

By James Macinko, Inês Dourado, Rosana Aquino, Palmira de Fátima Bonolo, Maria Fernanda Lima-Costa, Maria Guadalupe Medina, Eduardo Mota, Veneza Berenice de Oliveira, and Maria Aparecida Turci

DOI: 10.1377/hlthaff.2010.0251  
HEALTH AFFAIRS 29,  
NO. 12 (2010): 2149–2160  
©2010 Project HOPE—  
The People-to-People Health  
Foundation, Inc.

# Major Expansion Of Primary Care In Brazil Linked To Decline In Unnecessary Hospitalization

**ABSTRACT** In 1994 Brazil launched what has since become the world's largest community-based primary health care program. Under the Family Health Program, teams consisting of at least one physician, one nurse, a medical assistant, and four to six trained community health agents deliver most of their services at community-based clinics. They also make regular home visits and conduct neighborhood health promotion activities. This study finds that during 1999–2007, hospitalizations in Brazil for ambulatory care-sensitive chronic diseases, including cardiovascular disease, stroke, and asthma, fell at a rate that was statistically significant and almost twice the rate of decline in hospitalizations for all other causes. In municipalities with high Family Health Program enrollment, chronic disease hospitalization rates were 13 percent lower than in municipalities with low enrollment, when other factors were held constant. These results suggest that the Family Health Program has improved health system performance in Brazil by reducing the number of potentially avoidable hospitalizations.

**James Macinko** (james.macinko@nyu.edu) is an associate professor of public health and health policy at New York University, in New York City.

**Inês Dourado** is an associate professor at the Public Health Institute, Federal University of Bahia, in Brazil.

**Rosana Aquino** is an associate researcher at the Public Health Institute, Federal University of Bahia.

**Palmira de Fátima Bonolo** is an associate professor of medicine at the Federal University of Ouro Preto, in Brazil.

**Maria Fernanda Lima-Costa** is a professor of epidemiology at the Oswaldo Cruz Foundation's René Rachou Research Institute, in Belo Horizonte, Brazil.

**Maria Guadalupe Medina** is an associate researcher at the Public Health Institute, Federal University of Bahia.

**Eduardo Mota** is an associate professor and director of the Public Health Institute, Federal University of Bahia.

**Veneza Berenice de Oliveira** is an associate professor at the Medical School, Federal University of Minas Gerais, in Brazil.

**Maria Aparecida Turci** is a researcher at the Center for Public Health Education (NESCON), Federal University of Minas Gerais.

**T**his paper assesses whether the expansion of Brazil's Family Health Program (FHP)—which now provides care for 99.4 million people—has had an impact on reducing hospitalizations for chronic conditions that could be effectively managed and treated in the primary care setting. Measuring such hospitalization trends is a recognized approach used by wealthy countries such as members of the Organization for Economic Cooperation and Development<sup>1,2</sup> to identify access and quality weaknesses in primary care.<sup>3,4</sup> Yet this research approach has rarely been applied in low- and middle-income countries.

## Brazil's Family Health Program

Brazil's national health system—the Sistema Único de Saúde, or SUS—is a decentralized network of health services that offers primary, sec-

ondary, and hospital care free at the point of delivery to the entire population. The system reflects the Brazilian constitutional mandate of health care as a universal right and a responsibility of the state.<sup>5</sup>

**TEAM-BASED CARE** Since 1994 the Family Health Program has delivered a new, more robust model of primary care services designed to provide accessible, comprehensive care for the whole person. This care is coordinated with other health care services and takes place within the context of families and communities.

Family Health Program teams deliver most services at a community health clinic. The teams contain one physician, one nurse, one medical assistant, and four to six community health agents who—with other health professionals as needed—perform regular home visits and conduct neighborhood health promotion activities. Each team provides care for a geographic region, with each serving a population of approximately

3,500. The program uses local health data to plan relevant health services.

