS coverage per municipality from 1998 to 2017 comes from the Ministry of Health. The enrollment data were obtained from the Ministry of Education. To calculate FHS coverage, we use population data from the Brazilian Institute of Geography and Statistics (IBGE). For some of the descriptive statistics, we also use data from the 2000 and 2010 Demographic Censuses.

With these data, we estimate the following equation:

$$y_{cmt} = \alpha + \beta FHS_{cm} + \delta_{UF,c} + \gamma_m \times c + \eta_{tc} + \xi_{mt} + \varepsilon_{cmt} \qquad (1)$$

Where y_{cmt} represents total enrolments of cohort c born in municipality m observed in year t, FHS_{cm} is an indicator of the presence of the FHS program, $\delta_{UF,c}$ are interactions of state and cohort fixed effects, $\gamma_m \times c$ are municipality specific linear trends over the cohorts, η_{tc} are interactions between the current year and cohort fixed effects, ξ_{mt} are interactions between municipality and current year fixed effects, and ε_{cmt} is the error term.

The municipality fixed effects control for pre-existing municipality differences that are fixed over time that could determine the expansion of the FHS and be correlated with school enrollments. Those fixed effects also control for other possible time-fixed confounders, such as geographic, cultural or historical factors. The expansion of the FHS could also be correlated with specific dynamic trends in the State and in the municipalities, such as negative health shocks or trends in the number of live births, which can affect the number of enrollments in later years. For this reason, we control for flexible state time effects by cohort, in addition to linear trends specific to each municipality throughout the cohorts. Therefore, we do not have to rely on measures of the number of live births by municipality, which are known be have a great deal of measurement error (see Rasella, Aquino and Barreto (2010), for example). We further control for interactions of cohort and current year fixed effects, which capture shocks and dynamic trends that affect all units in each year of birth and year of outcome measurement. In addition, we control for possible effects of educational policies carried out in municipalities in certain years on the number of enrollments with the interactions between municipality and current year fixed effects.

In the main exercises, we use indicators of the presence of FHS teams in municipality as independent variables in various periods after the birth of the child. As they are not mutually exclusive, each indicator represents the independent effect of having the FHS in a certain period with respect to not having FHS at all. The effects of the presence of the FHS are therefore cumulative. As we control for municipality, cohort and current year, there is no variation for the municipality-specific linear trend for some observations in the period covered. Thus, the final sample is composed of 198,180 observations and the distribution of observations by cohort and current year are shown in Table 1.

The estimated standard errors are robust to serial-correlation within clusters at the municipality level, both among different observations of the same cohort in current years, and among different cohorts. We perform sensitivity analysis controlling directly for the observed number of live births in each municipality instead of the municipality fixed effects and linear trends and the results do not change significantly. We also carry out econometric regressions using the continuous coverage variables and indicators for three coverage levels: small (<30·0% of the population), intermediate (30·0-69·9%) or large (≥70%) (Rasella *et al.*, 2013).

Table 1: Observations (N=198,180)

Cohort	**Current year**									**Total**
birth year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
2000	5,505	5,505	5,505	5,505	0	0	0	0	0	22,020
2001	5,505	5,505	5,505	5,505	5,505	0	0	0	0	27,525
2002	0	5,505	5,505	5,505	5,505	5,505	0	0	0	27,525
2003	0	0	5,505	5,505	5,505	5,505	5,505	0	0	27,525
2004	0	0	0	5,505	5,505	5,505	5,505	5,505	0	27,525
2005	0	0	0	0	5,505	5,505	5,505	5,505	5,505	27,525
2006	0	0	0	0	0	5,505	5,505	5,505	5,505	22,020
2007	0	0	0	0	0	0	5,505	5,505	5,505	16,515
Total	11,010	16,515	22,020	27,525	27,525	27,525	27,525	22,020	16,515	198,180

Note – Data are number of observations.

