Evaluating the Impact of Physicians' Provision on Primary Healthcare: evidence from Brazil's More Doctors Program

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Resumo

Este trabalho objetiva avaliar o Programa Mais Médicos no que se refere ao provimento de médicos, apresentando estimativas de seu impacto nas internações por condições sensíveis à atenção primária (ICSAP). Foi empregado o método de diferenças-em-diferenças com pareamento por escore de propensão, sendo utilizadas três especificações, um teste de falseamento e também um teste de endogeneidade dinâmica para confirmar a robustez dos resultados. Para tanto, foi construído um painel de dados municipais abrangendo diversas variáveis relativas às características socioeconômicas, demográficas e de infraestrutura pública de saúde nas cidades para o período de 2010 a 2016. Os resultados mostram uma importante redução nas internações hospitalares nos municípios tratados com um efeito crescente e perceptível a partir do primeiro ano do programa.

Palavras Chave: Programa Mais Médicos; internações por condições sensíveis à atenção primária (ICSAP); diferenças-em-diferenças; Propensity Score Matching.

Abstract

This study aims to evaluate the More Doctors Program (Programa Mais Médicos – PMM) in terms of the provision of physicians, presenting estimates of its impact on hospitalization for ambulatory care sensitive conditions (ACSH). The differences-in-differences method was used with Propensity Score Matching, using three specifications, a falsification test and also a dynamic endogeneity test to confirm the robustness of the results. For the application of this methodology, a panel of municipal data was constructed covering several variables related to socioeconomic, demographic and public health infrastructure characteristics in the cities for the period from 2010 to 2016. The results show a significant reduction in hospital admissions in treated municipalities with an increasing and perceptible effect already in the first year of the program.

Key Words: More Doctors Program; Hospitalizations for conditions sensitive to primary care (ACSH); differences-in-differences; Propensity Score Matching.
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1 Introduction

The inadequate supply and poor geographical allocation of health professionals and services are problems that affect many countries in the world, regardless of their level of economic development. It is one of the major challenges faced by OECD member countries in terms of formulating public policies, according to the OECD (2016). For the United States, the AAMC (2016) forecasts that the demand for doctors has grown at a higher rate than the supply, estimating a deficit of 94.700 professionals in 2025.

In remote areas, the problem may be even more serious and difficult to resolve if we take into account the attraction and retention of doctors. Most of these professionals prefer to live in urban areas because of greater professional and educational opportunities and higher quality of life. As a result, there is a mismatch between the geographical distribution of physicians and the demand for them (Ono, Schoenstein & Buchan (2014)). This situation negatively affects accessibility to health services and, consequently, population health indicators.

Programs such as the Overseas Trained Doctors in Australia, the National Health Services Loan Repayment Program in the United States, and the Mission Barrio Adentro in Venezuela are examples of public policies that have been implemented to solve the problem of scarcity and poor distribution of physicians. However, as the OECD (2016) points out, there is little causal evidence of the impact of these policies on population health indicators. Evaluations of these programs have emphasized monitoring or have used qualitative approaches, emphasizing the debate surrounding the launch of the programs and the historical context of their implementation in the countries.

In Brazil, several initiatives have been implemented by the government since the creation of the Unified System of Health (Sistema Único de Saúde - SUS) in order to increase the population's access to health services, especially in the most remote and deprived areas. Among these measures, the Community Health Agents Program implemented in 1991 and the Family Health Program implemented in 1994 are highlighted. Both had the objective of reorganizing the public health system through the performance of health teams in communities, aiming at the prevention, diagnosis and treatment of diseases.

The literature on the subject points out that such programs have allowed a profound transformation in the health provision model in Brazil, moving away from a hospital-centered regime in the main urban areas of the country, towards a decentralized model, in which the first point of contact between the health system and the population became the health teams. These changes represented a notable advance in SUS coverage by ensuring the inclusion of a large number of poor families in the primary care assistance network (Macinko et al. (2007), Rocha & Soares (2010)).

Despite the advances, the restriction in the supply of doctors in less developed regions prevented a greater strengthening of public health care coverage. An OECD (2013) study for a sample of forty-three countries showed that Brazil was the seventh worst place in terms of the number of doctors per thousand inhabitants, being well below several countries in Latin America. According to a survey by the Institute for Applied Economic Research (IPEA, 2010), the problem was even more serious because of regional disparities in physician allocation. In several cities in the North and Northeast of Brazil, there was not even one doctor per thousand inhabitants, making it difficult for the population to access healthcare.

In this context, the More Doctors Program (Programa Mais Médicos - PMM) was launched in 2013 aiming to solve the main problem of the SUS, the lack of doctors. The program was constituted through three pillars of action: i) the emergency provision of doctors to attend basic care, prioritizing the municipalities with the greatest deficit of professionals, ii) the improvement of the infrastructure of basic health units and services, and iii) the increase in the number of admissions to medical courses in locations with greater need of physicians and fewer vacancies per capita.