**RAPID GROWTH** The Family Health Program grew rapidly during the past decade. Between 1999 and 2007 the number of program teams increased from 4,114 to more than 29,000. During the same period, patient enrollment increased from an initial 9 percent of Brazil's population, and now totals approximately 99.4 million people—more than half the country's population. The program is the world's largest community-based primary health care program.<sup>6</sup>

**EFFECTS ON ADULT OUTCOMES** Although there is evidence that the Family Health Program has had a positive impact on child mortality, there is little published evidence to date on its effect on adult illness or mortality.<sup>7–9</sup> Our study attempted to fill this gap by describing trends in the rates of hospitalizations for ambulatory care-sensitive conditions that are attributable to chronic diseases and by assessing the relationship of those trends with the expansion of Brazil's Family Health Program.

### Chronic Diseases In Brazil

Like many middle-income countries, Brazil has experienced major demographic, epidemiological, and nutritional changes since the 1960s. One result has been changing patterns of disease, including a substantial increase in the prevalence of chronic, noncommunicable diseases.

In 2005 the leading causes of death in Brazil were cardiovascular disease, which accounted for 30 percent of all deaths; cancer, 15 percent; external causes, 12 percent; respiratory diseases, 10 percent; endocrine and metabolic diseases, 6 percent; and digestive diseases, 5 percent.<sup>10</sup>

**CHANGES IN THE POPULATION'S HEALTH** Since 1990 deaths due to cardiovascular disease have declined by more than 10 percent, and deaths from stroke have fallen by nearly one-third—while diabetes-related deaths have nearly doubled.<sup>11</sup> Trends in these causes of death differ by geographic region. The largest declines were seen in the wealthy southern and southeastern regions of the country, where there are greater health care resources.<sup>11</sup>

Little information is available on the prevalence of chronic conditions nationwide, but estimates from large cities suggest that about 21 percent of Brazilians have been diagnosed with hypertension and about 5 percent with diabetes.<sup>12</sup> Risk factors for chronic disease such as obesity have increased from about 9 percent of the population in 1989 to about 14 percent in 2009.<sup>13</sup> During the same time period, the share of adults who smoke has decreased from more

than 26 percent to about 16 percent, which is lower than in Argentina and Chile.<sup>12</sup>

**BRAZIL'S RESPONSE** In response to chronic disease trends, national initiatives have sought to address risk factors through changes in primary health care and through policy interventions, such as cigarette taxes and bans on smoking in public places. The Family Health Program has prioritized cardiovascular disease and diabetes prevention and treatment, by implementing clinical guidelines and reporting on chronic disease prevalence at the municipal level.

Currently, each Family Health Program team is required to assess the adult risk for cardiovascular disease in its community, using evidence-based protocols to assess such risk factors as age, diabetes, smoking history, blood pressure, and cholesterol. The team then recommends interventions—for instance, dietary changes, smoking cessation, and increased physical activity—to individual patients based on their risk profiles. For high-risk cases, the physician prescribes drugs to treat hypertension, statins to lower cholesterol levels, and other medications as appropriate.

At the community level, the teams also develop health education programs to promote treatment adherence and group-level interventions to support changes in lifestyle.<sup>14</sup> Although treatment and disease management occur at the clinic level, the community health agents who make monthly household visits are directed to identify individuals at risk for cardiovascular disease and refer them to the health center (see the Appendix).<sup>15</sup>

**EXISTING EVIDENCE** There is limited evidence—confined to studies of a single municipality or specific clinic—that the Family Health Program is effective at managing chronic diseases. These studies suggest that the program's teams promote increased access to health care. However, the studies also indicate that chronic disease management may be more complex in this context because the teams have many clients who are poorer and slightly older than patients of traditional primary care clinics, and who also have more risk factors. In addition, the country's complex and fragmented information systems make it difficult to track patients as they proceed from primary to secondary and hospital care.

