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Effect of More Doctors (*Mais Médicos*) Program on geographic distribution of primary care physicians

Efeito do Programa Mais Médicos na distribuição geográfica dos médicos na atenção básica

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Abstract *This study assesses the effect of More Doctors Program (Programa Mais Médicos - PMM) on the equality in the distribution of primary care physicians (PCPs) in Brazil. Spatial data analysis, Lorenz curve and Gini coefficient were used to evaluate the geographic distribution of PCPs before and after the implementation of PMM (2012 and 2016). Data from 5,564 municipalities were used in the analyses. The results indicate that the distribution of PCPs has become more equal after PMM implementation. Between 2012 and 2016, overall Gini coefficient decreased by 11% from 0.255 to 0.227. At the state level, a statistically significant trend towards a more equal distribution of PCPs was found in 21 out of 26 Brazilian states. However, there still remains a substantial difference in the level of equality in PCP distribution, especially across states, with Gini coefficient ranging from 0.093 to 0.341 in 2016.*

Key words *Physicians, Primary Health Care, Healthcare Disparities, Health Workforce*

Resumo *Este artigo avalia o efeito do Programa Mais Médicos (PMM) na distribuição de médicos na atenção básica no Brasil. As técnicas de análise de dados espaciais, curva de Lorenz e coeficiente de Gini foram empregadas para avaliar a distribuição geográfica dos médicos antes e após a implementação do PMM (2012 e 2016). Para tanto, foram utilizados dados secundários de 5.564 municípios. Os resultados indicaram que a distribuição de médicos se tornou mais igualitária após a implementação do PMM. Entre 2012 e 2016, o coeficiente geral de Gini diminuiu 11%, passando de 0,255 para 0,227. No âmbito estadual, uma tendência estatisticamente significativa em direção a uma distribuição mais igualitária de médicos foi encontrada em 21 estados brasileiros. No entanto, ainda persiste uma diferença substancial na distribuição de médicos na atenção básica, especialmente entre os estados, com o coeficiente de Gini variando de 0,093 a 0,341 em 2016.*

Palavras-chave *Médicos, Atenção Básica à Saúde, Disparidades em Assistência à Saúde, Mão de Obra em Saúde*

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Introduction

The geographic distribution of physicians has been a persistent issue worldwide[1,2]. Despite many countries facing the uneven distribution of these professionals, this is a matter of great concern for low- and middle-income countries, since the population already have limited access to health care[3]. In general, physicians tend to concentrate mainly on wealthier and larger urban areas in the country. The lack of physicians in rural, poor and peripheral regions implies in significant disparities in health outcomes between the populations[2,4].

Over the past decades, different strategies have been adopted in order to attract and retain these professionals in underserved and high need areas[3,5,6]. In Brazil, despite great progress towards a more equitable access and utilization of health care[7-9], there still remains a marked unequal distribution of physicians across national territory. The unbalanced distribution of physicians is noticed even when compared the numbers between states. For example, Rio de Janeiro has 3.75 physicians per 1,000 population (61,346 physicians and 16,369,179 population in 2014), while Maranhão, the poorest state in Brazil, has 0.79 physician per 1,000 population (5,396 physicians and 6,794,301 population in 2014)[10]. Commonly, areas with lack of physicians are also areas with the largest population in need, intensifying the unequal access to health care[11].

There are two major reasons why the unbalanced distribution of physicians across areas is a concern to policy makers and researchers. First, in countries with system founded on the principles of equality and social justice, there is an issue when part of population has limited access to health care. Second, an extensive literature indicates the link between physician availability, access to medical care and health status[12,13]. Clearly, these impacts are considerable for primary health care. In general, primary care physicians (PCPs) are more equally distributed than specialists, but maldistribution of PCPs also occurs in many countries[14].

In recent years, Brazil has implemented new national policies to face the geographical maldistribution of health workforce, especially targeting primary care physicians. In 2013 was launched the More Doctors Program (*Programa Mais Médicos* - PMM). It was set up to reduce the shortage of physician in vulnerable areas and regional disparities in access to health[15].