Table 2 displays average school enrollments per cohort and current year, which jointly determine the age of individuals. Average enrollments decrease for a given age across cohorts (diagonal in the Table) as a result of the demographic transition, but mean number of enrollments in each cohort varies little over the current years (rows in the Table), as school evasion is small in primary schools. Table 3 displays average FHS presence and coverage in the birth year for the cohorts born between 2000 and 2007. Both increased significantly over time as FHS presence grew from 50% to 90%, while its average coverage increased from 31% to 74%.

Table 2: School Enrollment (N=198,180)

Cohort birth year	Current year									Total
	2008	2009	2010	2011	2012	2013	2014	2015	2016	
2000	610.5 (3206)	609.4 (3209)	601.6 (3222)	604.7 (3232)	..	..	..	..	..	606.5 (3217)
2001	543.9 (2923)	558.1 (2966)	560.4 (2989)	564.7 (2996)	568.7 (3004)	..	..	..	..	559.2 (2976)
2002	..	529.7 (2835)	539.8 (2892)	545.4 (2908)	549.8 (2917)	552.3 (2900)	..	..	..	543.4 (2890)
2003	..	..	522.7 (2825)	533.2 (2874)	538.8 (2890)	541.6 (2879)	543.7 (2878)	..	..	536.0 (2869)
2004	..	..	..	522.0 (2854)	531.9 (2899)	536.0 (2903)	538.0 (2894)	536.9 (2850)	..	533.0 (2880)
2005	..	..	..	..	526.9 (2828)	534.5 (2855)	537.1 (2850)	535.7 (2800)	540.1 (2820)	534.8 (2830)
2006	..	..	..	..	..	515.4 (2767)	520.9 (2778)	520.4 (2731)	524.9 (2754)	520.4 (2757)
2007	..	..	..	..	..	..	503.5 (2720)	505.4 (2688)	510.5 (2710)	506.5 (2706)
Total	577.2 (3068)	565.7 (3007)	556.1 (2986)	554.0 (2976)	543.2 (2908)	535.9 (2861)	528.6 (2824)	524.6 (2768)	525.2 (2762)	543.3 (2899)

Note – Data are municipality school enrollment mean (SD).

Table 3: FHS Presence and Coverage in the Birth Year (N=198,180)

	2000	2001	2002	2003	2004	2005	2006	2007
Presence of FHS in the birth year	0.5 (0.5)	0.7 (0.5)	0.8 (0.4)	0.8 (0.4)	0.8 (0.4)	0.9 (0.3)	0.9 (0.3)	0.9 (0.3)
FHS coverage in the birth year	0.311 (0.383)	0.460 (0.410)	0.542 (0.406)	0.601 (0.392)	0.631 (0.381)	0.710 (0.353)	0.736 (0.337)	0.741 (0.333)

Note – Data are FHS presence and coverage means (SD). Presence of FHS is a dummy variable of the presence of FHS teams in the municipality, FHS coverage is the proportion of the population covered by FHS teams in the municipality.

4. Results

In Table 4, we show the results of estimating equation 1, which relates the presence of FHS in the year of birth to the number of enrollments between ages 7 and 11, controlling for the effects of equation 1. Column 1 shows that the presence of the FHS in the year of birth is associated with 3.2 additional enrollments in the municipality. In column 2, we use FHS coverage instead of presence dummy and the estimated coefficient increases to 4.8, which represents the increase in the number of enrollments associated with the change from no coverage to full coverage.

Table 4: FHS in the year of birth and number of enrollments

	School Enrollment		
	(1)	**(2)**	**(3)**
FHS presence in the year of birth	3.189**	..	..
	(1.537)		
FHS coverage in the year of birth	..	4.818***	..
		(1.416)	
Small coverage	..	..	-0.751
			(2.750)
Intermediate coverage	..	..	3.344*
			(1.715)
Large coverage	..	..	4.993***
			(1.446)
Constant	540.8***	540.5***	540.2***
	(1.207)	(0.831)	(1.151)
State and cohort interactions	Yes	Yes	Yes
Municipality linear trens (over cohort)	Yes	Yes	Yes
Current year and cohort interactions	Yes	Yes	Yes
Municipality and current year interactions	Yes	Yes	Yes
Observations	198,180	198,180	198,180
R-squared	0.999	0.999	0.999
Dep. Var. Average	543.3	543.3	543.3