In 2016, More Doctors completed its third year of existence and since its creation has been motivating countless debates and analysis among researchers. In the studies already carried out, the greatest emphasis was placed on its implementation and effectiveness in terms of coverage, access and equity (Girardi et al. (2016), de Sousa Lima et al. (2016), Oliveira, Sanchez & Santos (2016)). Limitations and criticisms of the PMM and the formation of physicians were also addressed in a study by Kemper, Mendonça & Souza (2016). Regarding the evaluation of the program, only the works of Bento da Silva et al. (2016) and Santos et al. (2017) were found, who analyzed the satisfaction with the program from the point of view of the users of the healthcare system and the temporal trajectory of avoidable hospitalizations before and after the PMM, respectively. No studies were found that show causal evidence of the impact of this policy on population health indicators.

This article contributes to this literature by presenting an evaluation of the More Doctors Program on the variable of hospitalization for ambulatory care sensitive conditions (ACSH) in the period between 2010 and 2016. Although there are other health indicators, the choice to evaluate the ACSH occurred for two reasons. The first is related to the fact that this variable represents not only the level of coverage of health services, but also the degree of resolutiveness of primary care (Bindman et al. (1995), Starfield, Shi & Macinko (2005), Ansari, Laditka & Laditka (2006)). The second is due to Ordinance nº. 221 of 2008 of the Ministry of Health, which identifies hospitalizations for ambulatory care sensitive conditions as the main indicator for the monitoring and evaluation of basic care policies in Brazil. In addition, this indicator is the most recommended for measuring the impact and effectiveness of PMM according to a 2015 specific audit report about the program of The Federal Court of Accounts (TCU – Brazil). The results found in the present study show that there was a reduction in hospital admissions in the municipalities treated and an increasing and percievable effect from the first year of PMM, evidencing that the provision and the reassignment of physicians can positively impact the performance of the basic health system in Brazil.

2 More Doctors Program and Physicians' Provision

The More Doctors Program (PMM) was created by Provisional Measure n. 621 of July 2013 and regulated by Law n. 12.871 with the objective of "reducing the shortage of doctors in the priority regions for the SUS in order to reduce regional inequalities in healthcare" (BRAZIL, 2013, p. 1). For that, the Emergency Provision was established, called "More Doctors Project for Brazil". The physicians of the program work in Basic Health Units and teams of the Family Health Program, aiming at strengthening primary care for families. It is expected that until 2020 the mark of 2.5 doctors per thousand inhabitants will be reached (Brazillian Ministry of Health (2015)).

All municipalities may voluntarily apply for membership in the program. However, faced with the shortage of medical professionals in poorer areas, priority criteria were defined among participating cities[1]. The provision of physicians is performed from the opening of hiring notices, which establish a preference order for doctors to choose the vacancies offered in the program, with priority for Brazilians. If they do not fill all the vacancies, the program envisages the recruitment of professionals trained in other countries. According to the Ministry of Health, about 62% of PMM physicians are of Cuban origin.

The More Doctors Program has undergone a rapid expansion both in the number of doctors incorporated and in the number of cities served. According to Ministry of Health data, 2,101 cities were served by the PMM in December 2013. In July 2014, coverage reached 3,490 municipalities with a total of 14,106 active physicians. Currently, the PMM guarantees healthcare to about 63 million people.

Regarding the regional disparities in the allocation of physicians, until September 2014, there was a reduction of 53% in the number of municipalities with a shortage of these professionals. In the North, 91% of municipalities that had a small number of doctors were attended by the PMM. In addition, 82% of the municipalities with 20% or more of the population living in extreme poverty joined the program (Santos, Costa & Girardi (2015)).

3 Data and Identification Strategy

In the impact analysis, a municipal panel data, which comprises August 2010 to July 2016 is used[2], totaling six years - three years in the PMM and three years prior to the program. The panel includes variables related to public health provision and socioeconomic characteristics, whose detailed descriptions can be seen in Table A1 of Appendix A, where the other information about the database is also presented.

Since most of the municipalities that joined the PMM did so until July 2014 (92%)[3], it was decided not to use a staggered approach that considered different times of entry into the program. In this case, the cities that became part of the PMM in the second and third year of the program were excluded from the analysis. This strategy did not cause many losses and allowed the monitoring of a specific cohort of municipalities over time. The final sample is made up of 5,269 municipalities[4].

The great adhesion of cities in the first year of the program brought questions about the PMM's ability to generate the expected results by including a profile of non-priority municipalities (Oliveira, Sanchez & Santos (2016)), which eventually constituted a quite heterogeneous treatment group. Considering that this group is formed by 3,490 municipalities and given the heterogeneity already mentioned, we tried to identify the

[1]Municipalities with a percentage of the population in extreme poverty equal to or higher than 20%, with low or very low Human Development Index (HDI), and members of regions such as the Semi-arid, North with scarcity, Jequitinhonha, Mucuri and Ribeira; Vulnerable capitals and metropolitan areas and municipalities included in the G100 index; Special Indigenous Sanitary Districts (Brazillian Ministry of Health (2015))

[2]The program was created in July 2013, however it was in August of the same year that new doctors began to be incorporated. In this article, the periods of analysis are then composed of August of a base year and July of the following year, totaling twelve months for each period. In this way, we can analyze the three years of the program: August 2013 to July 2014, August 2014 to July 2015 and August 2015 to July 2016

[3]3,789 municipalities entered the program during its first three years, of which 3,490 joined the PMM in the first year.

