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Original Article

Assessing the performance of beneficiary targeting in Brazil's More Doctors Programme

Ece A Özçelik [1,*], Adriano Massuda[1,2], Margaret McConnell[1] and Marcia C Castro[1]

[1]Department of Global Health and Population, Harvard T.H. Chan School of Public Health, 677 Huntington Avenue, Boston, MA 02115, USA
[2]Department of Administration, São Paulo School of Business Administration, Fundação Getulio Vargas, Avenue Nove de Julho, 2029, São Paulo 01313-902, Brazil

*Corresponding author. Department of Global Health and Population, Harvard T.H. Chan School of Public Health, 677 Huntington Avenue, Boston, MA 02115, USA. E-mail: eozcelik@mail.harvard.edu

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Abstract

Many countries employ strategies that rest on the use of an explicitly defined set of criteria to identify underserved communities. Yet, we know relatively little about the performance of community-level targeting in large-scale health programmes. To address this gap, we examine the performance of community targeting in the More Doctors Programme (MDP). Our analysis covers all 5570 municipalities in the period between 2013 and 2017 using publicly available data. We first calculate the rate at which vulnerable municipalities enrolled in the MDP. Next, we consider two types of mistargeting: (1) proportion of vulnerable municipalities that did not have any MDP physicians (i.e. under-coverage municipalities) and (2) proportion of MDP enrolees that did not fit the vulnerability criteria (i.e. non-target municipalities). We found that almost 70% of vulnerable municipalities received at least one MDP physician between 2013 and 2017; whereas non-target municipalities constituted 33% of beneficiaries. Targeting performance improved over time. Non-target municipalities had the highest levels of socioeconomic development and greater physician availability. The poverty rate among under-coverage municipalities was almost six times that in non-target municipalities. Under-coverage municipalities had the lowest primary care physician availability. They were also smaller and more sparsely populated. We also found small differences in the political party alignments of mayors and the President between under-coverage and non-target municipalities. Our results suggest that using community-level targeting approaches in large-scale health programmes is a complex process. Programmes using these approaches may face substantial challenges in beneficiary targeting. Our results highlight that policymakers who consider using these approaches should carefully study various municipal characteristics that may influence the implementation process, including the level of socioeconomic development, health supply factors, population characteristics and political party alignments.

Keywords: Primary care, Brazil, Family Health Strategy, universal health coverage, beneficiary targeting, community-level targeting, More Doctors Programme, foreign-physician recruitment

Introduction

Expanding equitable access to primary care is a priority in many low- and middle-income countries that seek to achieve universal health coverage (WHO, 2018). Strong primary care systems are associated with improvements in population health, better quality of health services and reductions in socioeconomic inequities in access to care (Macinko *et al.*, 2003, 2009; Kruk *et al.*, 2010; Shi, 2012; Starfield, 2012; Kringos *et al.*, 2013; Hone *et al.*, 2017). Access to a trained health workforce is crucial to ensure effective health service coverage. Yet, many countries face imbalances in the distribution of

KEY MESSAGES

- The study provides the first comprehensive analysis of performance of beneficiary targeting in Brazil's More Doctors Programme (MDP) between 2013 and 2017 using municipal-aggregated data from publicly available sources.
- We quantify the rate of enrolment among target municipalities and examine two conceptually distinct version of mistargeting. We compare characteristics of vulnerable and non-vulnerable municipalities based on the level of socioeconomic development, health system supply and resources, population characteristics and political considerations.
- Our results show that MDP faced considerable challenges in beneficiary targeting, but targeting performance improved over time. Vulnerable municipalities that did not receive any MDP physicians had the highest poverty rate and lowest physician availability in primary care before the start of the programme. These municipalities were also smaller and more sparsely populated.

their health professionals. For instance, only about a quarter of the global health workforce work in rural areas, even though half of the world's population resides in rural settings (Scheil-Adlung, 2015).

A growing body of studies sheds light on the main drivers of geographic imbalances in the distribution of health professionals in countries across the development spectrum. Existing evidence suggests that providers' decisions over their location of work are influenced by monetary and non-monetary factors, including concerns over differences in income potential between urban and rural areas (Lehmann *et al.*, 2008), living conditions, safe working environment (Terry *et al.*, 2015), increased workload in rural areas (Pohontsch *et al.*, 2018), the perceived lack of supervision, equipment and medicines (Budhathoki *et al.*, 2017), as well as insufficient opportunities for continuous medical education and career advancement (Dussault and Franceschini, 2006). Countries rely on a wide range of policy levers to address geographic imbalances in the distribution of their health workers (Bärnighausen and Bloom, 2009; Witter, 2020).

Many countries rely on explicitly defined criteria to identify underserved communities in health programmes designed to alleviate imbalances in the distribution of the health workforce (OECD, 2016). However, there is little evidence on the consequences of these methods for the extent to which these programmes are able to allocate their resources to target communities and existing evidence comes primarily from high-income countries. In the USA, the Health Professional Shortage Area designation is assigned using a composite score calculated based on healthcare service provider density, level of poverty, infant mortality rate and the age structure of each community (HRSA, 2014). This designation is subsequently used for the recruitment of foreign physicians through visa waiver programmes (Goodfellow *et al.*, 2016). In Australia, communities with a shortage of medical practitioners are classified as the Distribution Priority Areas based on their demographic and socioeconomic status, population size and measures of geographic remoteness (Australian Government Department of Health, 2019a). Foreign-trained general practitioners are obligated to serve at least 10 years in these communities (Australian Government Department of Health, 2019b). In Canada, international medical graduates can join return-of-service programmes that require them to work in underserved provinces in exchange for receiving residency training in the country (OECD, 2016). Criteria used to define underserviced communities in Canadian provinces consider physician to population ratios, demographic and socioeconomic status and geographic accessibility (Ontario Ministry of Health Ministry of Long-Term Care, 2019).

An extensive body of literature examines the impact of methods that are used in social programmes (e.g. poverty alleviation initiatives, school feeding programmes, nutrition interventions) to identify beneficiaries on the targeting performance (Coady *et al.*, 2004; Devereux *et al.*, 2015; Sabates-Wheeler *et al.*, 2015). Two recent reviews highlight that mistargeting is a pervasive challenge across social programmes regardless of the methodology (Devereux *et al.*, 2017; White, 2017). A range of community-level factors, including the level of socioeconomic development (Park *et al.*, 2002), literacy (Baird *et al.*, 2009) and broader political economy considerations (Sen, 1992; Coady et *al.*, 2004; Baird *et al.*, 2009; Premand and Schnitzer, 2018), is shown to correlate with targeting performance. Yet, most empirical evidence in the literature that examines targeting methods in social programmes focuses on methods that identify beneficiaries at the individual level, with very limited evidence from programmes using community-level targeting mechanisms. Community-level targeting methods (e.g. geographic targeting) may be appealing to policymakers that consider designing large-scale health programmes to address regional inequalities, such as the imbalances in the distribution of the health workforce. In particular, community-level targeting methods may be preferable in settings where weak administrative capacity or lack of up-to-date information on community health needs hinder the implementation of large-scale programmes (Schady, 2002).