The positive impact of PMM on health indicators has been shown by an increasing number of studies[16,17]. However, there is a lack of evidence of the effect of the program towards a more equal distribution of physician at national level. Some studies have address this topic, but at the regional/local level or in a selected group of municipalities[18,19]. The present study asses the effect of More Doctor Program on the geographic distribution of PCPs and its contribution to a more equal distribution of PCPs in Brazil.

Brazilian strategies to deal with the maldistribution of physicians

Since the military dictatorship period, Brazil has designed programs aimed at attracting and retaining health professionals in underserved areas. Although these programs range in size, scope and implementation path, the common purpose is to address the problem of lack of health professionals. Some of these programs had specific actions to recruit and attract physicians.

The Program for Internalization of the Unified Health System (*Programa de Interiorização do Sistema Único de Saúde* - PISUS) was created in 1993. The PISUS was a cooperation of the three branches of government targeting municipalities without health services. It had the goal of retaining at least one physician with residence in the selected municipality; besides the installation of a small healthcare center with basic equipment and healthcare team. Due to the lack of political support, the program was extinguished even before it was effectively implemented[20].

The Program for Internalization of Health Work (*Programa de Interiorização do Trabalho em Saúde* - PITS) emerged in 2001. PITS used financial incentives and professional qualification to encourage physicians and nurses to move to selected municipalities. Initially, it was selected only municipalities with population of up 50 thousand inhabitants, no Family Health Program coverage, high infant mortality rate (80 per 1,000 live births), low indicator of medical consultation and participation in the Active Community or Alvorada Project. The Program selected 151 municipalities. In the second year of the program, some of the eligibility criteria of the municipalities were changed and 216 municipalities were selected. In additional to unfilled vacancies, the program registered the desistance of some professionals and municipalities in a few months. PITS ended in 2004[20].

In 2010, the federal government adopted new strategies to address the problem of physicians' distribution. The Law No. 12,202/2010 decreed that physicians, who had their courses funded by

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the Fund for Financing Student in Higher Education (*Fundo de Financiamento ao Estudante do Ensino Superior* - FIES), could have their debts reduced if they worked on the Family Health Program located in areas with difficult retention of professionals[21].

In 2011, another initiative was the Primary Care Professional Valorization Program (*Programa de Valorização do Professional da Atenção Básica* - PROVAB). It was created to encourage physicians, nurses and dental surgeons to move to underserved municipalities or areas with vulnerable population. A postgraduate course in family health and additional score of 10% on medical residency tests were offered to health professionals[22]. Initially, the program attracted 380 physicians; in subsequent years it registered more than 3 thousand physicians. Even so, it did not meet all the shortage recorded by the municipalities[23].

In January of 2013, the National Front of Brazilian Mayors (*Frente Nacional de Prefeitos do Brasil* - FNP), claiming support from the federal government, launched the campaign "Where is the Doctor" (*Cadê o médico?*). In October of 2013 was instituted the More Doctors Program (*Programa Mais Médicos* - PMM). It was created to reduce the shortage of physician in the priority SUS areas, minimize inequalities and strengthen the provision of primary care[15]. The actions of the program follow 3 bases: emergency supply of physicians; expansion and improvement of the infrastructure of primary healthcare centers and; creation of new medical schools and qualification of medical workforce[23]. PMM and PROVAB coexisted in parallel until the beginning of 2015, when PROVAB became part of the PMM.

PMM followed a combined set of criteria to classify the priorities regions, including: areas with high percentage of the population living in extreme poverty; low human development index; municipalities located in semi-arid and Amazon region; areas with indigenous and Maroon population and; areas with difficult to recruit and retain workforce[15]. After two years, the program recorded the participation of 18,240 physicians (Brazilians and foreigners) in 4,058 municipalities and 34 indigenous health districts[24].

Methods

This study investigates the effects of PMM on geographic distribution of primary care physicians and uses two years for comparison purposes, 2012 and 2016 (before and after PMM implementation). The analysis includes data from 5,564 municipalities.