[4]95% of the total number of Brazilian municipalities.

municipalities that would potentially be most affected by the intervention. In the literature, the same concern was present in the work of Santos et al. (2017), who used a treatment group composed only of municipalities with 20% or more of the population living in extreme poverty, as well as those located in border areas.

Our identification strategy considers as treated the municipalities that experienced a significant change of scale in the supply of doctors on account of the program. In this way, it aims to identify the priority municipalities according to the objective of the PMM, whose purpose was to increase the proportion of physicians by inhabitants and focus them in the poorest regions in terms of health care. To select such municipalities, we used the ratio between the number of PMM physicians and the total number of physicians in the year prior to the intervention as a measure of scale. This measure considers not only the number of doctors of the program received by the municipality, but also their lack of these professionals. From its calculation for each municipality, we defined as the most affected by the program those with variation in the supply of physicians corresponding to the last quartile of the distribution of this measure[5].

The control group, in turn, was composed of municipalities that did not receive doctors linked to the More Doctors Program. The municipalities that received PMM physicians, however in a smaller proportion compared to the treatment group, make up a group that will be used as pseudo-placebo to test the robustness of the results. Since these municipalities have not experienced a significant change in the supply of physicians, it is expected that the PMM will not impact the outcome variable of this group[6]. The descriptive statistics presented below (Table 1) show that the pseudo-placebo group had, on average, 6% variation in the physician scale versus 37% among the treated municipalities, suggesting that the treatment group may actually have been the most affected by the intervention.

In addition, the municipalities that make up the treatment group, one year before the program, had an average of 0.93 doctors per thousand inhabitants. It is a proportion below the minimum density recommended by the Ministry of Health (one per thousand inhabitants). In turn, the mean proportion of the pseudo-placebo group was 2.79 doctors per thousand inhabitants. A figure that is above the goal set by the Ministry of Health of 2.5 doctors for the Brazilian municipalities in 2020. Table 1 shows that the treated municipalities are considered the worst in socioeconomic and public health conditions, both in relation to pseudo-placebo as well as compared to the control group.

On average, these municipalities presented a smaller number of doctors, beds, professionals, and health equipments compared to the other groups of analysis. In regard to socioeconomic conditions, they are characterized by a higher per capita value of transfers linked to the Bolsa Família Program; a lower GDP per capita; a lower average salary; and a lower occupancy rate. In addition, they have the highest percentage of households registered in primary care with open garbage and a lower percentage of households with electric energy. The detailing of the profile of the treated from the descriptive statistics reinforces the identification strategy used, suggesting that the selected treatment group is in agreement with the priority municipalities of the program.

[5]This group corresponds to the cities that received doctors linked to the program in a proportion equal to or greater than the 15.4% (lower limit of the quartile) of the medical stock in the municipality.

[6]As Imbens (2004) points out, for the validation of the identification strategy, a common practice in the literature of causal inference is to estimate the results using as a placebo of treatment the group that, according to identification, would not suffer the intervention effects.

Table 1: Descriptive analysis of the variables for the three groups proposed in the identification strategy, one year before the PMM

	Treated			Placebo			Control		
Variable	Obs	Mean	Std. Dv.	Obs	Mean	Std. Dv.	Obs	Mean	Std. Dv.
ACSH	1,322	11.7	9.17	2,168	14.49	9.7	1,779	13.38	9.99
Physicians	1,322	0.93	0.55	2,168	2.79	2.28	1,779	1.96	1.6
Health Professionals	1,322	2.91	1.48	2,168	4.08	1.93	1,779	4.09	1.98
Beds	1,322	0.90	1.35	2,168	2.32	1.99	1,779	1.51	2.18
Health Facilities	1,322	0.87	0.46	2,168	1.26	0.70	1,779	1.17	0.61
Health Equipments	1,322	0.17	0.25	2,168	0.41	0.32	1,779	0.31	0.33
Schools	1,322	3.19	1.76	2,168	1.93	1.22	1,779	2.54	1.72
Open Garbage	1,306	0.15	0.17	2,087	0.07	0.11	1,719	0.09	0.14
Energy	1,306	0.90	0.12	2,087	0.96	0.07	1,719	0.96	0.08
Untreated Water	1,306	0.34	0.28	2,087	0.37	0.30	1,719	0.34	0.31
Average Wages	1,322	1.82	0.45	2,168	2.05	0.59	1,779	1.94	0.56
Occupancy rate	1,322	0.11	0.15	2,168	0.19	0.14	1,779	0.21	0.75
PBF per capita	1,322	3.19	0.73	2,168	2.58	0.85	1,779	2.67	0.87
GDP per capita	1,307	9.30	0.71	2,146	9.56	0.72	1,758	9.49	0.70
Physicians scale (*)	1,322	0.38	0.29	2,168	0.07	0.05	1,779	-	-
Population	1,322	12,790	13,460	2,168	67,380	325,472	1,779	12,343	20,856

Font: DATASUS, INEP, IPEA e RAIS. (*) This variable is a ratio between the number of PMM physicians and the total number of physicians in the city, one year before the program and is presented only because of the identification strategy.