Similar to many low- and middle-income countries, Brazil faces considerable challenges in access to healthcare services (Andrade *et al.*, 2018b). Started in 1994, the Family Health Strategy (FHS) has become the bedrock of Brazil's Unified Health System (UHS) that guarantees universal healthcare access free-of-charge at point of use (Macinko and Harris, 2015). As a community-based primary care delivery model, the FHS relies on multi-professional teams comprised of physicians, nurses and community health workers that serve up to 1000 households residing in non-overlapping catchment areas (Andrade *et al.*, 2018a). FHS teams typically provide a broad scope of preventive services and clinical assistance, including maternal and child health services, screening for avoidable cancers, monitoring the management of communicable and chronic conditions, and community outreach activities (Macinko and Harris, 2015). All Brazilians are eligible to utilize FHS services free-of-charge. The expansion of the FHS led to improvements in access to primary care (Andrade *et al.*, 2015), substantial reductions in maternal and child mortality (Macinko *et al.*, 2007; Rasella *et al.*, 2010; Rocha and Soares, 2010; Brentani *et al.*, 2016), in racial inequalities in mortality amenable to primary care (Hone *et al.*, 2017), and in hospitalizations and deaths due to conditions sensitive to primary care (Macinko *et al.*, 2010, 2011; Macinkoand Lima-Costa, 2012; Da Silva and Powell-Jackson, 2017; Cavalcante *et al.*, 2018).

Over the last two decades, the FHS scaled-up rapidly, though with considerable differences in its geographic coverage (Andrade

et al., 2018a). Geographic imbalances in the distribution of physicians have persistently been highlighted as one of the most difficult challenges hindering the expansion of the FHS (Scheffer *et al.*, 2013; Massuda *et al.*, 2018). Recent studies highlighted the important links between municipality characteristics and FHS professional availability. For instance, Andrade *et al.* (2018a) found that the uptake and expansion of FHS services have been uneven across geographic regions between 1998 and 2012, with community characteristics including municipal gross domestic product (GDP) per capita, population density and size, the coverage of private health insurance plans, availability of health supplies, as well as the political alignments between the state Governors and the President playing a crucial role in the scale of primary healthcare services. In a subsequent study, Andrade *et al.* (2018b) further showed that these municipality characteristics were further linked with the timing of the uptake and expansion of the FHS services.

Against this backdrop, the Ministry of Health (MOH) introduced a supply-side intervention called the More Doctors Programme (MDP) in 2013. The MDP became the world's largest government-led health programme that recruited foreign and domestic physicians to serve in traditionally underserved communities. The MOH used an explicitly defined set of criteria to designate vulnerability status using administrative data. The vulnerability status was subsequently used to inform decisions for the distribution of MDP physicians. While a growing body of literature examines the impact of the MDP on Brazilian health system performance, comprehensive analyses of the criteria used in the MDP to designate underserved community status on the implementation of the programme remains limited. To date, the MDP was associated with increases in the supply of physicians, the proportion of population covered by the FHS (Santos *et al.*, 2017), improvements in the use of primary care services (Mattos and Mazetto, 2019) and declines in hospitalizations due to conditions sensitive to primary care (Fontes *et al.*, 2018; Maffioli *et al.*, 2019; Özçelik *et al.*, 2020) and amenable mortality (Hone *et al.*, 2020), though evidence on infant mortality remains mixed (Carrillo and Feres, 2019; dos Santos *et al.*, 2020).

Our main objective is to study the performance of beneficiary targeting in the MDP in the period between 2013 and 2017. We built a 4-year time-series of municipal-aggregated data from multiple publicly available sources. We first documented the process of development and implementation of the MDP's criteria used to assign vulnerability status to municipalities. Next, we assessed the targeting performance of the MDP using an analytical framework that grouped municipalities into three categories: (1) successful enrolment, (2) under-coverage and (3) non-target enrolment. Quantifying the magnitude of under-coverage allowed us to assess the ability of the MDP to reach target communities in accordance with the objectives of the programme. Quantifying the prevalence of non-target communities allowed us to examine the extent to which programme resources were allocated to municipalities with fewer health personnel needs. Next, we investigated municipal-level differences across these three municipality classifications across four dimensions based on findings from earlier studies focusing on the factors associated with implementation of community-based primary care programmes in decentralized settings (Andrade *et al.*, 2018a,b): (1) socioeconomic development, (2) health system supply and resources, (3) population characteristics and (4) political considerations. We concluded by discussing the lessons learned from the Brazilian experience and their implications for other countries that are considering strategies for designing and implementing large-scale health programmes using criteria-based approaches to identify underserved communities.

Purpose, definition and application of the MDP vulnerability criteria

There is no universally agreed definition for what constitutes a vulnerable community. Here, we use criteria adopted by the MOH that was modelled from previous federal initiatives to designate vulnerability status to municipalities (e.g., Brazil without Misery Programme, created in 2011 to reduce poverty in target communities, and the Programme of Valorization of Health Professionals in Primary Care, created by the MOH in 2011 with a similar objective of increasing physician availability in underserved areas). In the context of the MDP that criteria aimed at ranking municipalities in accordance with socioeconomic, geographic and population characteristics in a systematic manner to inform decisions over the distribution of programme resources across communities. Therefore, even though all municipalities were eligible to join the MDP, the rank facilitated prioritization.

The process to develop the MDP vulnerability criteria was iterative. As shown in Table 1, the first set of criteria was published in Federal Ordinance 1369/MS/MEC on 8 July 2013, though they were never implemented (Ministry of Health, 2013a). The first revision to the MDP prioritization was issued within 10 days (Federal Ordinance 1.493/MS/MEC, 18 July 2013) (Ministry of Health, 2013b). The second revision was issued on 31 March 2014, in Notice SGTES 22 (Ministry of Health, 2014). Starting from 2014, all federal ordinances supplemented with a list of priority municipalities that were either (1) encouraged to apply to the MDP if they had not already done or (2) were eligible to receive more MDP physicians even if they had already received program physicians. Once a municipality received the vulnerable designation, it retained this status even if it did not qualify with the subsequent iterations of the prioritization criteria.

As Table 1 shows, in each iteration, the MOH aimed at capturing the socioeconomic, population and geographic characteristics of each community, though using a different set of indicators. For instance, the 2014 vulnerability criteria indicated that all municipalities in the North and Northeast regions were considered vulnerable even if they did not fit any of the other criteria. Most indicators used to define vulnerability were based on municipal-level administrative data collected by multiple agencies in different points in time, though more granular data from the 2010 Population Census were also used to identify communities within each municipality where a substantial proportion of the population was living in extreme poverty. By using more granular data, the MOH aimed at capturing urban impoverishment. Starting from 2014, all federal ordinances supplemented the MDP prioritization criteria with a list of priority municipalities that were either (1) encouraged to apply to the MDP if they had not already done or (2) were eligible to receive more MDP physicians even if they had already received programme physicians. Once a municipality received the vulnerable designation, it retained this status even if it did not qualify with the subsequent iterations of the prioritization criteria.

