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Results of primary health care intervention for prevention of hospitalizations and mortality due to hypertension in Brazil, 2000-2015

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Abstract: Access to primary health care represents in developing countries has additional benefits than the reduction in mortality rates since primary and secondary prevention have spillovers on non-communicable chronic diseases (NCD). Taking advantage on the staggered implementation of the primary health care program based on community agents visits at households in Brazil - the Family Health Strategy (FHS), widening population access to the public health system - the paper studies effects of access to primary health care on hypertension indicators. Based on annual observations of 5,560 municipalities (2000-2015), our estimates indicate that access to primary health system affects positively morbidity and mortality hypertension indicators. Effects of the FHS, however, were higher in the non-poor municipalities, possibly due to differences at a local level as governance problems, lack of infrastructure, socioeconomic inequalities, and deficiencies in primary health care operationalization in poor regions as pointed by literature.

Keywords: primary health care, hypertension, public health system, prevention, universal health coverage.

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1. Background

Hypertension refers to the health condition marked by persistently elevated pressure in blood vessels, caused by physiological and behavioral characteristics of the individual, including idiopathic hypertension, aging, obesity, diabetes, unhealthy diet, physical inactivity, alcohol consumption and tobacco use (WHO 2013, Poorolajal et al. 2016). Due to the lack or complete absence of specific symptoms at early stages, hypertension is commonly referred to as a silent killer disease, being undiagnosed in a high proportion of populations worldwide (WHO 2103).

However, it is usually the most prevalent health problem within primary health care facilities and it is significantly associated with higher risk of cardiovascular diseases, stroke, and kidney failure (Babad et al. 2002, James at al. 2014, Mills et al. 2016, Turi et al. 2017, Carey and Whelton 2017). Many studies point to the relationship between blood pressure and the risk of clinical complications and death (Carey and Whelton 2017, Whelton et al. 2018).

Hypertension is considered one of the main preventable causes of disease, premature mortality and disability worldwide due to its connection to cardiovascular problems (WHO 2013, James at al. 2014, Mills et al. 2016, Tolonen 2016). The latter is the main cause of mortality, being responsible for nearly 30% of deaths 45% of mortality due to cardiovascular disease (WHO 2013, Ministério da Saúde 2018), and 51% of mortality due to stroke are attributable to hypertension (WHO 2013).

There is a high prevalence of hypertension among adult populations in low-and-middle-income countries, which tend to have lack of infrastructure and human resources available in the national health system (WHO 2013, Mills et al. 2016).

A recent national survey conducted in Brazil pointed out that hypertension was the most prevalent chronic non-communicable disease diagnosed in the population (Ministério da Saúde 2015). Considering the impact of primary prevention strategies delivered at primary care level on exposure to risk factors and onset of hypertension, the Brazilian health system established public health interventions within the Family Health Strategy (FHS). FHS is a government-financed program focused on household visits by multidisciplinary health professional teams with community health agents, designed to foster universal health coverage through the delivery of primary health care in the Brazilian Unified Health System (Rocha and Soares 2010, Macinko and Costa 2012, Macinko and Harris 2015).

Numerous studies investigated the effects of FHS on diverse health-related outcomes. Rasella et al. (2014), Hone et al. (2017) and Aquino et al. (2009) concentrate on the analysis of a limited sample of Brazilian municipalities or short-term effects on maternal and infant health outcomes (Rocha and Soares 2015, Macinko et al. (2011), Bhalotra et al. (2016), Pinto et al. (2018). There is a lack of evidence, however, regarding the effects of FHS on chronic non-communicable diseases (Bastos et al. 2017). Thus, the aim of this study is to investigate whether primary health access provided by FHS affected hypertension indicators of morbidity and mortality at the municipal level in Brazil between 2000 and 2015.