4 Empirical Strategy

To estimate the impact of the More Doctors Program on ACSH, we will use the differences-in-differences method weighted by propensity scores (double difference matching). While differences-in-differences aim to reduce possible selection biases by unobservable characteristics, Propensity Score Matching (PSM), by matching similar municipalities, minimizes the possible biases due to the distribution of observable characteristics and lack of common support (Heckman et al. (1998))

4.1 Propensity Score Matching

In PSM we used a Logit model to estimate the probability of the municipalities being part of the PMM given a vector of characteristics of the period before the treatment ($X_{i,-1}$). The matching by variables related to the previous period is necessary due to the great adhesion of municipalities to the PMM in 2013. With this we avoided to cause distortion in the results of the analysis since the characteristics of the municipalities could have been affected by the intervention already in the initial year of the program.

The propensity score, formally defined as $\hat{P}(X) = Pr(PMM_{i,0} = 1|X_{i,-1})$, will be used to compute the weights to balance the municipalities in the control group, making, on average, this group similar to those treated. In the matching, a non-parametric kernel-based estimator will be used and to test matching balancing, two evaluation criteria will be adopted: the first refers to the verification of the overlap of the treatment probability for both experimental groups; and the second to the normalized difference of means between the variables for treated and controls according to Imbens & Wooldridge (2009)[7,8].

4.2 Differences-in-differences

The differences-in-differences method requires information from the treated and controls before and after the program. The effect of the intervention is captured by the difference in the difference of the results, for treated and controls, before and after treatment. In this way, it is aimed to control unobservable effects related to time and differences between experimental groups.

Denoting $t = 1$ as the period after the program and $t = 0$ as the previous one, the difference-in-differences estimator is given by:

$$DD_i = E[(Y^1_{i,1} - Y^1_{i,0}) - (Y^0_{j,1} - Y^0_{j,0})] \tag{1}$$

where Y_i and Y_j are the result variable of a treated municipality i and control j, respectively.

4.3 Double Difference Matching

After matching, the differences-in-differences model, weighted by the results obtained with the PSM, estimates the impact of the treatment on the matched municipalities within a common support (denoted as C). Considering two time periods ($t = 0, 1$), the estimate DDM_i for each treatment municipality i is calculated by:

$$DDM_i = E[(Y^1_{i,1} - Y^1_{i,0}) - \Sigma_{j \in C} W_{i,j}(Y^0_{j,1} - Y^0_{j,0})] \tag{2}$$

where $W_{i,j}$ is the weight given to a control municipality j, matched to a treatment municipality i. The weights are equal to 1 for the treated and $\frac{\hat{P}(X)}{1-\hat{P}(X)}$ for the controls.

To add robustness to the results, we used several specifications with the inclusion of fixed effects for municipality and year and a vector of control variables. Instead of estimating DDM_i only for a period after the beginning of the program, the parameter is estimated for all years, before and after More Doctors[9]. As suggested by Bertrand, Duflo & Mullainatha (2004), the standard errors were clustered at the municipal level, seeking to correct the possibility of serial correlation and heteroskedastic errors.

Considering that the adoption of PMM may depend on the preconditions of health of the municipality or its performance over time, the treatment variable may be endogenous. If the treatment variable is correlated only contemporaneously with the dependent variable, the use of fixed effects in the double difference-matching model could solve the problem. However, endogeneity may be worrisome if PMM adoption is related to the dynamics of the dependent variable, such as when municipalities that were already experiencing

[7] With the normalized means calculated, the authors propose as acceptable difference between groups, values of 0.25.

[8] Possible biases for selection by observable characteristics will be mitigated as these criteria have been met.

[9] According to Duflo (2001), the coefficients for years prior to treatment serve as a robustness test to assess whether in fact the estimated results are a reflection of the program or other shocks that affect treated and controls differently throughout the time.

improvement in health indicators (in this case, ACSH) are precisely those with a higher probability of participating in the program. This situation would make sense due to the self-selective character of the process of adhesion of the municipalities to the PMM, which could end up directing doctors to the cities whose governments have better planning capacity and proactive behavior related to health. It must also be considered that these more motivated governments can also invest their efforts in different social policy initiatives, which may end up attributing to the PMM an effect that is really due to all the interventions. This situation constitutes another form of endogeneity, related to omitted variables.

To estimate the extent of concern with dynamic endogeneity, we follow the procedure of Galiani, Gertker & Schargrodsky (2005) and Rocha & Soares (2010), which consists in estimating the probability of participation in treatment as a function of the dependent variable in level and variation for the period prior to treatment. In addition, we also considered the independent variables, both in level and variation. In regard to endogeneity due to omitted variables, we tried to control by a broad set of variables related to the municipal policy dimension. Our covariates vector includes aspects such as basic sanitation (percentage of houses with electricity, open garbage and lack of treated water), public health infrastructure (number of doctors, beds, equipment, professionals and health facilities). In addition to the number of public schools per capita.