The studies have also suggested that there is geographic variation in how well Family Health Program health professionals follow clinical guidelines. Finally, the studies have examined variation in intermediate outcomes, such as control of hypertension, and attributed it to both individual patient and health system factors, such as geographic and organizational barriers to access.<sup>16–19</sup>

# In 2005 the leading cause of death in Brazil was cardiovascular disease, which accounted for 30 percent of all deaths.

---

## Study Data And Methods

Our study is based on a list of ambulatory care-sensitive conditions adapted for use in Brazil.<sup>20</sup> From this list we selected the most important chronic conditions that can be controlled through primary care actions, such as the early identification of risk factors and regular screening; prescribing medications such as drugs to lower cholesterol and blood pressure and to control asthma symptoms; monitoring patients' adherence to the treatment regimen; counseling about smoking cessation, diet, and exercise; and coordination with other treatments, medications, and complementary diagnostic and specialty care.

**DATA SOURCES** Our principal data sources were the individual hospitalization files used for hospital reimbursement by the national health system, the Autorização de Internação Hospitalar (AIH), or Authorization for Hospitalization System. These files contain detailed information on the specific condition at discharge;<sup>21</sup> patients' age, sex, and municipality of residence; type of hospital; specific procedures performed; and total costs reimbursed.

We were thus able to link data on more than 60 million registered hospitalizations since 1999 with information on Brazil's 5,507 municipalities.<sup>22</sup> Municipal linkages are important because in Brazil, municipalities have considerable autonomy in managing health services. Municipal authorities determine when to adopt the Family Health Program approach and how quickly the program will expand over time.<sup>23</sup>

**ANALYSES** The main explanatory variable in our analysis was enrollment in the Family Health Program, measured by the number of people

enrolled in each municipality each year, divided by the total yearly municipal population and expressed as a percentage.<sup>24</sup>

Other control variables included socioeconomic conditions such as inflation-adjusted income per capita; the illiteracy rate among women age fifteen and older; the percentage of homes with access to clean water; the number of public and private hospital beds per 10,000 inhabitants; and the percentage of the population with private health insurance. Many municipalities did not have data on water availability, income, and female literacy rates for various years, so we interpolated these measures using a multilevel nonlinear approach described elsewhere.<sup>25</sup>

We used a time-series, cross-sectional design, observing variables for different municipalities (the cross-sections) over nine years.<sup>26</sup> This approach approximated a natural experiment because it took advantage of the fact that the adoption and rate of expansion of the Family Health Program have been heterogeneous across municipalities. Our models assessed whether yearly differences in hospitalization rates for each municipality were associated with yearly changes in the proportion of the municipal population enrolled in the program, while controlling for other explanatory variables likely to determine the need for hospitalization.

We used a fixed-effects negative binomial regression approach to model the number of hospitalizations in each municipality in each year, while controlling for differences in municipal-level population by age group (0–4, 5–19, 20–59, 60–69, and 70–79 years) and by sex. We used this technique in order to create stable hospitalization rates in municipalities with small populations.<sup>27</sup>

The fixed-effects approach took into account the fact that different municipalities started out with differences in hospitalization rates, levels of Family Health Program coverage, and other control variables. For example, at the beginning of the study period, about 70 percent (3,861 out of 5,507) of the municipalities had no residents enrolled in the program. The approach also controlled for unmeasured factors that did not vary over time (fixed effects) that might affect initial hospitalization rates, such as geography, historical disadvantages, or prevalent social norms.<sup>28</sup> We strengthened the model by including dummy variables representing each year (with 1999 as the reference) to control for new factors that would affect every municipality, such as changes in reimbursement rates and other national policies.

One difficulty we encountered was that Family Health Program adoption and yearly increases in enrollment were not randomly allocated across

municipalities. As noted above, the mayors of municipalities chose when to adopt the program and how quickly it could expand.

A well-established method to account for this type of phenomenon—known as endogeneity—is through the use of instrumental variables.<sup>29</sup> In our case, those were the factors that helped explain the likelihood that a mayor would adopt and expand the program but that did not have a direct relationship to hospitalization rates. Previous studies found that municipal adoption of the Family Health Program depended on the mayor's political party, the gross municipal product, and the municipality's infant mortality rate.<sup>30</sup> Since we believed that municipal wealth and the infant mortality might be directly associated with the number of hospitalizations, we used the mayor's political party and the proportion of the municipal budget that was dedicated to health and social services as instrumental variables.