Trends in the prevalence of hypertension

The prevalence of hypertension is around 30% to 40% of the adult population worldwide, being higher among individuals in low-and-middle-income countries (WHO 2013, Mills et al. 2016). In general, the populations in high-income countries have a lower prevalence

of decreasing trends, while an increasing trend is observed in low-and-middle-income countries (WHO 2013, Mills et al. 2016, Cifkova et al. 2018).

The Brazilian public health system faces the challenge of double burden of diseases due to demographic transition with persistence of substantial socioeconomic inequalities, where infectious diseases persist and chronic non-communicable diseases has increased (Schmidt et al. 2011, Bhalotra et al. 2016).

According to Alfradique et al. (2009), hypertension is sensitive to prevention strategies at the primary care level. The adoption of primary and secondary prevention, early diagnosis, treatment and control of hypertension may represent substantial socioeconomic and health gains as compared to curative interventions (WHO 2013, Miller at al. 2013, Turi et al. 2017).

There are considerable evidences regarding the effects of prevention strategies on hypertension outcomes, particularly focusing behavioral risk factors: tobacco use, alcohol consumption, unhealthy diets and sedentary lifestyles (WHO 2103, Poorolajal et al. 2016, Mills et al. 2016, Turi et al. 2017, WHO 2018).

Recent hypertension guidelines emphasize the need for lifestyle changes regardless the adoption of antihypertensive medication therapy, due to the high quality of scientific evidence about the adoption of healthy diets with low sodium, maintenance of appropriate body weight, the practice of aerobic exercises, low alcohol consumption, and absence of tobacco use (Carey and Whelton 2018).

Family Health Strategy in Brazil

The Family Health Strategy (FHS) program was released in 1994, but spreads its degree of coverage mainly after 2000, and was designed to target prevention and provision of primary health care delivered by a multidisciplinary health professional teams nationwide (Rocha and Soares 2010). The FHS teams are responsible for the health of around 3,000 inhabitants under municipality management (Rocha and Soares 2010, Ministério da Saúde 2013, Macinko and Harris 2015).

According to Rocha and Soares (2010), the FHS changed the health care provision in Brazil from a central curative to a decentralized preventive model at the local level. Currently, the FHS is the gateway to access specialized health care within the Brazilian Unified Health System (SUS), which provides publicly financed health care for around 80% of the Brazilian population (Macinko and Harris 2015).

Among the literature about the FHS effects on health there are: positive effects on infant mortality, maternal and infant care (Goldbaum et al. 2005, Guanais and Macinko 2009b, Bhalotra et al. 2016, Pinto et al. 2018); improvement of health access (Rocha and Soares 2010, Macinko and Costa 2012, Hone et al. 2017); decline in fertility (Rocha and Soares 2010); decrease in mortality inequalities among ethnic groups (Hone et al. 2017); decrease in cardiovascular disease, morbidity and, mortality associated (Rasella et al. 2014), and a great variability in health outcomes due to public policy articulation (Venacio et al. 2016).

2. Data and Methods

Data

Data from official sources were employed as annual panel data with information on 5,248 Brazilian municipalities from 2000 to 2015 (Table A1 in the Annex). The FHS coverage, the interest variable, was calculated using the number of individuals registered in the program. In order to handle the problem of increasing population coverage in the Brazilian health system promoted by the FHS throughout time, hypertension indicators per prevalence were adopted to avoid confounding increases in the registry of hypertensive due to expansion in hypertension prevalence in relation to increases in access to diagnosis that may be captured by hypertension indicators per capita.

Hence, the results are expected to show improvements in hypertension rates per prevalence, and worsening or unchanging hypertension rates per capita, in case there are simultaneous rises in the number of individuals accessing the public health system and in the effectiveness of the health system. Brazilian rates of mortality and inpatient days due to hypertension accompany trends described, and the hypertension prevalence per capita increases with municipalities' adherence to FHS.

The hypertension indicators selected were: mortality rates due to hypertension to measure final outcome (mortality), and rates of inpatient day due to hypertension (morbidity). The complete dataset encompassed approximately 90,000 observations of 5,560 municipalities. Cases with missing values were dropped off; however, more than 80% of observations were used, resulting in a complete dataset for 5,248 Brazilian municipalities.