The MOH organized the MDP enrolment process by periodically issuing public calls that invited municipalities to join the programme. To enrol in the programme, municipalities were required to submit an application to the MOH online portal, specify the number of physician vacancies that were required by the FHS teams in their communities, and indicate the specific FHS teams that the MDP physicians were planned to join. Any municipality, regardless

Table 1. Description of MDP vulnerability criteria used by the MOH, in chronological order, 2013-2017

Criteria definition	Source
Legislation: Federal Ordinance 1.369/MS/MEC [8 July 2013]	
• Areas defined by the Federal Ordinance 1.377/GM/MS; AND	MOH
• Municipalities with 20% or more of the population living with less than R$ 70 (equivalent to $US16.85); OR	Brazil Atlas of Human Development
• G100 Municipalities; OR	NFM
• Special Indigenous Health Districts as established by 1999 Law No 9836/99; OR	MOH
• Census tracks categorized as 4 and 5 within municipalities (category 4 - rural census cluster with urban extension within 1km of urban center; category 5 - secluded rural settlements)	2010 Population Census (IBGE)
Legislation: Federal Ordinance 1.493/MS/MEC [18 July 2013]	
• Areas defined by the Federal Ordinance 1.377/GM/MS; AND	MOH
• Municipalities with 20% or more of the population living with less than R$ 70; OR	Brazil Atlas of Human Development
• G100 municipalities; OR	NFM
• Special Indigenous Health Districts as established by 1999 Law No 9836/99; OR	MOH
• Census tracks with at least 40% of the population living in extreme poverty; OR	MOH
Legislation: Notice SGTES 22 [31 March 2014]	
• Municipalities with 20% or more of the population living with less than R$ 70; OR	Brazil Atlas of Human Development
• G100 municipalities; OR	NFM
• Municipalities with Human Development Index among the ranges of very low or low; OR	Brazil Atlas of Human Development
• Municipalities in the following geographic areas: Jequitinhonha Valley in the State of Minas Gerais, Mucuri Valley in the State of São Paulo, Ribeira Valley in the States of São Paulo and Paraná, or semi-arid regions in the Northeastern Region; OR	IBGE
• Municipalities with Quilombo settlements; OR	Palmares Cultural Foundation
• Municipalities with populations living in rural settlements with agrarian reform projects in the implementation phase according to the November 2013 Report of the Board of Land Procurement and Settlement Projects of the Ministry of Agrarian Development; OR	Ministry of Agrarian Development
• Municipalities in the North or Northeast regions that do not fit in any other criteria; OR	IBGE
• Census tracks with at least 40% of the population living in extreme poverty within large municipalities with a population of over 100,000 inhabitants	2010 Population Census (IBGE)

Notes: Federal ordinances are ministerial directives that can be adopted under the authority of the MOH and do not require approval by other levels of the government such as the Cabinet. G100 municipalities are defined as those with more than 80,000 inhabitants, with the lowest levels of tax payment to the Brazilian National Treasury Department, and the highest level of social vulnerability (FNDP 2012).Quilombo settlements are defined as communities that were founded by Brazilians of African descent.

of eligibility or current availability of physicians in the community, was able to submit an application. Upon receiving applications, project coordinators within the MOH analysed the compliance of each application with the targeting criteria to validate or reject it. For validated applications, the MOH separately determined the number of physicians that would be allocated to each municipality using a different set of criteria. The criteria used to calculate the number of MDP physicians that would be sent to the municipalities were also published through Federal Ordinances. It was possible for non-vulnerable municipalities to contest their vulnerability designation by filing an appeal that demonstrated the needs of the local FHS teams through up-to-date information on local health provider availability in the community.

Materials and methods

Study design

Our study design aims to replicate the process by which the MOH defined vulnerable communities.

To this end, we started our analysis by conducting a desk review of the MDP legislation that set the criteria used to determine the vulnerability status of municipalities and the application of these criteria to assign vulnerability status in a given year. We corroborated our interpretation of the language used in the legislation through interviews with a small set of stakeholders who were involved in the development and implementation of the prioritization criteria. In these interviews, we asked interviewees to describe each criterion used for prioritization as outlined in the Federal Ordinances, and how each iteration of the prioritization criteria was implemented in practice (e.g. whether a community that qualified according to one Federal Ordinance as a vulnerable municipality retained its status in a subsequent iteration).

To track MDP vulnerability status, we constructed a binary variable. For the year 2013, we replicated the vulnerability criteria published in the Federal Ordinance 1.493/MS/MEC. This Federal Ordinance granted vulnerability designation to only a subset of municipalities that were listed in the 2011 Federal Ordinance 1377/GM/MS, which was used by the Brazilian government in the past for identifying municipalities that had difficulty attracting and retaining trained health professionals (Ministry of Health, 2011). This requirement was later lifted in 2014. For the year 2013, we coded a municipality vulnerable if it was listed in the 2011 Federal

Ordinance and if it met at least one of the vulnerability criteria used by the MOH as shown in Table 1; otherwise, it was coded non-vulnerable. Starting from 2014, a municipality was coded vulnerable, if it fitted at least one of the vulnerability criteria used by MOH in a given year. Municipalities that were included in the list of priority areas published in the public calls in a given year were coded vulnerable even if they did not fit any of the vulnerability criteria. Once a municipality was coded vulnerable in a given year, we retained this classification in all subsequent years, as was done by the MOH (Supplementary Table S1 provides more detailed information on the vulnerability designation).

Next, we evaluated targeting performance over time. We adopted a commonly used analytical framework by Cornia and Stewart (1993) in the beneficiary targeting literature, as shown in Table 2. The framework considers two dimensions: enrolment status and vulnerability designation. To track enrolment, we constructed a binary variable for MDP enrolment defined as whether there was at least one MDP physician in the municipality at the end of each year (Supplementary Tables S1 and S2 provide a detailed analysis of MDP enrolment). We, first, analysed the rate at which target communities were successfully enrolled in the MDP and considered enrolment to be successful when vulnerable municipalities received MDP physicians (P_i/N_v) in a given year.

We then considered two conceptually different versions of mistargeting: under-coverage and leakage. Under-coverage occurs when intended beneficiaries do not enrol in the programme, whereas leakage occurs when programme resources are allocated to unintended groups. Both types of mistargeting warrant a careful study—under-coverage may indicate the extent to which the programme successfully reaches its target population, while leakage may signal inappropriate allocation of limited programme resources (White 2017). In the case of MDP, the concept of leakage as often referred to in the literature may not be applicable, because all municipalities were eligible to receive MDP physicians regardless of their vulnerability designation. Therefore, we labelled leakage municipalities as non-target enrolees in the rest of the analysis if they received MDP physicians even though they were not designated as a priority.

We assigned municipalities under-coverage designation if they did not receive any MDP physicians despite meeting at least one of the vulnerability criteria. We calculated under-coverage as the percentage of vulnerable municipalities that did not receive any MDP physicians (P_e/N_v). We calculated non-target enrolment as the proportion of municipalities that received MDP physicians despite not meeting the MDP's vulnerability designation (NP_i/N_i).