5 Results

Figure 1 depicts the distribution of treatment probability for treated and controls. The municipalities in the treated group were distinct from the municipalities in the control group in observable characteristics. After matching, the estimated probability distribution became very similar between the experimental groups. Table ?? in the Appendix shows that prior to matching the variables related to the health supply had different means. After matching, all variables met the balancing criterion, allowing for safer estimates by mitigating possible selection biases.

Figure 1: Distribution of the probability of treatment for treated and controls - Before and after matching

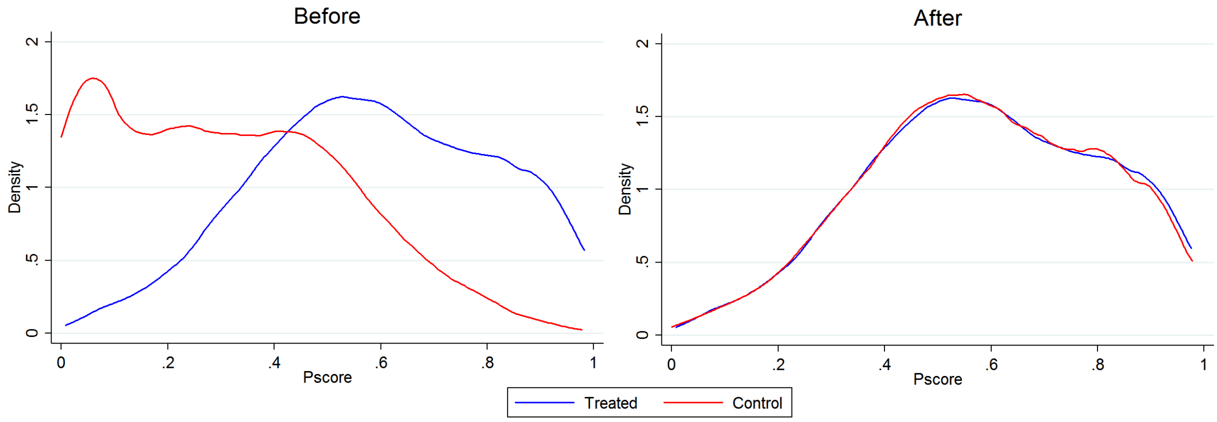

Table 2 shows the impacts of PMM on the treated municipalities that received doctors during the first year of the program. The specification (1) indicates that, after the intervention, there was a relative drop in the treated of 0.8 hospitalizations due to primary care-sensitive conditions per thousand inhabitants in comparison with the controls. By incorporating the control variables in the specification (2), it is noted that the statistical significance of the DDM estimator remained, albeit with a smaller impact (-0.656).

Table 2: Impact of PMM ($DDMi$) over ACSH for the treated municipalities that received doctors from the PMM program in year 1 (Aug/2013 –Jul/2014)

	(1)	*(2)*	*(3)*
Post PMM	-0,809**	-0,656**	-
	(4.16)	(3.15)	
PMM 3 years before	-	-	(omitted)
PMM 2 years before	-	-	-0,257
			(1.36)
PMM 1 year before	-	-	-0,217
			(0.86)
PMM year 1	-	-	-0,442
			(1.62)
PMM year 2	-	-	-0,918**
			(2.89)
PMM year 3	-	-	-1.432**
			(3.66)
Controls	No	Yes	Yes
Observations	16,950	15,770	15,770
R^2	0.02	0.03	0.04

Note: Significant to 1% (**) and 5% (*). Regressions with fixed effect for municipality and year. Specifications (2) and (3) with controls vector: health equipment / 1000 Hab., Other doctors / 1000 Hab., Other health professionals / 1000 Hab., Beds / 1000 Hab., Health establishments / 1000 Hab., Schools / 1000 Hab., Percentage of houses with electricity, untreated water and garbage in the open. Clustered robust standard errors at the municipal level. In parentheses, t statistics.

The specification (3) considers the DDM estimator for each year between 2010 and 2016 (three years before and three years after the start of the PMM), with the first interaction variable, for the year 2010, as omitted category. It is noted that the estimated result for the first year of the program is not statistically significant. In the second year, it is possible to capture the PMM effects represented by the relative drop of 8.3% (0.9 in absolute terms) in hospitalizations for conditions sensitive to primary care among the treated - considering the average hospitalization level of this group one year before the program. In the following year, this impact is even greater: 13.6% (1.4 in absolute terms) less hospitalizations among the participating cities of the More Doctors Program.

The lack of results for the estimator in the 'PMM year 1' may be the result of the great adhesion of municipalities over this period. As highlighted in Section 2, this movement can be thought of in two large expansion cycles: between August 2013 and December 2013 and between January 2014 and July 2014. In this case, even if we consider only incoming municipalities in the PMM in the first year of the program, the different times of entry may have caused a distortion in the results, when analyzed year by year.