Methods

Considering that FHS structure and managerial requirements are enforced by federal government, its adoption by the Brazilian municipalities may be regarded as policy intervention; thus considered as quasi-experimental intervention.

Ordinary Least Square (OLS) models were estimated using clustered errors by the municipality to account for specific local differences.

$$y_{it} = c + \partial . FHS_{it} + \boldsymbol{X}_{it}\beta + \lambda_t + \rho_s + \lambda_t\rho_s + \mu_{it} \qquad (1)$$

Where y_{it} is the hypertension indicator of municipality *i* at year *t* (outcomes); *c* is a constant; FHS_{it} is the proportion of population covered by FHS; ∂ is the parameter of interest; and $\boldsymbol{X}_{it}$ is a set of variables including municipal characteristics which may affect hypertension indicators (Table 1). λ_t, ρ_s, and $\lambda_t\rho_s$ represent, respectively, a set of time *t* dummies, a set of state *s* dummies, and its crossed product, in order to control for existence of other health or specific state policies affecting the health system throughout time. Finally, μ_{it} is the usual error term.

However, it is expected that municipalities with higher income and better governance structure and/or worse health conditions are prone to adopt earlier the program (Macinko et al 2011) that is, although the adoption of the program by the municipality may be random, the time of adoption and the proportion of population covered may be endogenous. In order to test the robustness of OLS results, estimates of fixed effect (FE) models, (2), to account for non-observable fixed characteristics of the municipalities, are performed as well,[2] where υ_i is the fixed effect of municipality *i*.

$$y_{it} = c + \partial . FHS_{it} + \boldsymbol{X}_{it}\beta + \lambda_t + \lambda_t\rho_s + \upsilon_i + \mu_{it} \qquad (2)$$

Finally, in addition to OLS estimates to study differentiated effects of FHS in poor and non-poor municipalities, quantile regressions (QR) were employed to investigate differences in the effect of FHS according to different levels of hypertension indicators among municipalities. In order to categorize municipalities as poor and non-poor, a classification of the Brazilian Ministry of Health was adopted regarding level of poverty based on socioeconomic development, health conditions and health infrastructure at local level.

While OLS estimates refer to average effects minimizing the sum of the square of residues, the QR estimates, (3), are valid for different positions of a municipality in the

hypertension indicator distribution. It allows the comparison of results according to different percentiles of the distribution of the health outcome variable, minimizing the weighted sum of the absolute value of residues. Estimator β_θ, regarding the quartile θ, solves the following equation:

$$\min_{\beta} \frac{1}{n}\left[\sum_{i:y\geq x_i'\beta} \theta\left|y_i - x_i'\beta\right| + \sum_{i:y\leq x_i'\beta} (1-\theta)\left|y_i - x_i'\beta\right|\right] \qquad (3)$$

Where y_i is the dependent variable, x_i is a vector of independent variables, and n is the number of observations. The regression is calculated according to median of the distribution for $\theta = 0.5$, and for other values between 0 and 1 it is calculated according to different percentiles of the distribution.

3. Results

Although FHS was established in middle-1990s, its adoption by the municipalities and the evolution of population coverage increased among municipalities throughout the 2000s (Figure 1). This allows investigating the effects of increasing access of individuals to the public primary health care system on hypertension indicators. It is possible to notice that the evolution in the prevalence of hypertension per 1,000 inhabitants in Brazil increased significantly throughout the period of FHS consolidation in municipalities (Figure 2).

OLS and fixed effect results

FHS coverage coefficients were negative using OLS, suggesting that access to primary health care through family health teams improves morbidity conditions of hypertensive individuals, i.e., primary care had positive effects on helping prevention against hypertension onset or its avoidable health consequences (Table 1). While additional 1% of ESF coverage reduces hypertension mortality value in -0.2% of hypertension mortality average; the effect for inpatient days due to hypertension is a reduction of -0.4% of average hospitalization length of stay. Considering hypertension, heart diseases, and stroke indicators, however, these numbers increase to -3.0% and -15.8%, respectively. Results referring to rates per capita were estimated (Table A2).