Note – Data are estimated mean effect (standard error) of FHS on school enrollment. Models adjusted for interactions of State and cohort fixed effects, municipality linear trends, interactions between current year and cohort fixed effects, and for interactions between municipality and current year fixed effects. Municipality level clustered standard errors in parenthesis. Sample of municipality cohorts born between 2000 and 2007 with 7 to 11 years of age, in the current years of 2008 to 2016. Significance: *** $p < 0 \cdot 01$, ** $p < 0 \cdot 05$, * $p < 0 \cdot 1$.

In column 3, we use the three coverage indicators and the estimates show that there is a dose-response effect of FHS coverage, suggesting that only municipalities/cohorts that have reached at least intermediate coverage at birth increase the number of enrollments when aged 7 to 11. The largest impact occurs in the municipalities with the highest coverage (5 additional enrollments).

Table 5: FHS in the first years of life and the number of enrollments

Independent Variables	Model: Presence of FHS and School Enrollment	Model: FHS Coverage and School Enrollment
	(1)	(2)
FHS in the birth year	4·192**	5·904***
	(1·676)	(1·549)
FHS 2 years after the birth	4·283***	3·034**
	(1·577)	(1·294)
FHS 4 years after the birth	4·649**	6·913***
	(2·257)	(1·895)
FHS 6 years after the birth	5·401***	3·300*
	(1·746)	(1·734)
Constant	526·9***	530·0***
	(4·574)	(3·469)
State and cohort interactions	Yes	Yes
Municipality linear trens (over cohort)	Yes	Yes
Current year and cohort interactions	Yes	Yes
Municipality and current year interactions	Yes	Yes
Observations	198,180	198,180
R-squared	0·999	0·999
Dep. Var. Average	543·3	543·3

Note – Data are estimated mean effect (standard error) of FHS on school enrollment. Models adjusted for interactions of State and cohort fixed effects, municipality linear trends, interactions between current year and cohort fixed effects, and for interactions between municipality and current year fixed effects. Municipality level clustered standard errors in parenthesis. Sample of municipality cohorts born between 2000 and 2007 with 7 to 11 years of age, in the current years of 2008 to 2016. Significance: *** $p < 0 \cdot 01$, ** $p < 0 \cdot 05$, * $p < 0 \cdot 1$.

Table 5 presents the main results of the paper, using the binary variables that indicate FHS presence from the year of birth, 2 years after birth, 4 years after birth and 6 years after birth. All estimates are positive and statistically significant at the 0.05% level, which means that FHS presence is important at different stages of early life cycle. The effects displayed in Table 5 are cumulative, hence the estimates of column 1 indicate that cohorts/municipalities that adopted the FHS since birth have on average 18 additional enrollments when the cohorts were aged 7 to 11. In column 2 of Table 5, we examine the effects of FHS coverage in the first years of life on the number of enrollments, showing that high coverage is especially important at birth and four years after birth. Table A1 in the Appendix shows how the effects of FHS presence on enrollments change after we include each set of fixed effects at a time and Table A2 details the age-specific results.

Table 6: Average number and proportion of children out of school, 2000 and 2010

Age	**# Children**		**% Children**	
	2000	**2010**	**2000**	**2010**
7	46.2	14.9	7.6%	2.2%
8	30.3	12.4	5.2%	1.9%
9	25.5	12.0	4.3%	1.7%
10	20.1	14.2	3.5%	1.8%
11	21.4	16.6	3.8%	2.3%
Total	28.7	14.0	4.9%	2.0%

Source: Demographic Censuses 2000 and 2010/IBGE. Note – Entries of the table report the number and the proportion of children of each age that are out of school, averaged by municipality.