Sample and data sources

Our study sample included all 5570 Brazilian municipalities in the period from 2013 to 2017. We tracked MDP enrolment status using aggregated administrative data obtained from the MOH. We obtained the list of priority municipalities for the UHS defined by the Federal Ordinance 1377/GM/MS from the MOH. We accessed the 2010 municipal human development index (MHDI) values from the Brazil Atlas of Human Development, and categorized municipalities as: (1) very-low development—MHDI <0.49 and (2) low development—$0.5 <$ MHDI ≤ 0.59 (Atlas of Human Development in Brazil, 2010). We obtained the list of G100 municipalities from the National Front of Mayors (NFM) website. This group of municipalities was defined as those with >80 000 inhabitants, with the lowest levels of tax payment to the Brazilian National Treasury Department, and the highest level of social vulnerability (FNDP, 2012). We extracted the list of municipalities that were included in the 34 Special Indigenous Health Districts from the MOH. We coded a binary variable that takes value one if the proportion of the population living in extreme poverty was 20% or more (and zero otherwise) using 2010 data from the Secretariat for Evaluation and Information Management website. Extreme poverty was defined as household income per capita under R$70 per month in 2010 (equivalent to $US16.85). We obtained data on the geographic location of municipalities from the Brazilian Institute of Geography and Statistics (IBGE), Ministry of Agrarian Development and Palmares Cultural Foundation.

To capture the level of socioeconomic development in each municipality, we used three proxy variables. First, we obtained the municipal GDP per capita between 2013 and 2017. Second, we extracted data from the Brazil Atlas of Human Development for the year 2010 to track the proportion of literate population aged 18 or older, defined as those who can read or write simple notes; and the proportion of population living in poverty, defined as household income per capita under R$140 per month (equivalent to $US33.70).

We measured health system supply using hospital beds per 1000 inhabitants (except psychiatric beds) as a proxy. To capture physician supply in primary cares settings, we calculated (1) number of physicians per 1000 inhabitants working at the primary care level and (2) whether the municipality had at least one physician working in primary care in May 2013. We obtained these data from the MOH website for the years 2013–17 (Ministry of Health, 2019). In Brazil, the private sector plays an important role in both the financing and delivery of healthcare services. To account for the role of the private sector, we measured the proportion of the population with private insurance plans in each municipality for the years 2013–17

Table 2 Classification of targeting performance used to measure targeting performance based on the enrolment and vulnerability dimensions

		Vulnerability status		
		Vulnerable municipality	Non-vulnerable municipality	Total
Enrolment status	Municipalities enrolled in MDP	P_i (successful enrolment)	NP_i (non-target enrolment)	N_i
	Municipalities unenroled in MDP	P_e (under-coverage)	NP_e (non-enrolment)	N_e
	Total	N_v	N_{nv}	N

Notes: Municipalities that adhered to at least one of the vulnerability criteria defined by MOH in a given year or municipalities that were included in the list of priority municipalities published in federal ordinances between 2014 and 2017 were designated vulnerability status according to the MDP. MDP enrolment was defined as municipality having at least one MDP physician serving in the community. P_i refers to vulnerable municipalities that enrolled in MDP. NP_i and P_e present municipalities classified as special cases and under-coverage, respectively. N_v and N_v denote the number of vulnerable and non-vulnerable municipalities. N denotes the overall sample size.

using data from the Brazilian Regulatory Agency (Agência Nacional de Saúde Suplementar, 2019).

We captured population characteristics using two variables: (1) population density and (2) population size. We include population characteristics in our analysis because the FHS coverage varies substantially across municipalities depending on their population density and size (Andrade *et al.*, 2018b). We calculated population density as the number of inhabitants by the area of the municipality measured in square kilometre. Data on the municipality area and population were obtained from the IBGE (2019b). We coded population size as a categorical variable, as was done in Andrade *et al.* (2018b): <5000 inhabitants, 5000–9999 inhabitants, 10 000–19 999 inhabitants, 20 000–49 999 inhabitants and 50 000 or more inhabitants.

We considered political factors that may influence the implementation of large-scale primary care programmes targeting underserved communities in highly decentralized settings. In Brazil, the health system is marked by a highly devolved governance structure, where municipalities enjoy a high degree of autonomy over decisions in financing and delivery of health services. Previous works from other settings showed that political alignment between government officials across levels of government has implications for the adoption and implementation of social policies (Sen, 1992; Larcinese *et al.*, 2006; Rodden, 2006). More recently, Niedzwiecki (2016) demonstrated that the level of alignment between political parties of local and federal government officials can influence the implementation of social policies such as FHS and *Bolsa Família*, the world's largest conditional cash transfer programme (Niedzwiecki, 2016). Similarly, Andrade *et al.* (2018b) showed in 2018 that the political party alignments of mayors and governors with the President was among the factors that influenced the uptake and implementation of FHS between 1994 and 2012. Building on these findings, we adopted the approach used by Niedzwiecki (2016) to measure the level of political alignment between the President and mayors. We used political party labels in Presidential and mayoral elections using data from the Supreme Electoral Court website between 2012 and 2016 (Tribunal Superior Eleitoral, 2019). We built a categorical variable to track political party alignment between mayors and the President in a given year. We coded this variable to take value zero if mayor was opposed to the president, one if the mayor and president were from the same party, and two if mayor and president were from the same political alliance in a given municipality.

Statistical analysis

We generated all maps with R-studio using *maptools* package. We started our statistical analysis by comparing community-level characteristics of municipalities with vulnerability designation against those considered non-vulnerable municipalities. Our main objective was to ascertain whether the vulnerability designations used by the MOH successfully distinguished municipalities into two distinct groups by their level of socioeconomic development, healthcare supply and resources, population characteristics and political party alignments. For this analysis, we tested whether the mean values of municipality-characteristics differed across vulnerable and non-vulnerable municipalities by performing multivariate tests of means, assuming heterogeneous covariance across the enrolment and vulnerability dimension. Next, we compared municipality characteristics across successful targeting, and under-coverage and non-target municipality groupings. Similar to our earlier analysis, we used multivariate test of means to ascertain whether these three categories successfully grouped municipalities into distinct categories. Data used in all statistical analyses were pooled for all municipalities covering the years 2013–17, except poverty and literacy rates for the year 2010 (the latest year for which data were available) and data pertaining to physician availability prior the launch of the programme. Pooled data were used in the analysis, because we did not note substantial differences in time-varying municipality characteristics (e.g. GDP per capita, population size, population density) over the study period. All calculations were done in Stata V16 (Stata Corp., College Station, TX, USA).

Results

Figure 1 displays vulnerability status by criteria. In 2013, about 24.4% of municipalities (1361/5570) were designated with a vulnerability status. Vulnerable municipalities were located across all geographic regions, though 76.9% (1046/1361) were located in the Northeast, followed by 16.5% (224/1361) in the North. The revision of the vulnerability criteria in 2014 led to a marked expansion in the number of municipalities that were considered vulnerable, with ~60.4% (3362/5570) of all municipalities fitting at least one of the criteria. Of the municipalities that achieved vulnerability status in the 2014 revision, 37.4% (748/2001) and 22.4% (448/2001) were located in the Northeast and Southeast regions, respectively, and only 13% (261/2001) in the Center-West. The number of municipalities with vulnerability status increased slightly after 2014, with ~66.9% (3725/5570) of municipalities in 2017 having vulnerability municipality designation (Supplementary Table S1 provides more details on the geographic distribution of vulnerable municipalities).