FE estimates controlling for fixed non-observed characteristics of municipalities show similar results to OLS estimates regarding coefficients signs of FHS (Table 2). Since FE results are robust to controls for potential sources of endogeneity, OLS was kept as our main reference model (Rocha and Soares 2010).

Heterogeneity among municipalities

There was a significant improvement in hypertension indicators for municipalities, as previously shown. However, splitting municipalities between poverty classification, there is a higher performance of FHS on hypertension among non-poor localities (Table 3). Additional 1% increase in FHS coverage represented a reduction of -0.26% in hypertension, heart disease, and stroke mortality among poor regions and reduction of -0.42% in non-poor municipalities. Regarding inpatient days, the reductions were respectively, -10.55% and -17.11%. Results are similar for just hypertension indicators.

Since the hypertension indicators and FHS coverage of poor and non-poor municipalities are different (Table 4), where the poor municipalities have higher FHS coverage and low level of hypertension indicators in average, quantile estimates are suitable to account for these differences.

Using quantile regressions (QR) to analyze differences in outcome level with categorization of FSH coverage into high (FHS high = 0.8 to 1.0), medium (FHS medium = 0.5 to 0.8), and low coverage (FHS low = 0 to 0.5), the results point to differences between municipalities according to quantiles 0.25 and 0.75 (Table 5).

The QR estimates show that FHS has a higher impact on municipalities with worse hypertension indicators (quantile 0.75 against quantile 0.25) regardless poverty classification or FHS coverage. The results also show robustness of the estimates regarding lower effects of FHS coverage on poor municipalities, since there are inferior effects among poor localities independently of higher or lower FHS coverage or level of hypertension indicators (at quantile 0.25 or 0.75).

4. Discussion

The results are based on the estimation of models using three techniques, in order to perform a robustness analysis of the FHS coverage effects, an agent health program, on hypertension indicators related to morbidity and mortality at the municipal level in Brazil between 2000 and 2015.

Shreds of evidence are that the adoption of FHS by a municipality improves Hypertension indicators of morbidity and mortality (single or including heart disease and stroke). Evidence are robust to fixed effect estimates that account for non-observable and observable municipal characteristics constant throughout the time. Considering the huge Brazilian inequalities (Macinko et al. 2011), the sample was split into poor and non-poor municipalities according to the Brazilian health ministry poverty criterion, and the estimates point to a greater improvement of FHS adoption on the non-poor municipalities as compared with the poor. The finding is robust to the estimates split by income per capita in quartiles.

In addition, the estimates of quantile regressions (QR), that account for the differences in the levels of hypertension indicators among municipalities, suggest substantial heterogeneity of the FHS effects between municipalities with good and bad hypertension indicators. The effects are bigger for municipalities with worst indicators and lower for better indicators of hypertension. These differences in the levels of indicators suggest decreasing improvements as the FHS coverage is near to full coverage, which is partially supported by findings of previous study (Macinko et al. 2011) regarding non-linearity of FHS coverage effects on hospitalization rates for ambulatory care-sensitive conditions. In addition, the QR estimates show the robustness of FHS adoption has higher positive effects in non-poor municipalities, independently of program coverage or health situation of the population at the local level.

The main limitation of the present study refers to the use of aggregate datasets at municipal the level, which allowed for completeness of information at local level; however, limited the possibility of individual analysis of risk factors for hypertension and linked negative health outcomes. To address the problem, the present study includes the percentage of the population older than 40 years, since it is the main group of chronic disease incidence.