As a result, the treated were separated into two groups: those who received physicians linked to the program in 2013 and those who received them in the first half of 2014. Table 3 presents the causal impact of PMM from this time cut. The results for specification (1) and (2) are higher for the group of municipalities that received doctors linked to PMM in 2013 and who had a longer time of exposure to the program. The main result is that, in the first year, in the treated group a reduction in admissions for conditions sensitive to primary care was observed in relation to those cities that did not receive program doctors - the relative drop was 6.3% (0.69 in absolute terms) in hospitalizations. The result was intensified in the second and third year of the program, when the participating cities had, on average, 8.2% and 15.8% (0.89 and 1.6 in absolute terms) less hospitalizations than non-participants.

Table 3: Impact of PMM (DDM_i) over for the treated municipalities that received doctors from the PMM program in two distinct periods of the program

	Aug/2013 – Dez/2013			Jan/2014 –Jul/2014		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
Post PMM	-0,934**	-0,779**	-	-0,777**	-0,665*	-
	(3.57)	(3.05)		(3.14)	(2.54)	
PMM 3 years before	-	-	(omitted)	-	-	(omitted)
PMM 2 years before	-	-	-0,269	-	-	-0,023
			(1.28)			(0.09)
PMM 1 year before	-	-	-0,206	-	-	-0,045
			(0.73)			(0.86)
PMM year 1	-	-	-0,690*	-	-	-0,176
			(2.17)			(0.14)
PMM year 2	-	-	-0,892*	-	-	-0,865*
			(2.27)			(2.23)
PMM year 3	-	-	-1,622**	-	-	-1.310**
			(3.59)			(2.67)
Controls	No	Yes	Yes	No	Yes	Yes
Observations	15.048	14.026	14.026	11,988	11,139	11,139
R^2	0.02	0.03	0.04	0.02	0.03	0.04

Note: Significant to 1% (**) and 5% (*). Regressions with fixed effect for municipality and year. Specifications (2) and (3) with same control vector as the previous table. Clustered robust standard errors at the municipal level. In parentheses, t statistics.

When analyzing the second treatment group, in reference to the cities that received doctors in 2014, the DDM estimator of the first year of the program is not statistically significant. This is an expected result, since physicians had less time to act so that there would be a decrease in the hospitalization variable for the whole period. However, from the second year on, it is possible to capture the effects of PMM: reduction of 7.9% (0.86 in absolute terms) of hospitalizations for conditions sensitive to primary care among those treated in the 'PMM year 2' and 12.5% (1.4 in absolute terms) less hospitalizations among the cities participating in the 'PMM year 3'.

6 Robustness Analysis

In the specifications (3) of Tables 2 and 3, the DDM coefficients for the three periods before the program were also estimated. The parameters were statistically insignificant, which indicates, on average, that there is no difference between treated and controls for the trajectory of the ACSH variable in the periods prior to the PMM. This strategy served as a robustness test to confirm that the results are capturing the effect of the More Doctors Program on hospitalizations and not other shocks that could differentiate the treatment and control groups over time, since the outcome variable only differentiated between the groups after the intervention started.

Table B2 of Appendix B presents the results for two falsification tests. The first consisted of estimating the effect of the program without considering the proposed identification strategy, that is, for the group of treated and pseudo-placebo together ('All'). In none of the three specifications, the coefficients for the program were significant. For this result the PMM would have no impact. The second test involved the estimation of the effect of More Doctors for the pseudo-placebo group. The coefficients were not significant, suggesting that the absence of effects in the previous estimation is associated with the group of municipalities that participated in the PMM, but did not have a significant change in the supply of physicians.

Finally, B3 presents the determinants of the participation of municipalities in the program in order to test the hypothesis of dynamic endogeneity between ACSH and the variable referring to PMM. The ACSH coefficients both at the level of the year preceding the program and at the variation of the previous three years are not significant, indicating that there is no correlation between adherence in the program and the contemporary and dynamic behavior of the dependent variable.

7 Discussion and Conclusion

The results found in this article indicate that PMM had an impact on the reduction of hospital admissions due to conditions sensitive to primary care in Brazilian municipalities in need of public health care. From the coefficients in Table 2 for the third year of the program (-1.4) we can analyze the approximate gross reduction in the number of hospitalizations. Considering that the treated municipalities had approximately 13 thousand inhabitants in average, it is estimated that after three years of the program, the PMM contributed to a decrease of 23,148 hospitalizations[10]. In monetary terms, it is equivalent to an economy of US$ 6,185,019.85, considering the average cost of hospitalizations referring to the diseases contained in the result variable proposed in this study for the municipalities of the treatment group[11,12].

The results obtained are in line with other studies in existing literature on this subject that, although they do not use causal impact methodologies, point to an inverse relationship between the supply of physicians and hospitalization for ambulatory care

[10]A total of 1,286 treated municipalities remaining after the matching required for Double Difference Matching were used. The exercise consisted of the following operation: $\frac{13{,}000}{1{,}000} \times 1.4 \times 1,286$

[11]Information obtained from DATASUS. The average cost of hospitalizations for August 2016, equivalent to US$ 267.19, was considered.