We estimated the model in two steps. First, we used regression analysis to predict municipal enrollment in the Family Health Program as a function of the two instrumental variables defined above. We then divided the resulting adjusted value of Family Health Program enrollment into quintiles and used those figures to predict municipal-level hospitalization rates in our second-stage models.<sup>31</sup>

## Results

**HOSPITALIZATIONS** Exhibit 1 presents the number of ambulatory care-sensitive hospitalizations related to chronic illnesses, by age group and sex. The results in this exhibit are not di-

vided by population size, so that the absolute value of hospital use in the population can be displayed. Beginning in 1999, the largest number of hospitalizations occurred among females ages 20–59; however, by 2007 they had declined 29 percent. For males ages 0–19 and ages 20–59, similar numbers of hospitalizations were observed in 1999. For both age groups, these numbers declined by approximately 20 percent by 2007. The decline in hospitalizations for all males (14 percent) was twice that observed for all females (7 percent).

Exhibit 2 gives the mean values for all variables in 1999 and 2007 and shows whether the changes in values for these years was statistically significant. In 1999 the hospitalization rate for the population under eighty for all causes was 543 per 10,000 for males and 553 per 10,000 for females. Ambulatory care-sensitive chronic diseases accounted for about 17 percent of this total.

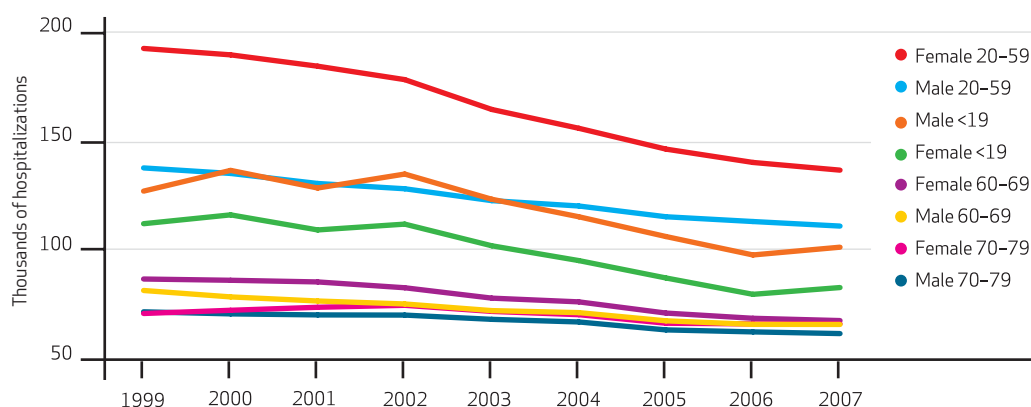
Hospitalization rates for ambulatory care-sensitive chronic diseases were higher for females than for males in 1999, and they declined more rapidly for females over time. Hospitalization declines were statistically significant for all conditions except diabetes. Reductions in hypertension hospitalization rates were significant only among males.

Exhibit 2 also shows that during the study period, most living conditions, except for income, showed statistically significant improvements. In addition, there was a huge expansion of the Family Health Program, a related large decline in the number of beds in private-sector hospitals, and a substantial increase in the number of beds in public-sector hospitals.

Exhibit 3 presents the results of municipal-

### EXHIBIT 1

Numbers Of Ambulatory Care-Sensitive Hospitalizations For Chronic Conditions, By Age And Sex, Brazil, 1999–2007



**SOURCES** Ministry of Health and Brazilian Institute of Geography and Statistics. **NOTES** Hospitalizations for which the principal condition at discharge was diabetes, hypertension, stroke, asthma, chronic obstructive pulmonary disease, angina, or acute myocardial infarction. Hospitalizations for births have been excluded.