Although the vast majority of Brazilian children were already attending school in our sample, the estimated cumulative effects of the FHS are quite important. According to data from the Brazilian Demographic Census collected in 2000 and 2010 and displayed in Table 6, the average proportion of children aged between 7 and 11 years who were out of school decreased from 4.9% to 2% and the average number of children out of school dropped from 29 to 14. The cumulative effects of the FHS add up to 18 additional

Table 7: FHS coverage levels in the first years of life and the number of enrollments

	School Enrollment
Small coverage in the year of birth	0.337
	(2.800)
Intermediate coverage in the year of birth	4.072**
	(1.838)
Large coverage in the year of birth	6.194***
	(1.605)
Small coverage 2 years after birth	5.246*
	(2.819)
Intermediate coverage 2 years after birth	3.423*
	(1.788)
Large coverage 2 years after birth	4.376***
	(1.561)
Small coverage 4 years after birth	3.508
	(4.125)
Intermediate coverage 4 years after birth	3.250
	(2.503)
Large coverage 4 years after birth	5.802***
	(2.211)
Small coverage 6 years after birth	2.014
	(7.448)
Intermediate coverage 6 years after birth	7.083**
	(2.930)
Large coverage 6 years after birth	6.155***
	(2.210)
Constante	525.2***
	(4.790)
State and cohort interactions	Yes
Municipality linear trens (over cohort)	Yes
Current year and cohort interactions	Yes
Municipality and current year interactions	Yes
Observations	198,180
R-squared	0.999
Dep. Var. Average	543.3

Note – Data are estimated mean effect (standard error) of FHS on school enrollment. Models adjusted for interactions of State and cohort fixed effects, municipality linear trends, interactions between current year and cohort fixed effects, and for interactions between municipality and current year fixed effects. Municipality level clustered standard errors in parenthesis. Sample of municipality cohorts born between 2000 and 2007 with 7 to 11 years of age, in the current years of 2008 to 2016. Significance: *** $p < 0 \cdot 01$, ** $p < 0 \cdot 05$, * $p < 0 \cdot 1$.

enrollments, which is remarkably close to the decline in the average number of children out of school (15 children).

Table 7 uses the three coverage indicators at different periods of life and shows that small coverage is not enough to produce significant impacts on school enrollment. Intermediate and large coverage have statistically similar impacts. Large coverage since birth translates into 22 more enrollments at age 7 to 11, which reinforces the message that continuity of the program is important to achieve the desired health and development outcomes.

4.2. Robustness

We now carry out additional econometric exercises to assess the robustness of our main results. In Table 8, we perform placebo tests by including indicators of future FHS presence for each cohort, one year after the enrollments are measured. For the 2000 cohort that is observed between 2007 and 2011 in our sample to compute total enrolments, for example, we include an indicator of FHS presence in 2012 and do the same for the other cohorts.

Column 1 includes the placebo dummy for FHS presence, which attracts a small coefficient that is not statistically significant from zero, while in column 2 we include future FHS coverage for each cohort that also attracts a negligible coefficient. These results alleviate concerns that FHS might be capturing the effects of other policies taking place in the municipalities at the same time.

Table 8: Including Placebo Effects

Independent Variables	Model: Presence of FHS and School Enrollment	FHS Coverage and School Enrollment
	(1)	(2)
FHS in the birth year	4.192**	5.904***
	(1.676)	(1.549)
FHS 2 years after the birth	4.283***	3.034**
	(1.577)	(1.294)
FHS 4 years after the birth	4.649**	6.913***
	(2.257)	(1.895)
FHS 6 years after the birth	5.401***	3.300*
	(1.746)	(1.734)
FHS 1 year after outcome measurement	-2.63e-06	0.0564
	(0.000351)	(0.0382)
Constant	526.9***	529.9***
	(4.574)	(3.488)
State and cohort interactions	Yes	Yes
Municipality linear trens (over cohort)	Yes	Yes
Current year and cohort interactions	Yes	Yes
Municipality and current year interactions	Yes	Yes
Observations	198,180	198,180
R-squared	0.999	0.999
Dep. Var. Average	543.3	188.8

Note – Data are estimated mean effect (standard error) of FHS on school enrollment. Models adjusted for interactions of State and cohort fixed effects, municipality linear trends, interactions between current year and cohort fixed effects, and for interactions between municipality and current year fixed effects. Municipality level clustered standard errors in parenthesis. Sample of municipality cohorts born between 2000 and 2007 with 7 to 11 years of age, in the current years of 2008 to 2016. Significance: *** $p < 0 \cdot 01$, ** $p < 0 \cdot 05$, * $p < 0 \cdot 1$.