We summarize selected municipal characteristics by vulnerability status in Table 3 and plot their distribution in Figure 2. Mean tests for differences for select municipal indicators were all statistically significant, except physician availability at primary care settings and population density. Poverty rate among vulnerable municipalities was 17%, more than four times that of the poverty rate in non-vulnerable municipalities. Vulnerable municipalities had fewer hospital beds and physicians working in primary care before the launch of the MDP (1.22 hospital beds and 0.16 physicians per 1000 inhabitants working in primary care), compared with non-vulnerable municipalities (1.37 hospital beds and 0.28 primary care physicians per 1000 inhabitants). Around 23% of vulnerable and non-vulnerable municipalities lacked a primary care physician deployed in the community in May 2013, though this difference was not statistically different from zero. Population density was slightly higher among vulnerable municipalities, with 118 inhabitants per square kilometre, compared with 113 in non-vulnerable municipalities. But this difference was also not statistically significant. Almost 65% of municipalities with vulnerability designation had populations >10 000 inhabitants, compared with about 45% among non-vulnerable municipalities. In terms of political party alignments, almost 92% of municipalities with vulnerability designation had mayors whose political parties were either the same or in political alliance with the President's party, compared with about 83% among non-vulnerable municipalities.

Figure 3 displays the geographic distribution of municipalities that were classified under one of the three outcomes describing targeting performance of the MDP. Considering successful targeting, we find that almost 70% of municipalities that enrolled in MDP between 2013 and 2017 fit at least one of the criteria to designate socioeconomically vulnerable community status. In the first year of the MDP implementation, successful enrolment among vulnerable

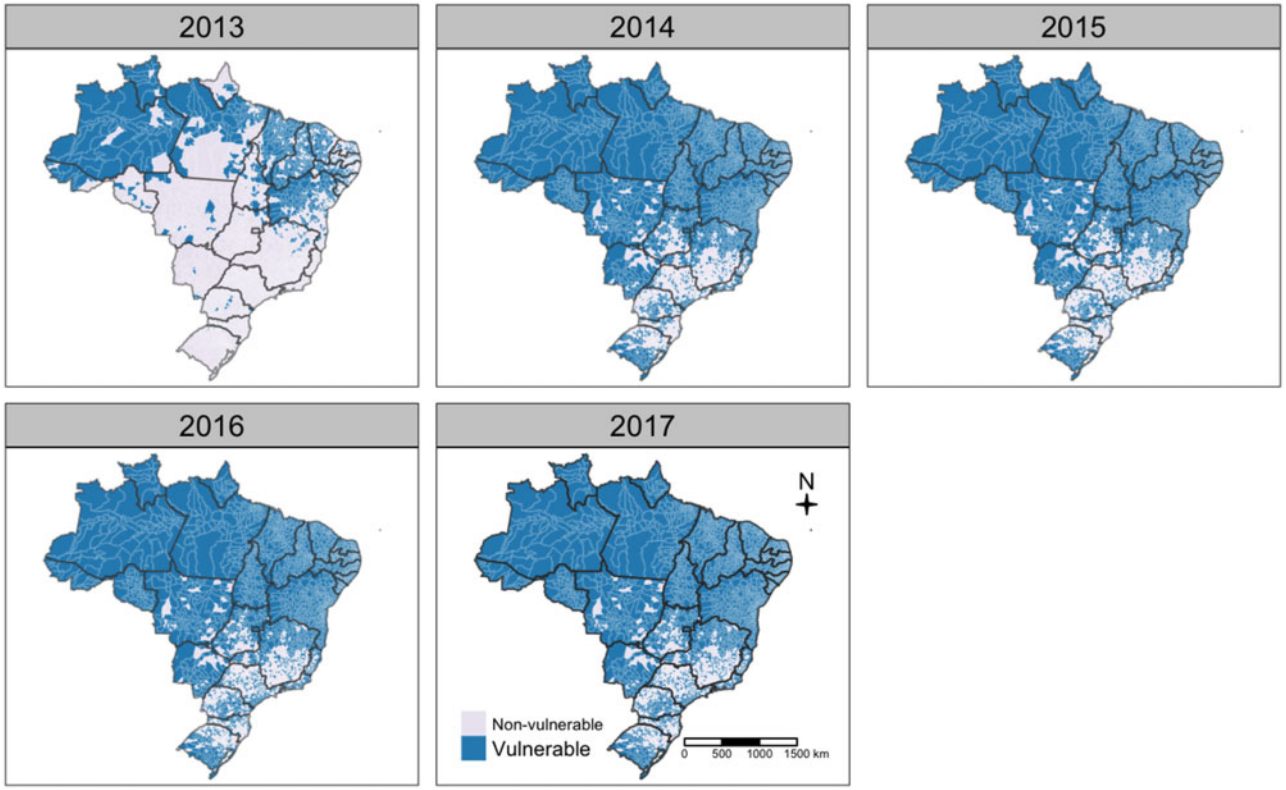

Figure 1 Brazilian municipalities by MDP vulnerability status, 2013–17. Light and dark blue denotes municipalities non-vulnerable and vulnerable designations in the MDP, respectively. State boundaries (federal units) are indicated in black.

municipalities was 45% (612/1361). In the subsequent years, targeting accuracy improved substantially reaching 76.2% (2840/3725) in 2017. Non-target municipalities constituted a substantial share of MDP beneficiaries, with ~33% of municipalities that were enrolled in the programme not fitting any of the vulnerability criteria between 2013 and 2017. In 2013, non-target municipalities represented 44.6% (492/1104) of MDP beneficiaries. This share declined steadily in subsequent years to 25.6% (974/3814) in 2017 (Supplementary Table S3 provides more detailed information on the geographic distribution of municipalities by all three MDP target categories).

Table 4 displays selected municipality characteristics by enrolment and vulnerability domain. Results from our multivariate means tests suggest that the differences in the municipality characteristics between successful enrolment, under-coverage and non-target groupings were all statistically different from zero. We find that the greatest differences in terms of socioeconomic development and health system characteristics were between municipalities classified as under-coverage and non-target enrolment. For instance, the poverty rate among under-coverage municipalities was around 18%, almost six times that of the poverty rate in non-target enrolees. We also show that the density of physicians working in primary care was lowest among successful enrolment municipalities in May 2013, followed by under-coverage and non-target municipalities (0.16, 0.18 and 0.26 per 1000 inhabitants, respectively). Despite these disparities in the physician density working in primary care settings prior to the launch of the programme, the MDP physicians were similarly distributed between vulnerable municipalities that received MDP physicians and non-target municipalities (0.18 and 0.19 per 1000 inhabitants, respectively). Under-coverage municipalities had fewer hospital beds and primary care physicians. In 2013, these municipalities had 1.12 hospital beds and 0.18 primary care physicians per 1000 inhabitants, compared with 1.44 hospital beds and 0.26 primary care physicians in non-target municipalities, respectively. About 30% of under-coverage municipalities lacked a physician working in primary care prior to the implementation of MDP, compared with one-fifth of non-target enrolees.