**EXHIBIT 2**
**Hospitalization Rates By Condition And Characteristics Of Brazilian Municipalities, 1999–2007**

Variable	1999		2007		Change from 1999 to 2007	
	Mean	SD	Mean	SD	Absolute difference	Percent change
<b>HOSPITALIZATION RATES PER 10,000</b>						
All conditions						
Males	543.34	211.29	465.75	181.12	-77.59 <sup>a</sup>	-14
Females	552.66	230.78	464.83	194.10	-87.83 <sup>a</sup>	-16
All chronic conditions						
Males	84.02	35.01	60.17	20.19	-23.84 <sup>a</sup>	-28
Females	87.94	38.83	57.39	21.42	-30.54 <sup>a</sup>	-35
Diabetes						
Males	4.67	1.55	4.81	1.56	0.14	3
Females	6.87	2.33	6.72	2.48	-0.15	-2
Hypertension						
Males	5.60	2.26	5.76	2.21	0.16	3
Females	9.38	4.01	8.20	3.62	-1.17 <sup>b</sup>	-12
Asthma						
Males	23.74	12.36	14.55	7.44	-9.19 <sup>a</sup>	-39
Females	26.99	14.8	14.67	7.59	-12.31 <sup>a</sup>	-46
COPD						
Males	14.29	13.67	7.32	6.67	-6.97 <sup>a</sup>	-49
Females	12.35	10.75	5.86	4.98	-6.49 <sup>a</sup>	-53
Stroke						
Males	9.70	4.26	7.16	2.32	-0.50 <sup>a</sup>	-5
Females	8.91	3.97	6.17	2.06	-2.75 <sup>a</sup>	-31
Other CVD						
Males	26.02	10.99	20.56	8.09	-1.16 <sup>c</sup>	-4
Females	23.43	12.74	15.76	7.68	-7.67 <sup>a</sup>	-33
<b>CHARACTERISTICS OF MUNICIPALITIES</b>						
Income per capita (R\$)	155.76	239.83	137.98	162.68	-17.18	-11.03
Public hospital beds per 10,000	8.14	4.63	11.03	4.24	2.89 <sup>a</sup>	35.5
Private hospital beds per 10,000	15.94	1.72	8.46	4.32	-7.49 <sup>a</sup>	-46.99
Access to clean water (% population)	77.83	16.47	85.84	12.03	8.01 <sup>a</sup>	10.29
Illiteracy rate, age 15 and older (% female population)	15.37	7.68	11.76	5.78	3.60 <sup>a</sup>	23.42
Enrollment in Family Health Program (% population)	12.95	11.24	56.98	21.16	44.03 <sup>a</sup>	340

**SOURCES** Brazilian Ministry of Health, Institute for Applied Economic Research, and Brazilian Institute of Geography and Statistics. **NOTES** Hospitalizations are of people under age eighty. SD is standard deviation. COPD is chronic obstructive pulmonary disease. CVD is cardiovascular disease. R\$ is reais (Brazilian currency). In November 2010, 1 real was equivalent to 0.5889 dollar. <sup>a</sup> $p < 0.001$  from paired t-test. <sup>b</sup> $p < 0.05$  from paired t-test. <sup>c</sup> $p < 0.01$  from paired t-test.

level analyses for the level of enrollment in the Family Health Program. Holding differences in municipal-level characteristics constant, higher levels of population enrollment were associated with lower rates of hospitalization for chronic diseases. Higher enrollments (measured in quintiles) were associated with even greater relative reductions in hospitalization rates. Municipalities in the highest quintile of family health program enrollment had a 13 percent lower hospitalization rate relative to municipalities with the very lowest enrollments (quintile 1).

The full set of results is available in the Appendix.<sup>15</sup> Because of the large sample size, almost all control variables were statistically significant.

**TRENDS BY AGE** We found that after population size and other municipal characteristics were adjusted for, the majority of hospitalizations occurred among the very young (under age five)

and those age sixty and older. Males had a 7–9 percent increased risk of hospitalizations, compared to females. Other control variables were positively associated with hospitalization rates, but the magnitude of the association was very small. Dummy variables for each year (with 1999 as the reference) confirmed the downward trend in hospitalizations over time (data not shown).