In Table 9, we assess the robustness of our main result to using the actual number of live births in the specification instead of the municipality-specific linear trends and to using the sample of non-migrants only instead of all children born in the municipality. We prefer to use the trends in the main specifications because the measures of the number of live births are known to have a great deal of measurement error, especially in the poorer municipalities in rural areas (see Rasella, Aquino and Barreto, 2010). Column (1) reports the main results again as a benchmark and the results of column (2) shows that the estimated coefficients of FHS presence actually increase when we include the number of live births, which means that if anything we are underestimating the impact of FHS on total enrolments. Column (2) estimates the impact of FHS presence on enrolments using only the children who are still living in their municipality of birth to minimize the selectivity problems associated with migration. The results vary little with respect to those of column (1).

Table 9: Robustness

Independent Variables	Benchmark	Live Births	Non-Migrants
	(1)	(2)	(3)
FHS in the birth year	4.192**	6.964***	3.124**
	(1.676)	(1.789)	(1.497)
FHS 2 years after the birth	4.283***	8.351***	3.783**
	(1.577)	(2.116)	(1.480)
FHS 4 years after the birth	4.649**	9.570***	3.625*
	(2.257)	(2.428)	(2.138)
FHS 6 years after the birth	5.401***	5.408***	5.222***
	(1.746)	(1.678)	(1.800)
Live Births	-	0.808***	-
		(0.0636)	
Constant	526.9***	69.91*	340.5***
	(4.574)	(37.34)	(4.627)
State and cohort interactions	Yes	Yes	Yes
Municipality linear trens (over cohort)	Yes	No	Yes
Current year and cohort interactions	Yes	Yes	Yes
Municipality and current year interactions	Yes	Yes	Yes
Observations	198,180	198,180	198,180
R-squared	0.999	0.999	0.999
Dep. Var. Average	543.3	553.2	354.5

Note – Data are estimated mean effect (standard error) of FHS on school enrollment. Models adjusted for interactions of State and cohort fixed effects, municipality linear trends, interactions between current year and cohort fixed effects, and for interactions between municipality and current year fixed effects. Municipality level clustered standard errors in parenthesis. Sample of municipality cohorts born between 2000 and 2007 with 7 to 11 years of age, in the current years of 2008 to 2016. Significance: *** $p < 0 \cdot 01$, ** $p < 0 \cdot 05$, * $p < 0 \cdot 1$.

4.3 Discussion of Mechanisms

The FHS can affect the number of enrollments in later years through two main channels. First, there is extensive evidence that the FHS reduces infant mortality (Rocha and Soares, 2010; Macinko, Guanais and Souza, 2006; Macinko *et al.*, 2007; Aquino, Oliveira and Barreto, 2009; Guanais and Macinko, 2009; Rocha, Nishijima and Peixoto, 2013; Brentani *et al.*, 2016), and mortality under 5 years of age (Rocha and Soares, 2010;

Rasella *et al.*, 2013). Even if we assumed that the enrollment rate of a cohort in a municipality did not change, the increase in the number of surviving children could generate an increase in the number of students enrolled. This is unlikely to be the main channel, however, since the FHS effects on children survival seem to be much smaller than the effects we find on enrollment. Previous research shows that the magnitude of the FHS impact on infant mortality rate is between 2% to 20% (Rocha and Soares, 2010), which would mean an increase of less than 1.2 additional children in 2010 considering a reduction of 10% in the infant mortality rate of the 2000 cohort in a municipality that is four years into the program.