[12]A more accurate cost-benefit analysis is not possible since we do not have information about the program's costs.

sensitive conditions (Parchman & Culler (1994), Basu, Friedman & Burstin (2002), Laditka, Laditka & Probst (2005), Ansari, Laditka & Laditka (2006)). In Brazil, the magnitude of this relationship is noteworthy since the PMM was established, once for the treated cities, which entered the program from August 2013 to December 2013, there was a drop in admissions in the first year of the program, suggesting that the provision of doctors has a fairly rapid effect on this variable. Santos et al. (2017), although using a distinct strategy to identify the treated municipalities, also found that avoidable hospotalizations dropped after the beginning of the program.

Some of the mechanisms by which this relationship operates are described by Laditka (2004). According to the author, asthma, diabetes, lung and heart disease exemplify some of the chronic diseases whose hospitalization can be prevented, in part, by simple drug prescription or patient education by a primary care physician. Other acute illnesses, such as pneumonia and urinary tract and kidney infections, can also be prevented without the need of hospitalization by the prescription of antibiotics from a medical professional.

In terms of public policy effectiveness, the results presented are even more relevant considering that the ACSH variable is also understood as an indicator of accessibility and overall effectiveness of a country's basic health care (Institute Of Medicine (1993), Bindman et al. (1995), Starfield, Shi & Macinko (2005), Ansari, Laditka & Laditka (2006), Brazillian Ministry of Health (2008)). In this sense, the More Doctors Program seems to be fundamental for the strengthening of primary health care in Brazil, especially considering another result found here: the increasing effect of the program over its three years of validity - a result consistent with Rocha & Soares (2010) in the evaluation of another Brazilian public health program, the Family Health Program.

However, the results found in this article also point to the need for a more in-depth discussion on targeting physicians in poorer regions. As already highlighted, the More Doctors Program was conceived with the objective of correcting regional inequalities in the distribution of doctors in Brazilian national territory. As a positive point, it should be emphasized that the cities that had a significant change of scale in the supply of physicians due to PMM were precisely those disadvantaged in terms of socioeconomic and public health characteristics. However, there are a greater number of cities receiving physicians from program which do not fit these characteristics. In this sense, the Ministry of Health could review the design of the program around the priority municipalities.

Corroborating this discussion, the causal estimates obtained in this study pointed to a positive effect of PMM only in treated municipalities, while effects on the pseudo-placebo municipalities were not found. Thus, these results suggest that the global debate about physician supply policies should be guided by the reduction of inequities in the geographical distribution of these professionals (Goodman (2004), Luo, Wang & Douglass (2004), Matsumoto et al. (2010), Ono, Schoenstein & Buchan (2014)).

Finally, the contribution of this study is to present evidence that can go beyond the evaluation of the More Doctors Program. The results indicated that in Brazil the provision and reallocation of physicians could positively impact the performance of the basic health system, contributing to the formulation of related public policies around the world.

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Apendix A - Data

The outcome variable, hospitalizations for conditions sensitive to primary care, was obtained from the Department of Information Technology of SUS (DATASUS) based on the diseases contained in Ordinance n°. 221 of 2008 of the Ministry of Health. Other public health variables (doctors, health care establishments, health professionals and health facilities) as well as sanitation (percentage of households registered in Primary Care with electricity, open garbage and without water treatment) were also obtained in DATASUS. The number of public schools in the municipalities was obtained from the National Institute of Studies and Educational Research Anísio Teixeira (INEP); The per capita Gross Domestic Product (GDP) and transfers from the Bolsa Família Program (PBF) per capita at the Institute of Applied Economic Research (IPEA); And the average salary and occupancy rate in the Annual Report on Social Information (RAIS) of the Ministry of Labor. The variables occupancy rate, average salary, per capita GDP, per capita PBF and dummies for states were used only for matching. The data referring to the number of PMM physicians in each municipality were obtained through a request for access to information to the Ministry of Health (Brazilian Access to Information Law, No. 12.527/2011

Table A1: Description of variables

Variable	Description
ACSH	Hospitalization for conditions sensitive to primary care for every 1,000 inhabitants by place of residence.[13].
Open Garbage	Percentage of households registered in Primary Care with open garbage.
Energy	Percentage of households enrolled in Primary Care with electric energy.
Untreated Water	Percentage of households enrolled in Primary Care with treated water.
Health Professionals	Number of health professionals, except physicians, per 1,000 inhabitants.
Health Equipments	Number of health equipments per 1,000 inhabitants.
Physicians	Number of physicians, except veterinarian, for every 1,000 inhabitants disregarding physicians linked to PMM.
Beds	Number of beds per 1,000 inhabitants.
Health Facilities	Number of health facilities per 1,000 inhabitants.
Schools	Number of public schools per 1,000 inhabitants.
Occupancy rate	Percentage of employed persons over the total population, considering active links on 31/12 of each year.
Average Wages	Value of the average remuneration, measured in minimum salaries, referring to the month of December considering only active bonds on December 31.
GDP per capita	Natural logarithm of the Gross Domestic Product (GDP) per capita at 2012 values.
PBF per capita	Natural logarithm of per capita transfers from the Bolsa Família Program (*) at 2012 values.
States dummie	Binary variables for the 27 Brazilian states.