The results regarding morbidities, measured by the rate of inpatient days, contrast with findings of recent systematic review accounting for studies investigating hospitalizations due to chronic conditions in Brazil with no conclusive results (Bastos et al. 2017). These studies, however, use a limited sample of municipalities (Rasella et al. 2014) or period for analysis (Guanais and Macinko 2009a). Macinko et al. (2011) show negative effects of hospitalization rates and FHS coverage more similar. The analysis performed by these authors, however, uses hospitalization rates per 10,000 inhabitants, which include the problem of detection bias regarding FHS coverage, i.e., municipalities with higher

coverage tend to have population with increased access to diagnosis and hospitalization, generating the contrary effect of growth in prevalence and hospitalization in the municipality in the short run.

The issue was addressed in the present study by performing two sets of analysis. The first is based on rates per prevalence of hypertension that cleans the effect of the increasing access from the quality of the access. The second based on rates per 1,000 inhabitants for comparison purposes (in the annex) with similar results of previous study that have the large access and quality effect of FHS confounded (Macinko et al. 2011).

The higher effects of the FHS coverage on hypertension indicators in non-poor municipalities is the opposite of Rocha and Soares (2010) regarding the influence of the FHS on infant mortality, where the effects were higher for poor regions. The infant mortality, however, is an indicator highly sensitive to other external effects beyond primary health care, as sanitation and clean water access.

On the other hand, indicators of prevalence, awareness and access or adherence to treatment of hypertension are considered robust evidence on extent and availability of appropriate infrastructure for health care, having better results in high-income countries (WHO 2013, McNaughton et al. 2014, Chor et al. 2015, Mills et al. 2016, Tolonen at al. 2016).

In Brazil, there are significant differences in availability of and access to health services among Brazilian municipalities, states and regions (Gasparini and Ramos 2004, Estellita Lins et al. 2018). Furthermore, there are substantial divergences in operationalization of primary health care procedures, especially regarding chronic non-communicable diseases, due to governance issues (Guanais and Macinko 2009b).

The limited effects of FHS coverage on hypertension indicators at municipal level were constrained by differences at local level, comprising barriers to primary health care in certain municipalities: governance problems, lack of infrastructure and human capital (WHO 2013, Mills et al. 2016), socioeconomic inequalities (McNaughton et al. 2014, Chor et al. 2015), and deficiencies in primary health care operationalization (Macinko et al. 2011, Venancio et al. 2016).

The rise of hypertension in low-and middle-income countries (Mills et al. 2016, Cifkova et al. 2016), allied to increase in risk exposure (WHO 2013, Mills et al. 2016), and the lack of support within health systems may impose an escalation in the burden of hypertension among developing countries (Tolonen et al.2016).

Considering the significant gains derived from primary prevention strategies of hypertension, efforts should be made to accomplish an integrated public health system approach to chronic non-communicable diseases (WHO 2013), especially due to low cost and high benefits of lifestyle changes regarding tobacco use, alcohol consumption, overweight and obesity, unhealthy diets, physical inactivity, and salt intake (WHO 2013, Mills et al. 2016).

In view of the principle of universal health coverage adopted in Brazil, the FHS comprises a comprehensive primary health care program implemented at community level which may be able to tackle strategies for prevention, control and treatment of chronic non-communicable diseases (WHO 2013, Szwarcwald et al. 2013, Rasella et al. 2014), including preventable causes of morbidity and mortality like hypertension.

Nevertheless, barriers identified at municipal level may compromise the fulfillment of its main features, reducing its potential to contribute for financial sustainability of the Brazilian Unified Health System (Mills et al. 2016). The challenge resides in gathering support of multiple stakeholders to promote health system integration through assessment of factors contributing to successful health assistance for the population at municipal level (WHO 2013, Estellita Lins et al. 2018).

5. Conclusions

Based on a huge sample of municipalities of a large developing economy observed from 2000 to 2015, a positive effect of the population access to primary care health public system, by means of an agent health care program, is found on the hypertension indicators of mortality and morbidity (inpatient days). The effects are bigger for the morbidity indicators as compared with mortality, both, including just hypertension or including heart disease and stroke, have the same trend. Results, however, are very heterogeneous according to regions, poor municipalities have a lower effect on their hypertension indicators than the non-poor municipalities. What suggests the need for studies and policies in order to reduce the differences in health access quality between poor and non-poor regions. In addition, results differ according to the current level of the municipal hypertension indicators, the effects are bigger for municipalities with the worst level of hypertension indicators, regardless of being poor or a non-poor municipality.