The second transmission channel is related to the child health and development status, which is likely to impact educational outcomes in the long run. A recent survey provides evidence that shocks in early childhood related to nutrition, maternal stress, infectious diseases, exposure to pollution, climate change and alcohol and tobacco have lasting effects on the accumulation of human capital and socioeconomic status in adulthood (Almond, Currie and Duke, 2018). There is evidence that the FHS reduced the incidence of children with linear growth retardation among children aged 6 to 59 months and linear growth delay is one of the main risk factors for children to reach their development potential, affecting cognitive skills and educational outcomes in later years (Walker *et al.*, 2011; Benício *et al.*, 2013; Walker *et al.*, 2007). Moreover, FHS affects the health of children and babies by reducing hospitalizations for causes sensitive to primary care in two states in the Northeast of Brazil (Pinto-Junior *et al.*, 2018; Carvalho *et al.*, 2015; Monahan *et al.*, 2013). There is additional evidence that the presence of the FHS during the prenatal phase also improves the health status of children in later years, controlling for specific effects of families (Reis, 2014). The FHS can also affect child health and development through the mother's health. Interventions that improve maternal health reduce child stunting, underweight and iron deficiency (Britto *et al.*, 2017). Furthermore, the presence of diabetes during pregnancy can affect children's cognitive abilities and educational outcomes (Robles *et al.*, 2015).

5. Conclusions

Our results show that the presence of FHS in the municipality for cohorts born between 2000 and 2007 is associated with an increase in the number of school enrollments when they are between 7 and 11 years old. This relationship is maintained even after adjusting for a variety of fixed effects and municipality-specific linear trends, including interactions of municipality and current year fixed effects, which capture effects of regional policies in the current year. The existence of a consolidated FHS coverage in the municipality at birth and two, four and six years after the birth is associated with an average cumulative increase of 18 enrollments when the cohorts are between 7 and 11 years of age. This figure is close to the observed reduction in the average number of children who were out of school between 2000 and 2010.

We contribute to the literature by bringing evidence that the FHS, a large-scale primary care strategy with a wide coverage among the poorest population, is associated not only with the population's health outcomes, but also with the increase in enrollments in later years in a middle-income country like Brazil. In addition, our results contribute to the literature that investigates the effects of health-related shocks during early childhood on educational outcomes, showing that these effects might occur in large-scale programs already implemented by governments (Almond, Currie and Duke, 2018). We also show that the impact of home visiting programs on schooling is maximized when children are followed from birth until later ages, without interruptions.

FHS does not have specific actions directed for child development, but it has some characteristics that could affect it, such as priority nutritional surveillance, monitoring of growth and development, promotion of breastfeeding, immunization, health promotion, disease prevention, guaranteeing access to hospital and outpatient reference and assistance and prevention of oral pathologies (Brazil, 2001). In addition, FHS teams identify common health risks for the population, perform health and epidemiological surveillance procedures and promote actions and partnerships with existing organizations and families in the community to changes habits with respect to food preparation, hygiene and cleaning and also strategies to deal with less complex health problems.

Given the recent challenges posed to the public health system in Brazil (Castro *et al.*, 2019), our study shows that interruptions in the supply of primary care services such as the FHS could generate adverse consequences not only for the health status of the population, but also for the accumulation of human capital and the well-being of generations in the future. The results of the paper are especially relevant in the current context with the covid19 pandemics that is affecting children all over the world. With the social distancing measures that were put in place in Brazil, the FHS workers are not being able to reach the most vulnerable families to carry out their normal tasks, affecting millions families with young children that are not receiving the visits designed to endow them with time, resources, knowledge and skills so that they can provide integral care for children. This is likely to increase both infant and adult mortality and have negative effects on child development and future education outcomes. It is therefore important to put in place alternative policies to reach out to those families to attenuate these harmful long-term effects.

Contributors

Naercio Menezes Filho: Conceptualization, Methodology, Supervision. Alan Funtowicz: Formal Analysis, Writing – Original Draft. Bruno Komatsu: Formal Analysis, Writing – Review & Editing.

Declaration of Interests

None.