**DISEASE-SPECIFIC FINDINGS** Exhibit 4 shows similar analyses for specific diseases. Holding all other municipal characteristics constant, higher levels of enrollment in the Family Health Program were associated with up to 23 percent lower hospitalization rates for asthma. Stroke and other cardiovascular diseases showed smaller but still significant reductions. For hypertension, all quintiles of enrollment except the highest had lower relative hospitalization rates.

## EXHIBIT 3

## Ambulatory Care-Sensitive Hospitalization Rates For All Chronic Conditions, By Level Of Family Health Program Enrollment In Brazil, 1999–2007

Quintile of municipalities by enrollment	Adjusted prevalence ratio compared to quintile 1 (lowest enrollment)
Quintile 2	0.96
Quintile 3	0.92
Quintile 4	0.89
Quintile 5 (highest enrollment)	0.87

**SOURCES** Brazilian Ministry of Health, Institute for Applied Economic Research, and Brazilian Institute of Geography and Statistics. **NOTES** All adjusted prevalence ratios are significant ( $p < 0.001$ ). Results from fixed-effects negative binomial regression of hospitalizations per municipality, controlling for log population size, age distribution, hospital beds per 10,000, clean water, female illiteracy rates, log income, and years (1999 as reference). Family Health Program enrollment estimated using instrumental-variable approach described in text

Rates of chronic obstructive pulmonary disease were not consistently associated with program enrollment. For diabetes, there was an overall positive relationship: the highest level of enrollment had a higher hospitalization rate.

The Appendix shows the full results of the disease-specific analyses relative to quintile 1.<sup>15</sup> We found marked differences by sex. When other factors were controlled for, males had a 3 percent higher hospitalization rate for asthma, a 25 percent higher rate for stroke, and a 19 percent lower rate for diabetes, compared to females.

## Discussion

**PROGRAM IMPACT** This study sought to describe national changes in patterns of potentially avoidable hospitalizations for chronic conditions and to determine to what extent such changes could be reasonably attributed to expansion of primary health care in Brazil during the past decade.

Hospitalizations for the main ambulatory care-sensitive chronic diseases in Brazil have fallen significantly since 1999—almost twice as fast as hospitalizations for all other causes. Our

results suggest that the expansion of the Family Health Program was associated with some of this decline. In municipalities with high enrollment in the program, hospitalization rates for chronic diseases were 13 percent lower than in municipalities with low enrollment, after other factors were controlled for. This reduction was driven primarily by reduced hospitalizations for asthma, cardiovascular disease, and stroke, and potentially for other conditions as well.

There are several reasons why the expansion of the Family Health Program may have had such a substantial effect.

► **IMPROVED ACCESS:** First, access to comprehensive primary health care has improved dramatically throughout Brazil. The Family Health Program's rapid expansion since 1999 made primary care the usual source of care for 57 percent of Brazilians in 2008, up from about 40 percent in 1998. Simultaneously, the proportion of people listing hospitals as their usual source of care declined from 21 percent in 1998 to 12 percent in 2008.<sup>32</sup>

► **CLINICAL PRACTICE CHANGES:** Second, changes in clinical practice—including increased ability to manage chronic conditions at the primary care level—may also have contributed to declines in hospitalizations for ambulatory care-sensitive conditions. For example, although improved hypertension control might not have led to large reductions in hospitalizations for this specific condition, it may still have contributed to lower rates of hospitalization for all conditions related to cardiovascular disease. Hospitalizations for stroke also declined substantially during the study period.