Data

Primary care physician density is defined as the total number of PCPs per 10,000 population in each municipality. The PCP data source is the Information Department of Brazil's Unified Health System (DATASUS) from the Brazilian Ministry of Health. The TabWin 32 (Tab for Windows) program was used for collect the data. Primary care physicians include physicians from the Family Health Strategy (FHS) and Primary Health Teams (PHT). It was included only PCPs who work in healthcare centers designed to provide primary health care to the population (*Centro de Saúde/Unidade Básica de Saúde, Posto de Saúde* and *Centro de Apoio a Saúde da Família* - CASF). Physicians working in hospitals are not included. In Brazil, it is known that physicians can work different number of hours and/or in more than one municipality. So, for a more accurate number of the provision of this service and avoid an overestimation, the total number of PCPs is calculated dividing the total hours worked weekly in the municipality by 40.

Analysis

The study uses different approaches to analyse the inequality in the distribution of PCPs. First, it was employed spatial data analysis, where the geographic distribution of PCPs and patterns of spatial association (clusters) were displayed. The maps of geographic distribution provide some indicators regarding the inequality that exist across Brazilian municipalities. The cluster maps detect patterns of spatial dependence between neighbouring municipalities. Spatial dependence (or spatial autocorrelation) can be interpreted a systematic pattern in the values recorded in geographic space[25,26]. To identify local patterns of spatial association, it was calculated the Local Indicator of Spatial Association (LISA). In formal terms, LISA statistic can be expressed as follows[27]:

$$I_{i,t} = \frac{x_{i,t} - \mu_t}{m_0} \sum_j w_{i,j} (x_{j,t} - \mu_t) \quad \text{with}$$

$$m_0 = \sum_i (x_{i,t} - \mu_t)^2 / n \qquad (1)$$

Where $x_{i,t}$ represents the observation in municipality i and year t; μ_t corresponds the mean of the observation across municipalities in year

t and the summation over *j* includes only neighbouring values of *j*.

Then, the Lorenz curves and Gini coefficient were used to evaluate the level of inequality in the distribution of PCPs. These measures have been widely employed to analyse the distribution of physicians[28-30]. Lorenz curve illustrates the entire distribution and allows to compare how the structure of inequality change over time. Lorenz Curves is displayed with cumulative population proportion on the horizontal axis and cumulative proportion of PCPs on vertical axis. The diagonal line represents the complete equity. This study follows the formal definition of Lorenz curve given by Jann[31].

The Gini coefficient is derived from the Lorenz curve and it is calculated by the ratio of the area between the Lorenz curve and the diagonal line, and the whole area bellow the diagonal line. The closer the Lorenz curve is the equity line (diagonal), the smaller is Gini coefficient. It is also possible to compare two Lorenz curves. If the curves do not cross, the Lorenz curve closer to the diagonal line has the lower Gini coefficient. Gini coefficient ranges from 0 (perfect equality) to 1 (perfect inequality)[32].

The following equation was estimated to calculate the time trend in the Gini coefficient:

$$G_i = \beta_0 + \beta_1 \, Year + \varepsilon_i \qquad (1)$$

Where G_i is the Gini coefficient for the unit of analysis i and ε_i denotes the error term. The equation (1) was estimated for Brazil and each state (26 states) and region (5 regions).

Results

The number of PCPs has increased considerably after the implementation of More Doctor Program. The average number of PCPs in Brazilian municipalities increased from 3.45 per 10,000 population in 2012 to 3.93 per 10,000 population in 2016. Figure 1 shows the kernel density plots of PCPs before and after PMM. There was an increase of PCPs in municipalities with shortage of these professionals. In 2012, there were 43 municipalities without PCP and 952 municipalities with less than 2 PCPs per 10,000 population. In 2016, there was an expressive reduction of municipalities with a low number of PCPs. It was recorded 13 municipalities without PCP (70% decrease) and 500 municipalities with less than 2 PCPs per 10,000 population (47% decrease).

Brazilian municipalities have an expressive uneven distribution of physicians. The municipal number of PCPs ranged from 0 to 16.2 PCPs per 10,000 population in 2012 and from 0 to 16.1 PCPs per 10,000 population in 2016. The municipalities with shortage of physicians are located in all Brazilian regions. However, there is a massive concentration of these municipalities in the North, the poorest region of the country. Figure 2 displays the spatial distribution of the municipalities below and above the average number of PCPs. North region is clearly the area with the lowest density of PCPs and largest spatial concentration in both years (Maps (A) and (B)). Map (C) shows the municipalities that increased the number of PCPs after PMM implementation. In general, although the same municipalities remain below average in both years, it is noted that they received more physicians in 2016.