Note: (*) The Bolsa Família Program is the main Brazilian income transfer program for populations living in poverty and extreme poverty.

[13] Iron deficiency anemia, Mellitus Diabetes, Malnutrition, Vitamin A deficiency, Other vitamin deficiencies, Sequelae of malnutrition and other nutritional deficiencies, Volume depletion, Epilepsy, Average Otitis and other disorders in middle ear and mastoid, Acute rheumatic fever, Other acute hypertension, Primary hypertension, Other hypertensive diseases, Heart failure, Other heart diseases, Acute pharyngitis and acute tonsillitis, Other acute upper respiratory infections, Pneumonia, Acute bronchitis and acute bronchiolitis, Asthma, Skin infections Other diseases of the skin and subcutaneous tissue, Cystitis, Other diseases of the urinary tract, Salpingitis and oophoritis, Inflammatory disease of the cervix, Other inflammatory diseases of the female pelvic organs.

Apendix B - Robustness

Table B1: Differences of the normalized means of the variables for treated and controls, before and after matching, one year before the PMM

Variable	Before	After
ACSH	0.1269*	0.1928*
Open Garbage	0.2972	0.0904*
Energy	0.3391	0.1968*
Untreated Water	0.0196*	0.1595*
Physicians	0.5085	0.2042*
Beds	0.2286*	0.1057*
Health Facilities	0.3680	0.1727*
Health Professionals	0.4296	0.1822*
Health Equipments	0.2970	0.1149*
Schools	0.2355*	0.0896*
Average Wages	0.1252*	0.1928*
Occupancy rate	0.1219*	0.0870*
PBF per capita	0.4004	0.1607*
GDP per capita	0.1695*	0.1853*

Note: (*) Differences lower than |0.25|

Table B2: Impact of PMM (DDM_i) on ACSH for all municipalities that received program doctors and for the placebo group

	All			Pseudo-Placebo		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
Post PMM	-0.087	-0.113	-	0.387	0.446	-
	(0.33)	(0.43)		(1.47)	(1.54)	
PMM 3 years before	-	-	(omitted)	-	-	(omitted)
PMM 2 years before	-	-	-0.3	-	-	-0.099
			(1.46)			(0.46)
PMM 1 year before	-	-	0.041	-	-	-0.004
			(0.15)			(0.01)
PMM year 1	-	-	-0.027	-	-	0.418
			(0.08)			(1.31)
PMM year 2	-	-	-0.249	-	-	0.429
			(0.67)			(1.21)
PMM year 3	-	-	-0.308	-	-	0.423
			(0.79)			(1.02)
Controls	No	Yes	Yes	No	Yes	Yes
Observations	29,112	29,112	29,112	22,350	21,721	21,721
R2	0.05	0.07	0.1	0.04	0.05	0.06

Note: Significant at 1% (**) and 5% (*). Regressions with fixed effect for municipality and year. Specifications (2) and (3) with controls vector: health equipment / 1000 Hab., Other doctors / 1000 Hab., Other health professionals / 1000 Hab., Beds / 1000 Hab., Health establishments / 1000 Hab. Schools / 1000 Hab., Percentage of houses with electric power, treated water and garbage in the open. Clustered robust standard errors at the municipal level. In parentheses, t statistics.

Table B3: Logit estimation of the probability of joining the program, PMM year 1

Time-varying covariates		Variables measured in the PMM 1 year before	
Δ ACSH	-0.00143	ACSH	-0.00514
	(0.19)		(0.94)
Δ Open Garbage	0.743	Open Garbage	0.465
	(0.48)		(0.91)
Δ Energy	-1.477	Energy	-1.115
	(0.81)		(1.67)
Δ Untreated Water	-0.0551	Untreated Water	-0.129
	(0.07)		(0.55)
Δ Health Professionals	0.125	Health Professionals	-0.0293
	(1.86)		(0.69)
Δ Health Equipments	0.126	Health Equipments	0.295
	(0.21)		(1.49)
Δ Physicians	-0.101	Physicians	-0.996**
	(0.7)		(9.75)
Δ Beds	-0.0779	Beds	-0.0775*
	(0.13)		(2.33)
Δ Health Facilities	-0.301	Health Facilities	-0.187
	(1.2)		(1.44)
Δ Schools	0.0195	Schools	0.0245
	(0.6)		(0.74)
		Occupancy rate	0
			(1.75)
		Average Wages	-0.00847
			(0.7)
		GDP per capita	0.0936
			(1.03)
		PBF per capita	0.399**
			(3.83)
Observations		2,913	
Pseudo R2		0.23	

Note: Significant to 1% (**) and 5% (*). Regressions with fixed effect for municipality and year. Specifications (2) and (3) with same control vector as the previous table. Clustered robust standard errors at the municipal level. In parentheses, t statistics.