Under-coverage and non-target municipalities also differed in population size and density. About 56% of under-coverage municipalities had fewer than 10 000 inhabitants, compared with about 49% among non-target municipalities. Under-coverage municipalities were also more sparsely populated, with population density averaging at around 51 inhabitants per square kilometre, compared with 174 inhabitants per square kilometre in non-target enrolees. In terms of political alignment, about 10% of under-coverage municipalities had mayors from parties in opposition to the political party of the President, compared with about 8% of vulnerable municipalities that received MDP physicians and 12% among non-target enrolees.

Discussion

While many studies on beneficiary targeting focus on individuals, we know relatively little about the consequences of community-level targeting methods in large-scale health programmes. Evaluating the performance of community-targeting methods can help assess the extent to which the social programme is able to reach its target populations and ascertain how programme resources are distributed across communities. In recent years, the literature on the impact of MDP on health system performance has grown. Evidence on the performance of beneficiary targeting remains limited, even though a detailed analysis of this aspect of programme implementation is

Table 3 Selected characteristics of municipalities by vulnerability status, 2013–17

Characteristic	Vulnerable		Non-vulnerable		Means test
	Mean,%	SD	Mean,%	SD	*P*-value
GDP per capita (R$)	22 798.71	31 591.88	32 696.94	35 394.53	$P < 0.001$
Poverty rate (2010, %)	17.31%	12.28	3.74%	4.39	$P < 0.001$
Literacy rate (2010, %)	77.58%	10.8	88.96%	6.25	$P < 0.001$
Hospital beds per 1000 inhabitants	1.22	1.29	1.37	1.85	$P < 0.001$
Has physician working in primary care (2013, %)	22.9%	0.42	23.30%	0.42	0.55
Physician density per 1000 inhabitants working in primary care (2013)	0.16	0.18	0.28	0.34	$P < 0.001$
Proportion of the population with private plans	5.17	0.09	11.51	0.12	$P < 0.001$
Population density (inhabitants/km^2)	117.81	619.35	113.33	592.17	0.54
Population size					
<5000	14.66%		31.87%		
5000–9999	20.43%		23.59%		$P < 0.001$
10 000–19 999	28.02%		20.26%		
20 000–49 999	23.12%		15.15%		
≥50 000	13.77%		9.13%		
Political alliances					
Opposition	8.71%		17.27%		
Same party	7.11%		7.65%		$P < 0.001$
Alliance	84.18%		75.09%		

Notes: Municipalities that adhered to at least one of the vulnerability criteria defined by MOH in a given year or municipalities that were included in the list of priority municipalities published in federal ordinances between 2014 and 2017 were designated vulnerability status according to MDP. Analysis pools data from all Brazilian municipalities regardless of their MDP enrolment status. Multivariate tests of means were performed, assuming heterogeneous covariance between vulnerable and non-vulnerable municipalities. Data were pooled for the years for all municipalities 2013–17, except poverty and literacy rates for the year 2010. Similarly, data on physician density and whether a physician was working in primary care is for May 2013, because our analysis aimed to examine whether the vulnerability designations were successful in differentiating differences in physician availability prior to the introduction of the MDP.

SD, standard deviation.

crucial for informing the selection of methods used in impact evaluations. To address these gaps in the literature, we studied the performance of community targeting in a large-scale primary care initiative from Brazil, called the MDP.

We showed that the set of criteria used by the MOH was able to group municipalities into two distinct categories by their level of socioeconomic development, health supply factors and population characteristics. Municipalities with vulnerability designation had the highest poverty rates and lowest levels of literacy. Compared with non-vulnerable municipalities, they also had lower supply of hospital beds and availability of physicians working in primary care settings. However, the MDP vulnerability criteria did not distinguish between vulnerable and non-vulnerable municipalities with no physicians working in primary care prior to the launch of the MDP.

We found that almost 70% of municipalities with vulnerability designation enrolled in MDP between 2013 and 2017. In this period, approximately one-third of municipalities that enrolled in the programme were considered non-target municipalities. Targeting performance improved over time. MDP physician density in non-target municipalities was similar to vulnerable municipalities that successfully received MDP physicians, even though the density of physicians working in primary care prior to the implementation of the programme was the lowest among the latter group and under-coverage municipalities. This finding suggests that the MDP may have faced challenges in the distribution of MDP physicians between communities in accordance with its objective of addressing health worker shortages in Brazil's most underserved communities.

We observed stark differences between vulnerable municipalities that did not receive any MDP physicians and municipalities that received MDP physicians despite not meeting any of the vulnerability criteria. Non-target enrolees with higher levels of socioeconomic development, health infrastructure and physician availability were more likely to receive MDP physicians. Conversely, under-coverage municipalities had the highest poverty rate and the lowest supply of hospital beds and primary care physicians prior to the launch of the MDP. These municipalities were also sparsely populated and smaller in size. The political parties of the mayors in under-coverage municipalities were less aligned with the party of the President, compared with the vulnerable municipalities that received MDP physicians.

Our results provide three important lessons to policymakers that seek to understand challenges and strategies for designing and implementing large-scale health programmes that use community-level targeting methods. First, our results highlight that criteria-based approaches to identify underserved communities is a complex