Figure 3 shows the cluster analysis of PCPs per 10,000 population in Brazilian municipalities in (A) 2012 (B) and 2016. The majority of the identified clusters are formed by municipalities with low number of PCPs per 10,000 population surrounded by municipalities with low number of PCPs, representing 58.4% of the total clusters in 2012 and 57.8% in 2016. Municipalities with high number of PCPs per 10,000 population surrounded by municipalities with high PCPs represented 18% of the total clusters in 2012 and 20.2% in 2016. The total number of municipalities identified as clusters was 1,086 in 2012 and 1,143 in 2016. Even after a significant increase in the number of PCPs, the univariate analyses show a large low-low cluster in North region in 2016. The number of low-low clusters demonstrates that the spatial concentration occurs mainly due to the lack of physicians.

Lorenz curves both before and after PMM are represented in Figure 4. The curve corresponding to the PCP density in 2016 is closer to the diagonal, compared to the curve representing the PCP density in 2012. It shows that the distribution of PCPs was better balanced in 2016 than was the distribution of physicians in 2012.

Trends in the Gini coefficient for the distribution of PCPs between 2012 and 2016 are shown in Table 1. The Gini coefficient was 0.255 in 2012 and 0.227 in 2016, which corresponds to a decrease of 11%. The Gini coefficient showed a statistically significant trend from 2012 to 2016 ($p<0.01$).

The distribution of PCPs has become more equal after PMM implementation in 4 (North, Southeast, Northeast, South) out of 5 regions.

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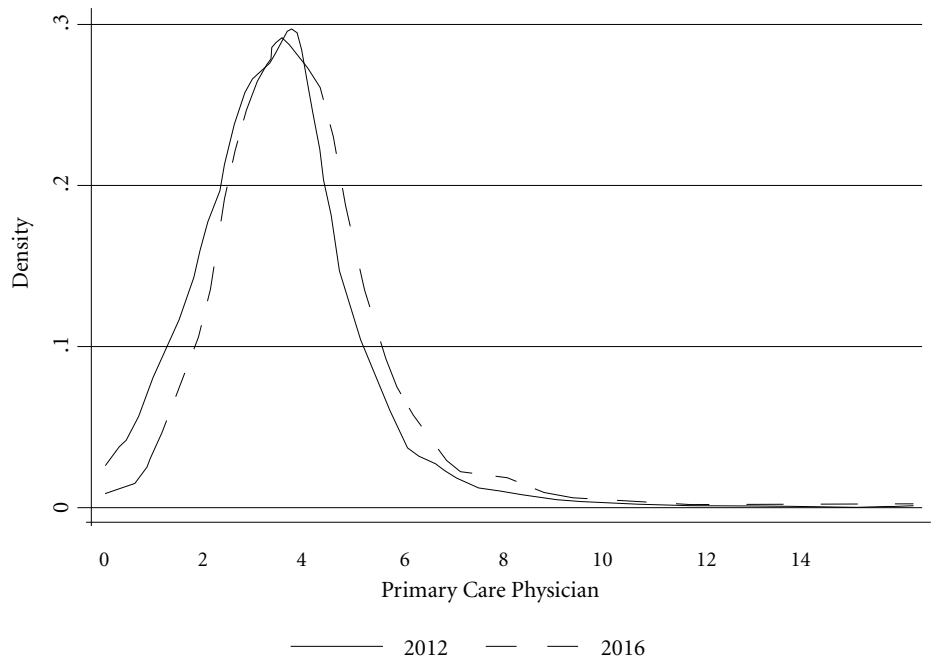

Figure 1. Kernel density plots of primary care physicians in Brazilian municipalities in 2012 and 2016[a].

[a] Number of PCPs per 10,000 population.