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Tables

Table 1 - OLS estimates for hypertension mortality and inpatient days per prevalence

Variables	Mortality		Inpatient days	
	Hypertension	Hypertension, heart diseases, and stroke	Hypertension	Hypertension, heart diseases, and stroke
FHS coverage	-0.0019***	-0.0039***	-0.0292***	-0.1580***
	(0.000)	(0.000)	(0.002)	(0.005)
% Population > 40y	0.0004	0.0031***	0.0178***	0.0727***
	(0.001)	(0.001)	(0.004)	(0.013)
Log. Population	0.0001**	0.0003***	0.0008***	0.0110***
	(0.000)	(0.000)	(0.000)	(0.001)
%Health expenditure paid by municipality	0.0005**	0.0009***	0.0010	0.0125***
	(0.000)	(0.000)	(0.001)	(0.004)
Illiteracy	0.0011**	0.0023***	0.0181***	0.0570***
	(0.000)	(0.001)	(0.003)	(0.009)
Health expenditure per capita	-0.0000	0.0002	-0.0014**	-0.0012
	(0.000)	(0.000)	(0.001)	(0.002)
Mayor graduated	0.0000	-0.0000	0.0001	0.0003
	(0.000)	(0.000)	(0.000)	(0.001)
Log. Income per capita	-0.0000	-0.0001**	-0.0004	-0.0003
	(0.000)	(0.000)	(0.000)	(0.001)
Observations	72,662	72,650	72,604	72,065
R-squared	0.01	0.055	0.15	0.385

*** p<0.01; ** p<0.05; * p<0.1. Robust standard errors in parentheses.

Year dummies, state dummies and year-state crossed dummies included.

Table 2 - FE estimates for hypertension mortality and inpatient days per prevalence of hypertension and hypertension, heart diseases, and stroke

	Mortality		Inpatient days	
	Hypertension	Hypertension, heart diseases, and stroke	Hypertension	Hypertension, heart diseases, and stroke
FHS coverage	-0.0013***	-0.0030***	-0.0248***	-0.1143***
	(0.000)	(0.001)	(0.004)	(0.013)
Observations	72,662	72,650	72,604	72,065
R^2	0.011	0.027	0.114	0.277
Municipalities	5,248	5,247	5,247	5,244

*** p<0.01; ** p<0.05; * p<0.1. Robust standard errors in parentheses. % Population>40y, population, %Health expenditure paid by municipality, illiteracy, Health expenditure per capita, Mayor graduated, income per capita, year dummies, state dummies and year-state crossed dummies included.

Table 3 - OLS estimates for hypertension mortality and inpatient days per prevalence - Poor and Non-poor

Hypertension						
OLS model	Mortality			Inpatient days		
Variables	Brazil	Poor	Non-Poor	Brazil	Poor	Non-Poor
FHS coverage	-0.0019***	-0.0007**	-0.0021***	-0.0292***	-0.0186***	-0.0315***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.003)	(0.002)
Observations	72,662	21,910	50,752	72,604	21,898	50,706
R-squared	0.018	0.029	0.022	0.150	0.138	0.164
Hypertension, heart diseases, and stroke						
OLS model	Mortality			Inpatient days		

Variables	Brazil	Poor	Non-Poor	Brazil	Poor	Non-Poor
FHS coverage	-0.0039***	-0.0026***	-0.0042***	-0.1580***	-0.1055***	-0.1711***
	(0.000)	(0.001)	(0.000)	(0.005)	(0.014)	(0.005)
Observations	72,650	21,910	50,740	72,065	21,818	50,247
R-squared	0.055	0.038	0.073	0.385	0.324	0.406

*** p<0.01; ** p<0.05; * p<0.1. Robust standard errors in parentheses. % Population>40y, population, %Health expenditure paid by municipality, illiteracy, Health expenditure per capita, Mayor graduated, income per capita, year dummies, state dummies and year-state crossed dummies included.