There are several plausible mechanisms for this effect. The development of national policy guidelines to diagnose, monitor, and treat hypertension and their implementation in the Family Health Program may have played a role. So might monetary incentives to municipalities to implement hypertension control programs

## EXHIBIT 4

## Ambulatory Care-Sensitive Hospitalization Rates For Six Chronic Conditions, By Family Health Program Enrollment In Brazil, 1999–2007

Quintile of municipalities by enrollment	Adjusted prevalence ratio compared to quintile 1 (lowest enrollment)					
	Asthma	Stroke	Other CVD	Hypertension	Diabetes	COPD
Quintile 2	0.95 <sup>a</sup>	0.98 <sup>a</sup>	0.98 <sup>a</sup>	0.97 <sup>a</sup>	1.02 <sup>a</sup>	0.99 <sup>b</sup>
Quintile 3	0.87 <sup>a</sup>	0.96 <sup>a</sup>	0.95 <sup>a</sup>	0.96 <sup>a</sup>	1.05 <sup>a</sup>	1.01
Quintile 4	0.83 <sup>a</sup>	0.96 <sup>a</sup>	0.91 <sup>a</sup>	0.95 <sup>a</sup>	1.06 <sup>a</sup>	1.00
Quintile 5 (highest enrollment)	0.77 <sup>a</sup>	0.99	0.92 <sup>a</sup>	1.02 <sup>c</sup>	1.09 <sup>a</sup>	1.03 <sup>a</sup>

**SOURCES** Brazilian Ministry of Health, Institute for Applied Economic Research, and Brazilian Institute of Geography and Statistics. **NOTES** Results from fixed-effects negative binomial regression of hospitalizations per municipality, controlling for log population size, age distribution, hospital beds per 10,000, clean water, female illiteracy rates, log income, and years (1999 as reference). Family Health Program enrollment estimated using instrumental-variable approach described in text. CVD is cardiovascular disease. COPD is chronic obstructive pulmonary disease. <sup>a</sup>Significantly different from quintile 1 rate ( $p < 0.001$ ). <sup>b</sup>Significantly different from quintile 1 rate ( $p < 0.01$ ). <sup>c</sup>Significantly different from quintile 1 rate ( $p < 0.05$ ).

# Controlling diabetes represents a real challenge for the Brazilian health system.

within the Family Health Program, the ability of program teams to easily measure and monitor blood pressure; and the availability of medications to reduce hypertension at no cost to program enrollees.<sup>33</sup> Given the scale at which the Family Health Program operates, and the myriad conditions that are caused or exacerbated by high blood pressure, even a small reduction in hypertension across the population could potentially stimulate reductions in avoidable hospitalizations over time.

► **ENHANCED PRIMARY CARE CAPACITY:** Third, reductions in hospitalizations for asthma and chronic obstructive pulmonary disease may also be due to increased access to primary care for some patients, even though clinical confirmation of these conditions requires access to diagnostic care not provided by the Family Health Program. For example, asthma is most common among children under age five, and that age group represents the majority of patients who visit many program clinics. As a result, it is certainly possible that increased access to the program's services increased awareness of asthma symptoms and led to more widespread prescription of rescue inhalers, resulting in reduced need for hospitalization for this condition.

**FOCUS ON DIABETES** Contrary to our initial hypotheses, access to the Family Health Program was associated with increased rather than reduced hospitalizations for diabetes. This could represent detection bias: As the program's teams extended services to previously underserved communities, they might have detected diabetic patients who required hospital care.

Diabetic patients and program team members also faced barriers in access to secondary and diagnostic care. There is evidence that in some areas, the teams do not consistently follow clinical guidelines for diabetes.<sup>34</sup> Each of these factors may also have led to increased hospital referrals.

We may also have somewhat underestimated diabetes-related complications because we analyzed only the principal diagnosis for each hos-

pitalization and did not include diabetes as a contributory cause.<sup>35</sup> In the final analysis, controlling diabetes represents a real challenge for the Brazilian health system.

## **DIFFERENCES ACROSS MUNICIPALITIES**

Although there was a generally consistent relationship between increased enrollment in the Family Health Program and declines in hospitalization rates for ambulatory care-sensitive conditions, the program's effect was not linear for all outcomes. This observation was consistent with prior studies.<sup>36,37</sup>

Some of this variation may be attributable to the characteristics of the municipalities. Our analysis of the municipalities in the highest quintile of enrollment in the program showed that they typically had small populations, averaging about 12,000 inhabitants, and the highest levels for some risk factors, such as illiteracy. Small populations and rural locations may be responsible for some variation in hospitalization rates.