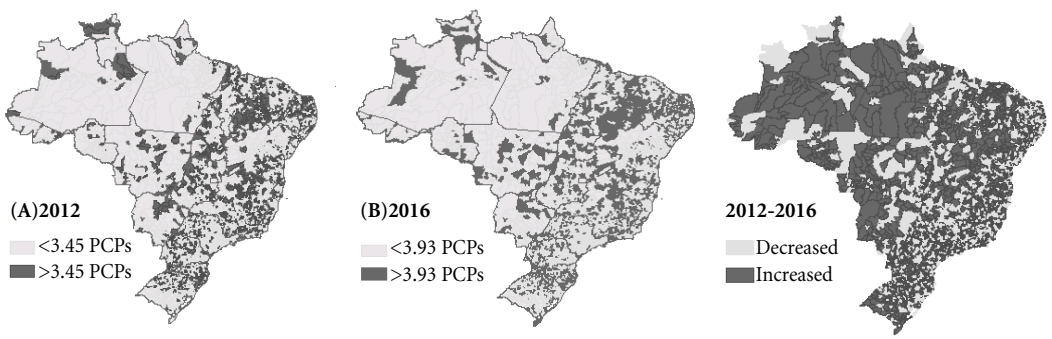

Figure 2. Geographical distribution and changes in the number of primary care physicians in Brazilian municipalities, 2012 and 2016[a].

[a] Number of PCPs per 10,000 population.

In North, Gini coefficient reduced by 23% from 0.300 in 2012 to 0.230 in 2016. North is the region where was identified a large low-low cluster, as showed in Figure 3.

It was identified a statistically significant trend towards a more equal distribution of PCPs in 21 out of 26 states, with Gini coefficient change ranging from -37% to -6%. The distribution of

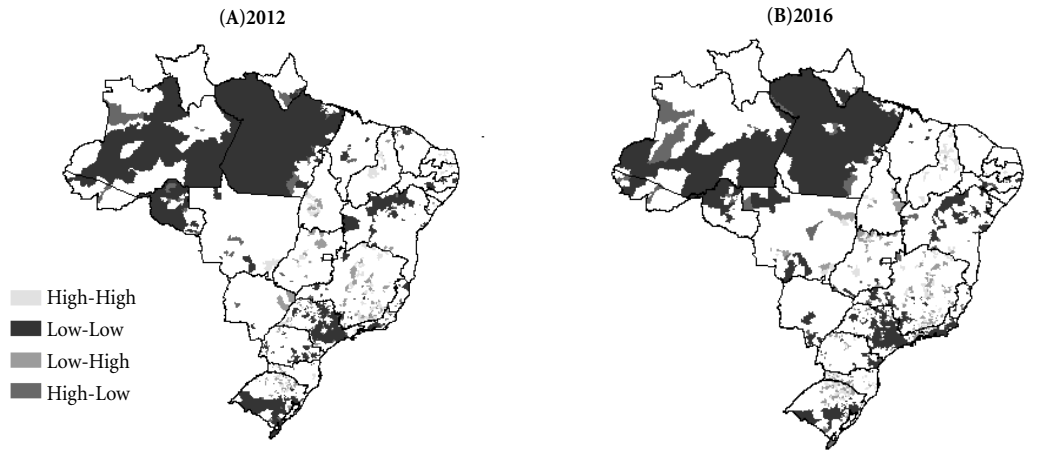

Figure 3. Cluster maps of primary care physicians distribution, 2012 and 2016[a].

[a] Number of PCPs per 10,000 population. The chosen matrix was the queen. Moran's I value was 0.1934 in 2012 and 0.2058 in 2016. Moran's I value was statistically significant at 1% in both years.

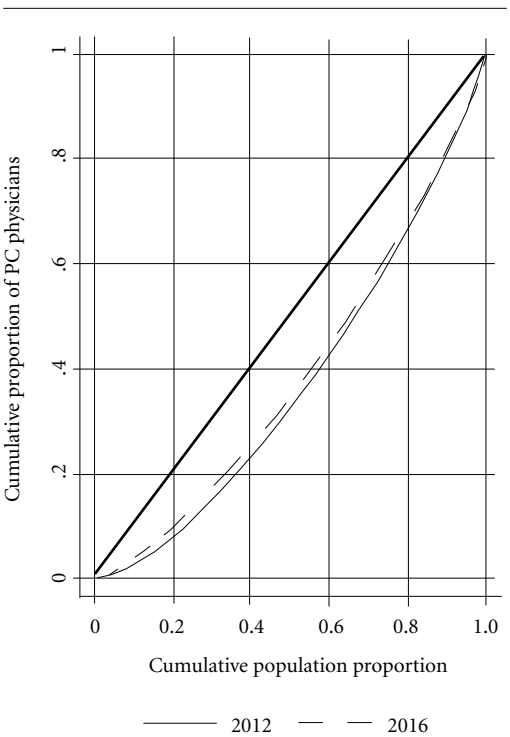

Figure 4. Lorenz curves of primary care physicians in 2012 and 2016[a].