Table 4 – t-test of differences between poor and non-poor municipalities

Variables	Non-poor	Poor	Diff.	p-value
Hypertension mortality rate	0.00061	0.00042	0.00019	0.000
Hypertension inpatient days	0.00949	0.00759	0.00759	0.000
Hypertension prevalence	0.856	0.770	-0.086	0.000
FHS coverage	0.776	0.870	0.094	0.000
% Population>40y	0.332	0.294	-0.038	0.000
Population	9.435	9.316	-0.119	0.000
%Health expenditure paid by municipality	0.647	0.572	-0.074	0.000
Illiteracy	0.329	0.408	0.078	0.000
Health expenditure per capita	5.012	4.860	-0.152	0.000
Mayor graduate	0.428	0.374	-0.054	0.000

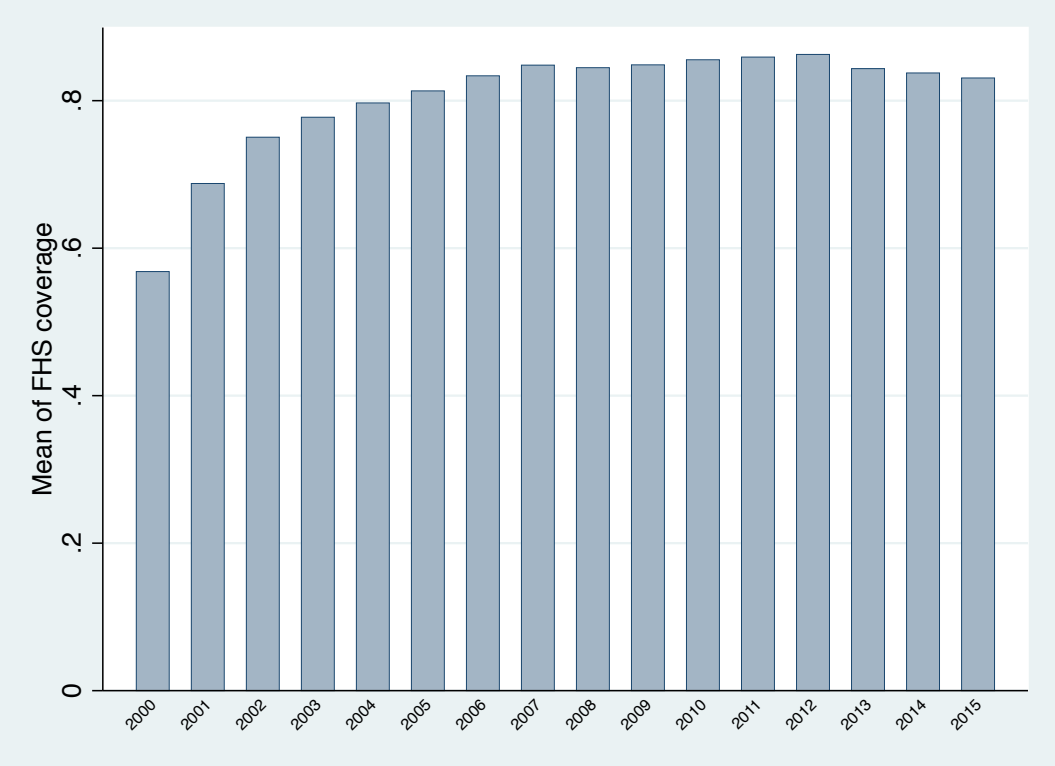
Table 5 - QR estimates for hypertension mortality and inpatient days per prevalence according to poor and non-poor municipalities and to FHS coverage