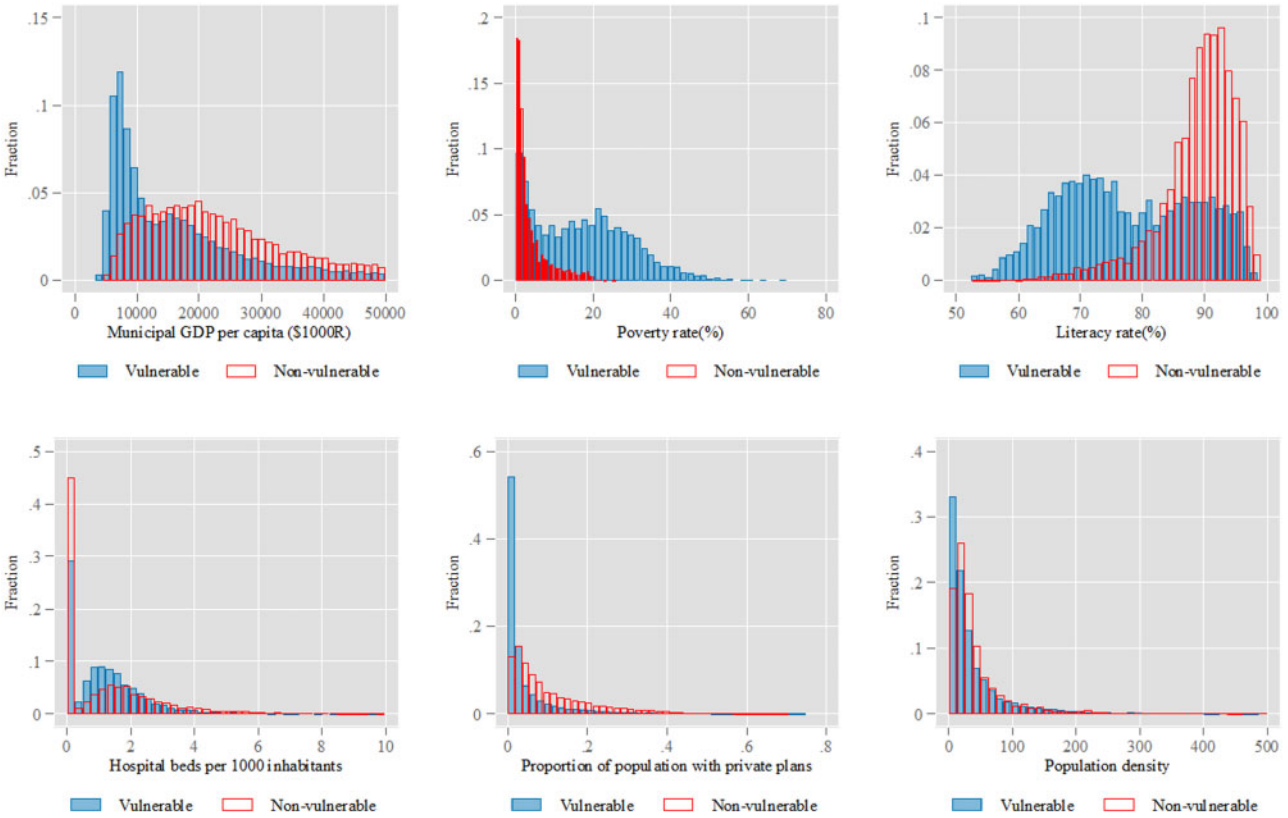

Figure 2 Distribution of select municipality characteristics by MDP vulnerability status, 2013–17. Vulnerability was defined as municipalities that adhered to at least one of the prioritization criteria defined by MOH in a given year. Data for all indicators were pooled for the years 2013–17, except poverty and literacy rates, which are for the year 2010.

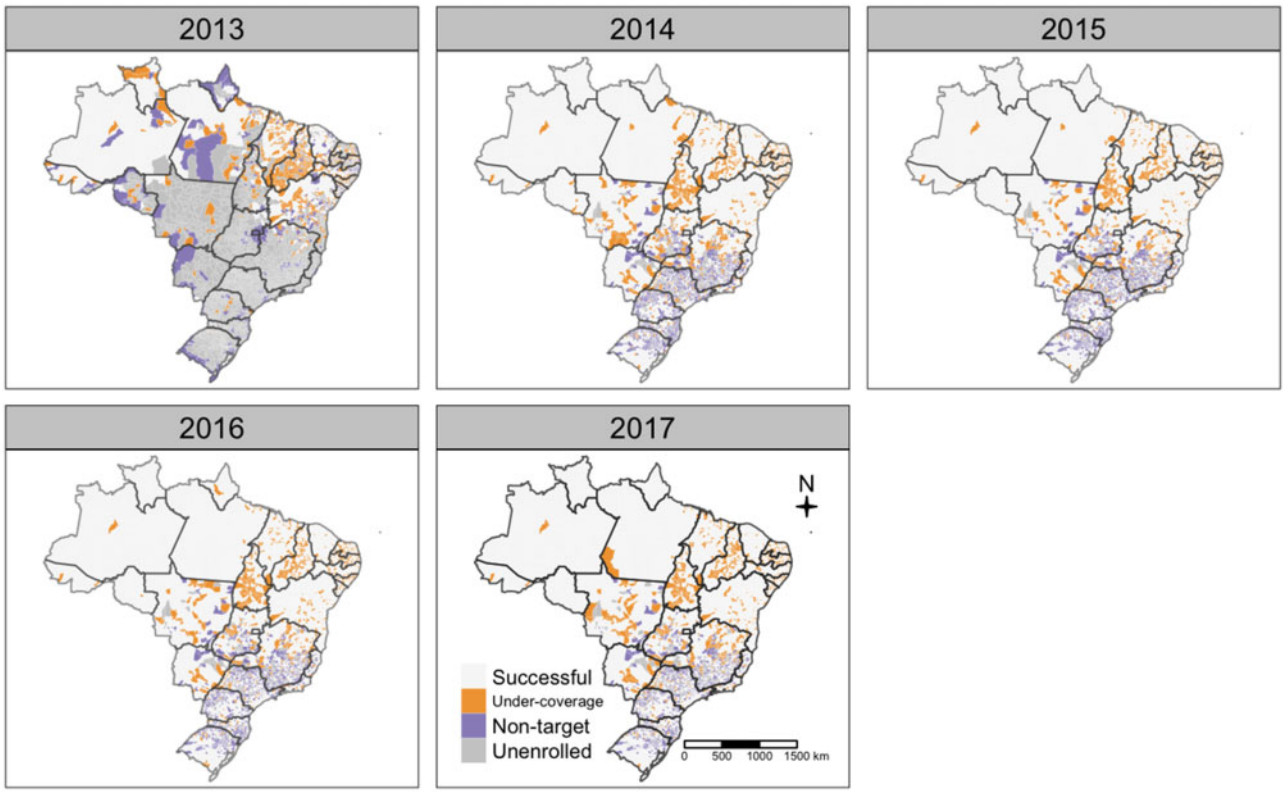

Figure 3 Brazilian municipalities by MDP vulnerability and enrolment status, 2013–17. White, orange and purple denote successful enrolment, under-coverage and non-target enrolment, respectively. State boundaries (federal units) are indicated in black.

Table 4 Selected characteristics of municipalities by enrolment and vulnerability domains, 2013–17

Characteristic	Successful enrolment		Under-coverage		Non-target enrolment		Means test
	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD	*P*-value
GDP per capita (R$)	23 306.7	35 965.19	21 379.29	36 728.64	35 183.37	34 412.45	$P < 0.001$
Poverty rate (2010, %)	16.93%	4.67	18.38%	11.84	3.23%	3.89	$P < 0.001$
Literacy rate (2010, %)	78.52%	6.65	74.95%	10.29	90.07%	5.44	$P < 0.001$
Hospital beds per 1000 inhabitants	1.26	1.87	1.12	1.43	1.44	1.82	$P < 0.001$
Has physician working in primary care (May 2013, %)	20.43%	0.40	30.12%	0.46	20.71%	0.41	$P < 0.001$
Physician density per 1000 inhabitants working in primary care (May 2013)	0.16	0.17	0.18	0.18	0.26	0.30	$P < 0.001$
Proportion of the population with private plans	5.61	0.12	3.91	0.08	12.55	0.12	$P < 0.001$
Population density (inhabitants/km^2)	141.91	418.02	50.45	195.78	174.48	772.17	$P < 0.001$
Population size							
<5000	10.00%		27.66%		25.51%		
5000-9999	17.61%		28.32%		23.60%		
10 000-19 999	28.34%		27.12%		20.75%		$P < 0.001$
20 000-49 999	26.81%		12.83%		17.23%		
≥50 000	17.24%		4.07%		12.92%		
Political alliances							
Opposition	8.14%		10.32%		12.46%		
Same party	7.75%		5.32%		7.97%		$P < 0.001$
Alliance	84.11%		84.37%		79.57%		
GDP per capita (R$)	11456		4100		5056		

Notes: Enrolment is considered successful when vulnerable municipalities receive MDP physicians. Under-coverage occurs when municipalities with vulnerability designation do not enrol in the MPD. Non-target municipalities are non-vulnerable municipalities that receive MDP physicians. Municipalities that adhered to at least one of the vulnerability criteria defined by MOH in a given year or municipalities that were included in the list of priority municipalities published in federal ordinances between 2014 and 2017 are designated vulnerability status according to MDP. Multivariate tests of means were performed, assuming heterogeneous covariance across municipalities classified as successful enrolment, under-coverage, non-target enrolment. Data were pooled for the years for all municipalities 2013–17, except poverty and literacy rates for the year 2010. Data on physician density and whether a physician was working in primary care is for May 2013.