[a] Number of PCPs per 10,000 population.

PCPs has become more unequal in 3 states, but only Goiás exhibited a statistically significant trend toward increasing inequality ($p<0.05$).

Despite substantial improvements in PCP distribution, there is still an expressive difference in the level of equality in physician distribution in 2016, especially across states. São Paulo is the state in which PCPs are most unequally distributed (0.341), while Piauí is the most equal state (0.0093).

Discussion

This paper addresses the problem of distribution of physicians in the Brazilian municipalities. Since the 70's, the government has adopted strategies to recruit and retain physicians in underserved areas and regions with shortage of health professionals. In general, these strategies have been targeted towards primary care and focused to ensure the equitable access of health service around the country[20].

In 2013, More Doctors Program was instituted to provide physicians to remote and deprived areas. This study presented an overview of the effect of More Doctor Program on the distribution of PCPs and assessed its contribution to a more equal distribution of PCPs in Brazil. Between 2012 and 2016, overall Gini coefficient decreased

Table 1. Trends in the Gini coefficient for the distribution of primary care physicians per 10,000 population in Brazil between 2012 and 2016[a].

Region/State[b]	2012	2013	2014	2015	2016	Coefficient	p-value (robust S.E.)	% change (2012-2016)
Brazil	0.255	0.250	0.238	0.231	0.227	-0.007	<0.01	-11%
North	0.300	0.284	0.254	0.235	0.230	-0.019	<0.01	-23%
RO	0.304	0.250	0.227	0.199	0.191	-0.028	<0.05	-37%
AC	0.200	0.208	0.190	0.125	0.139	-0.020	<0.05	-30%
RR	0.178	0.190	0.192	0.139	0.125	-0.016	<0.10	-30%
AM	0.259	0.252	0.190	0.185	0.189	-0.021	<0.05	-27%
PA	0.347	0.336	0.290	0.272	0.262	-0.023	<0.01	-24%
TO	0.200	0.191	0.168	0.162	0.170	-0.009	<0.10	-15%
AP	0.155	0.155	0.178	0.176	0.140	-0.001	0.899	-9%
Southeast	0.315	0.307	0.292	0.280	0.271	-0.011	<0.01	-14%
ES	0.239	0.222	0.191	0.181	0.182	-0.016	<0.05	-24%
SP	0.412	0.404	0.374	0.348	0.341	-0.020	<0.01	-17%
RJ	0.277	0.273	0.237	0.236	0.237	-0.012	<0.05	-14%
MG	0.239	0.230	0.225	0.223	0.213	-0.006	<0.01	-11%
Northeast	0.178	0.175	0.160	0.157	0.155	-0.006	<0.01	-13%
SE	0.200	0.211	0.160	0.137	0.142	-0.019	<0.05	-29%
CE	0.191	0.168	0.139	0.141	0.137	-0.014	<0.05	-28%
PE	0.183	0.172	0.159	0.151	0.148	-0.009	<0.01	-19%
BA	0.203	0.192	0.174	0.169	0.165	-0.010	<0.01	-19%
AL	0.152	0.158	0.145	0.138	0.128	-0.007	<0.05	-16%
PI	0.109	0.117	0.097	0.094	0.093	-0.006	<0.05	-15%
MA	0.168	0.170	0.147	0.141	0.144	-0.008	<0.05	-14%
RN	0.170	0.164	0.152	0.162	0.156	-0.003	<0.10	-8%
PB	0.121	0.114	0.120	0.123	0.122	0.001	0.399	1%
South	0.264	0.261	0.255	0.246	0.245	-0.005	<0.01	-7%
RS	0.318	0.312	0.296	0.284	0.284	-0.010	<0.01	-11%
PR	0.232	0.234	0.229	0.217	0.217	-0.005	<0.05	-6%
SC	0.204	0.200	0.211	0.211	0.204	0.001	0.437	0%
Midwest	0.223	0.224	0.233	0.237	0.234	0.004	<0.05	5%
MS	0.200	0.182	0.178	0.154	0.160	-0.011	<0.05	-20%
GO	0.228	0.226	0.245	0.249	0.247	0.006	<0.05	9%
MT	0.214	0.231	0.227	0.241	0.229	0.004	0.24	7%