Groups		Hypertension mortality			Hypertension inpatient days		
	Quantiles	High coverage (0.8-1.0)	Medium coverage (0.5-0.8)	Obs.	High coverage (0.8-1.0)	Medium coverage (0.5-0.8)	Obs.
Brazil	Q0.25	-0.00014 ***	-0.00014 ***	72,662	-0.00205 ***	-0.00195 ***	72,604
		(0.000)	(0.000)		(0.000)	(0.000)	
	Q0.75	-0.00082 ***	-0.00074 ***	72,662	-0.0169 ***	-0.01561 ***	72,604
		(0.000)	(0.000)		(0.000)	(0.000)	
Non-Poor	Q0.25	-0.00016 ***	-0.00016 ***	50,752	-0.00226 ***	-0.00217 ***	50,706
		(0.000)	(0.000)		(0.000)	(0.000)	
	Q0.75	-0.00086 ***	-0.00078 ***	50,752	-0.0177 ***	-0.01641 ***	50,706
		(0.000)	(0.000)		(0.000)	(0.000)	
Poor	Q0.25	-0.00002 **	-0.00001 *	21,910	-0.00126 ***	-0.00108 ***	21,898
		(0.000)	(0.000)		(0.000)	(0.000)	
	Q0.75	-0.00049 ***	-0.00039 ***	21,910	-0.00988 ***	-0.00781 ***	21,898
		(0.000)	(0.000)		(0.001)	(0.001)	

*** p<0.01; ** p<0.05; * p<0.1. Robust standard errors in parentheses. % Population>40y, population, %Health expenditure paid by municipality, illiteracy, Health expenditure per capita, Mayor graduated, income per capita, year dummies, state dummies and year-state crossed dummies included

Figures

Figure 1 - Evolution of Family Health Strategy program coverage in Brazil



Annex

Table A1 – Variables description

Variables	Obs.	Mean	SD	Min	Max	Source
Indicators of hypertension in rates						
Mortality per prevalence	84,266	0.0006	0.0059	0	0.5	DATASUS
Inpatient days per prevalence	84,197	0.0089	0.0283	0	0.96	DATASUS
Hypertension, heart diseases, and stroke rates						
Mortality	84,251	0.0008	0.0054	0	0.5	DATASUS

Inpatient days	83,491	0.0602	0.09	0	0.99	DATASUS
Percentage of population covered by the FHS						
FHS coverage	89,472	0.8036	0.2682	0	1	DATASUS
Control variables						
% Population older than 40y	88,909	0.3214	0.0724	0.065	0.746	DATASUS
Log. Population	88,973	9.4008	1.1423	6.678	16.298	DATASUS
%Health expenditure paid by municipality	88,093	0.6258	0.1668	0	1.04	DATASUS/IBGE
Illiteracy - older than 15y	84,423	0.3523	0.1006	0	0.999	DATASUS
Health expenditure per capita	88,092	4.9686	0.567	0.143	7.456	DATASUS/IBGE
Mayor graduated	78,288	0.4119	0.4922	0	1	DATASUS/TRE
Log. Income per capita at prices of 2000	88,951	5.7031	6.6557	0.1286	327.44	DATASUS/IBGE
Poor municipality in health	89,054	0.2843	0.45109	0	1	DATASUS/IBGE

DATASUS = Department of Informatics of the Brazilian Ministry of Health (www.datasus.gov.br)

IBGE = Brazilian Institute for Geography and Statistics (www.ibge.gov.br)

TRE = Brazilian Regional Court of Elections (www.tre.gov.br)

Table A2 - OLS estimates for hypertension mortality and inpatient days due to hypertension per 1,000 inhabitants

Variables	Mortality rate	Inpatient days	Prevalence
FHS coverage	0.2712***	-0.0001	0.8232***
	(0.058)	(0.000)	(0.017)
Observations	73,879	73,879	73,867
R^2	0.148	0.086	0.252

% Population>40y, population, %Health expenditure paid by municipality, illiteracy, Health expenditure per capita, Mayor graduated, income per capita, year dummies, state dummies and year-state crossed dummies included.