SD, standard deviation.

process that requires careful consideration of various design choices. The MOH used readily available, municipal-level data to inform the selection of indicators to define what constitutes a vulnerable community in the context of the MDP. We show that the MDP vulnerability definitions were able to discriminate communities that had lower levels of socioeconomic development, and lower health supplies and resources as vulnerable. However, the vulnerability criteria did not allow the identification of municipalities that did not have any primary care physicians at baseline, even though addressing physician shortages was the primary objective of the programme. An important aspect of vulnerability in Brazil relates to intra-municipal poverty. Even very rich municipalities have large pockets of inequalities and thus of populations living with precarious access to health. The broad MDP vulnerability criteria acknowledge these inequities and thus is an attempt to reach to as many vulnerable areas as possible. In their review, Devereux *et al.* (2017) highlight that policymakers that consider beneficiary targeting may benefit from carefully considering the consequences of the design choices on the implementation of social programmes. Similarly, our findings suggest that in large-scale programmes that aim to address health system challenges in vulnerable areas, the choice of indicators to designate vulnerability status should be informed by careful consideration of the underlying causes of vulnerability in the unique to the context.

Second, our results indicate that the choice of beneficiary targeting method is a prominent feature of large-scale health programmes that present various trade-offs for policymakers. For instance, Sabates-Wheeler and colleagues (2015) highlight that community-level targeting methods such as geographic targeting may be preferable because of their ease of administration and relatively low costs. However, these methods are also shown at the expense of targeting accuracy (Sabates-Wheeler *et al.*, 2015). In Brazil, the MOH used readily available data to construct MDP vulnerability designations. However, our findings suggested that the MDP faced considerable challenges in beneficiary targeting in the study period. While targeting performance improved over time; non-target municipalities remained a substantial proportion of MDP beneficiaries, whereas one-third of target municipalities opted out of the programme. Our findings corroborate findings from two recent reviews (Sabates-Wheeler *et al.*, 2015; Devereux *et al.*, 2017).

Third, our results indicate that the targeting performance is influenced not only by the design choices made by policymakers but also by the implementation process. We find marked differences between under-coverage and non-target municipalities. Under-coverage municipalities had substantially lower GDP per capita compared with non-target municipalities. The poverty rate among under-coverage municipalities was almost six times that of the poverty rate in non-target enrolees. Their health system characteristics were markedly different from non-target municipalities, with non-coverage municipalities having fewer hospital bed capacity and lower coverage of private plans. They also had lower population density. We noted small differences in the political party alignments of Mayors and the President between under-coverage and non-target municipalities. Approximately 10% of mayors in under-coverage municipalities were affiliated with political parties that were in opposition to the political party of the President, compared with 12% among non-target municipalities. Combined, these findings suggest that in highly decentralized settings a diverse set of

factors ranging from the level of socioeconomic development, population characteristics and political party alignments may influence the implementation of large-scale health programmes.

This study presents the first comprehensive assessment of beneficiary targeting in Brazil's MDP between 2013 and 2017 by utilizing data from multiple, municipal-level publicly available sources. It adopts a conceptual framework commonly used in the beneficiary targeting literature that allows for a systematic assessment of targeting performance over time. Our approach extends the literature on beneficiary targeting by providing new evidence from a large-scale health programme that relied on a community-level targeting method to identify target communities. The results highlight the complexities associated with the design and implementation of a community-based targeting mechanism to address the inequitable distribution of health personnel.

This study has some limitations. First, an important design feature of the MDP was that municipalities were required to submit online applications to the MOH to join the programme. Upon receiving applications, the MOH would evaluate whether the municipality fit vulnerability designation to inform decisions related to MDP physician allocations. In principle, the MOH could deny the application of municipalities to receive MDP physicians. In our study, we did not have information on the number of denied applications. It is plausible that a portion of municipalities we considered as non-enrolled municipalities were those whose applications were denied by the MOH. However, we do not expect this to be a considerable limitation, as earlier works indicated that denial of municipal applications was rare (Oliveira *et al.*, 2016). Second, our study found that non-target municipalities constituted a substantial share of MDP beneficiaries. This finding may be partly explained by our data limitations. In this study, we were unable to determine whether, among municipalities considered non-target, the MDP physicians were actually placed within communities with a high proportion of the population living in extreme poverty, because data on MDP implementation is at the municipality level. It is plausible that some of the non-target municipalities allocated the MDP physicians within the FHS teams that work with highly vulnerable populations with greater health needs. If this is the case, then our study may have overestimated the extent to which the MDP resources were allocated to non-target communities. Alternatively, it is possible that the MDP physicians recruited to the non-target municipalities worked in non-vulnerable communities because the MOH did not monitor in which census tracts MDP physicians worked once they were placed in a municipality. Future studies with more granular data can examine MDP's targeting accuracy within non-target municipalities. Third, we were unable to measure the proportion of municipalities that had to contest their vulnerability status due to lack of data. However, our results showed that a considerable proportion of programme beneficiaries were considered non-target municipalities, suggesting that some portion of these municipalities had to contest their status by providing more up-to-date information on their health resource needs to the MOH. This process of contestation of vulnerability status may have created an administrative burden. Fourth, our choice of municipal-level indicators was limited by publicly available and reliable data. For instance, we did not have information on the strength of physician associations in each municipality or local community groups, even though they might have been relevant to influencing decisions of local politicians related to the community's enrolment in MDP. Fourth, we were unable to identify the main factors that contributed to the improvements in beneficiary targeting. Future studies are needed to understand why targeting performance improved over time. In our analysis, we considered municipalities as enrolled in the MDP if they received at least one physician from the programme, because we aimed to assess how beneficiary targeting at the community level changed over time. While our approach enabled us to track the number of municipalities that received MDP physicians over time, we were unable to provide an in-depth assessment of the changes in the number of physicians within and across municipalities in accordance with the priorities of the MDP due to the dearth of publicly available data. Future studies can examine the different set of municipal-level criteria used by the MOH to determine the number of MDP physicians allocated to each municipality and assess whether changes in the number of MDP physicians reflect prioritization of communities set by these criteria. This study does not attempt to explain the factors that underlie geographic imbalances in the distribution of FHS professionals. Future qualitative and quantitative studies can shed light on factors that contribute to the long-standing challenges in attracting and retaining health workers in certain communities in Brazil.

Conclusion

This study investigated the performance of beneficiary targeting in a large-scale health programme in Brazil using data from multiple municipal-level, publicly available sources. We showed that the MDP faced challenges in community targeting, though the targeting performance improved from 2013 to 2017. Our results suggest that policymakers who consider using community-level targeting approaches should carefully consider various municipality characteristics that may influence the implementation of large-scale health programmes, including the level of socioeconomic development, health supply factors, population characteristics and political party alignments between politicians.

Supplementary data

Supplementary data are available at *Health Policy and Planning* online.

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