[a]The constant values were not reported in the table; [b]Acre (AC), Alagoas (AL), Amapá (AP), Amazonas (AM), Bahia (BA), Ceará (CE), Espírito Santo (ES), Goiás (GO), Maranhão (MA), Mato Grosso (MT), Mato Grosso do Sul (MS), Minas Gerais (MG), Pará (PA), Paraíba (PB), Paraná (PR), Pernambuco (PE), Piauí (PI), Rio de Janeiro (RJ), Rio Grande do Norte (RN), Rio Grande do Sul (RS), Rondônia (RO), Roraima (RR), Santa Catarina (SC), São Paulo (SP), Sergipe (SE), Tocantins (TO).

by 11% from 0.255 to 0.227. At the state level, a statistically significant trend towards a more equal distribution of PCPs was found in 21 Brazilian states.

It was identified only one study that had applied the Gini coefficient to evaluate inequality trends in the distribution of health workers in Brazil. Sousa et al.[33] used data of Brazilian Minimum Comparable Areas (MCA) for 1991, 2000 and 2005. The authors found that the Gini for physicians was 0.60 in 1991 and 0.58 in 2000 and 2005. These coefficients are larger than the found in this study. However, they measured the inequalities in the distribution of all physicians, including specialists, which it is much more concentrated than primary care physicians. The ratio of specialists to generalists in Brazil is 1.67, with a significant difference between the regions, for example, the ratio of specialists to generalists is 2.27 in South and 1.06 in North[34].

The results are consistent with previous studies, which show that the recent increased in the

level of PCPs has contributed towards a more equal distribution of PCPs in Brazil. The More Doctor Program has been succeeded in providing physicians to vulnerable and deprived areas[18,35,36], including semi-arid zone[37], indigenous areas[19], Maroon communities[38] and rural Amazon[39].

After the implementation of PMM, the number of municipalities without PCP decreased by 70% and the number of municipalities with less than 2 PCPs per 10,000 population decreased by 47%. Girardi et al.[40] identified that the number of municipalities with shortage of physicians decreased by 35% after implementation of the program, 1,200 municipalities in 2013 and 777 municipalities in 2015. They used the Primary Healthcare Physicians Shortage Index, which takes into account, besides the number of physicians, the infant mortality rate, the access to health service (distance) and percentage of poor households.

The cluster analysis evidence the uneven distribution of these professionals faced, especially, in the North region. This is the region with highest proportion of municipalities with scarcity of physicians [40]. The large low-low cluster may indicate that these municipalities and its neighbours follow similar policies, and may also have closely resembling regional characteristics. After the implementation of PMM, North was the region with largest drop in Gini coefficient. This expressive reduction of scarcity of physician in the North has been reported in the literature[36,40].

Despite the lowest Gini coefficient, Northeast is the region that received the largest number of PMM physicians[41]. This is explained by poor social and health indicators in the region, also criteria considered by the program[19]. In general, the limited access to healthcare is often associated with poor socioeconomic indicators, such as lower income and higher levels of social vulnerabilities[42]. This combination of limited access to health care and poor socioeconomic indicators contributes to aggravate the health status of the population.

In conclusion, findings in this study evidence that the implementation of PMM has contributed to reduce inequalities in the distribution of PCPs in Brazil. This experience shows the relevance of policies oriented at promoting a more equal distribution of physicians, especially in a context with notable disparities in access to healthcare. However, although the recent increase in the number of PCPs has led to systemic changes, there is still substantial difference in the level of equality in PCP distribution across geographic regions.

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