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Appendix

Table A1: FHS in the first years of life and the number of enrollments

	School Enrollment				
	(1)	(2)	(3)	(4)	(5)
Presence of FHS in the birth year	12.37***	11.78***	3.805**	3.805**	4.192**
	(3.805)	(3.767)	(1.658)	(1.658)	(1.676)
Presence of FHS 2 years after the birth	5.684**	11.22***	3.937**	3.937**	4.283***
	(2.385)	(2.674)	(1.603)	(1.603)	(1.577)
Presence of FHS 4 years after the birth	10.90***	14.47***	5.086**	5.086**	4.649**
	(2.741)	(3.033)	(2.325)	(2.325)	(2.257)
Presence of FHS 6 years after the birth	12.78***	15.86***	5.578***	5.578***	5.401***
	(3.132)	(4.038)	(1.873)	(1.873)	(1.746)
Constant	506.5***	495.9***	526.9***	526.9***	526.9***
	(8.335)	(9.601)	(4.720)	(4.720)	(4.574)
Municipality fixed effects	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Current year fixed effects	Yes	Yes	Yes	Yes	Yes
State and cohort interactions	No	Yes	Yes	Yes	Yes
Municipality linear trens (over cohort)	No	No	Yes	Yes	Yes
Current year and cohort interactions	No	No	No	Yes	Yes
Municipality and current year interactions	No	No	No	No	Yes
Observations	198,180	198,180	198,180	198,180	198,180
R-squared	0.997	0.997	0.999	0.999	0.999
Dep. Var. Average	543.3	543.3	543.3	543.3	543.3

Note – Data are estimated mean effect (standard error) of FHS on school enrollment. Models adjusted municipality fixed effects, cohort fixed effects and current year fixed effects. Further controls for interactions of State and cohort fixed effects, municipality linear trends, and for interactions of the other fixed effects are subsequently introduced in each column. Municipality level clustered standard errors in parenthesis. Sample of municipality cohorts born between 2000 and 2007 with 7 to 11 years of age, in the current years of 2008 to 2016. Significance: *** $p < 0 \cdot 01$, ** $p < 0 \cdot 05$, * $p < 0 \cdot 1$.

Table A2: FHS in the first years of life and the number of enrollments

	School Enrollment				
	7 years	**8 years**	**9 years**	**10 years**	**11 years**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Presence of FHS in the birth year	0.991	3.652*	3.172*	3.539**	3.882**
	(1.158)	(2.012)	(1.828)	(1.674)	(1.910)
Presence of FHS 2 years after the	2.709	5.406**	4.396**	2.499	3.036*
	(1.767)	(2.392)	(1.942)	(1.566)	(1.693)
Presence of FHS 4 years after the	0.103	6.227*	5.475*	3.027	2.250
	(1.635)	(3.493)	(2.969)	(2.091)	(2.152)
Presence of FHS 6 years after the	1.373	6.640**	5.790**	5.432**	4.945**
	(1.738)	(2.201)	(2.186)	(2.043)	(2.478)
Constant	511.5**	514.7**	520.3**	530.5**	537.9**
	(3.641)	(7.091)	(5.966)	(4.144)	(4.362)
State and cohort interactions	Yes	Yes	Yes	Yes	Yes
Municipality linear trens (over	Yes	Yes	Yes	Yes	Yes
Current year and cohort interactions	Yes	Yes	Yes	Yes	Yes
Municipality and current year	Yes	Yes	Yes	Yes	Yes
Observations	38,528	44,032	44,032	38,528	33,024
R-squared	1.000	0.999	0.999	0.999	0.999
Dep. Var. Average	516.1	534.3	537.2	543.3	550.1

Note – Data are estimated mean effect (standard error) of FHS on school enrollment. Models adjusted for interactions of State and cohort fixed effects, municipality linear trends, interactions between current year and cohort fixed effects, and for interactions between municipality and current year fixed effects. Municipality level clustered standard errors in parenthesis. Sample of municipality cohorts born between 2000 and 2007 with 7 to 11 years of age, in the current years of 2008 to 2016. Significance: *** $p < 0 \cdot 01$, ** $p < 0 \cdot 05$, * $p < 0 \cdot 1$.