In addition, 40 percent of these municipalities have no hospital, so there may be errors in attributing municipality of residence in such locations. Future analyses should explore alternative ways to model the nonlinear effects of the Family Health Program measure and should incorporate measures of primary care quality.<sup>38</sup> (See the Appendix for a breakdown of municipal characteristics by Family Health Program enrollment quintile.)<sup>15</sup>

As a sensitivity test, we analyzed the amount that the Brazilian government reimburses hospitals for different procedures associated with the chronic conditions we examined. If reimbursement rates decreased dramatically, hospital administrators could have become less inclined to admit patients for such conditions, finding alternative ways to manage these patients and devoting hospital beds instead to individuals whose conditions would be reimbursed at higher rates.

However, Brazilian hospitals are paid according to the actual procedures performed, which must be linked to a diagnostic code that would justify those procedures. Moreover, reimbursement for most hospital-based procedures associated with chronic diseases increased over time, sometimes even exceeding mean rates of reimbursement, as shown in the Appendix.<sup>15</sup> This suggests that changes in reimbursement, although important, were probably not the main drivers of the large declines we observed for ambulatory care-sensitive hospitalizations only.

Other alternative hypotheses must be considered and tested. For example, during the study period, there was an increase in the supply of ambulatory specialist care. Most of this expan-

sion occurred in the private sector, available only to those with a private health plan or through out-of-pocket spending, and so is not likely to be the principal driver of changes in hospitalization rates.<sup>39</sup>

Our study controlled for the availability of beds in both public and private hospitals. Future research should seek to incorporate additional measures that capture the independent effects of changes in access to secondary and diagnostic care on hospitalizations for ambulatory care-sensitive conditions throughout the country.

**IMPLICATIONS FOR RESEARCH** Our study illustrates how ambulatory care-sensitive hospitalizations can be used to monitor and evaluate the effectiveness of primary care in a middle-income country. Several recommendations may help policy makers in other countries perform such analyses.

► **LOCAL CONTEXT:** First, analysts in other countries may first need to review the list of ambulatory care-sensitive conditions as needed for the local context. In addition to systematically reviewing national and international lists, the research team consulted with primary care professional organizations to determine which conditions primary care providers were capable of treating, and for which conditions screening and treatment technology was available. Authorities included a period for public comment on the proposed set of conditions. Researchers provided empirical validation of the relationship between variations in hospitalization rates for ambulatory care-sensitive conditions and the availability of primary care.<sup>24</sup>

► **PARTNERSHIPS:** Second, researchers should consider working in partnership with other stakeholders and learning by doing. We consulted with Brazilian researchers, the national and local governments, and the Brazilian Society of Family and Community Medicine at various stages of the process to help stimulate critical analysis of the list of conditions considered to be sensitive to primary care. Engaging diverse stakeholders also had the benefit of getting their approval for the final list of ambulatory care-sensitive conditions we used in our study, and stimulating its use in planning and other research.

► **QUALITY OF DATA:** Third, researchers should assess and validate the availability and quality of hospital data. In countries that regularly collect hospitalization claims data, decision

makers and researchers may be skeptical about data quality. These important concerns should be addressed by identifying the data's limits and strengths. One advantage to working with a list of ambulatory care-sensitive conditions—as opposed to conducting disease-specific analyses—is that it may reduce some coding biases, which are more likely to occur with single, specific causes of death than with larger groupings of related conditions. National inpatient surveys and other approaches could also be used to determine where access to and quality of health care most need improving.

► **PRIMARY CARE:** Fourth, it is essential to have an accurate measure of primary health care supply. We were able to monitor increased enrollment in the Family Health Program at the municipal level. In other settings, it will be important to define a consistent and verifiable measure of primary care and to consider the extent to which the existing model of care is able to perform the main primary care functions relevant to improving prevention and management of chronic diseases, such as providing accessible, comprehensive, coordinated, and person-focused care over time.

► **VARIED TOOLS:** Fifth, researchers and policy makers should be aware that hospitalization rates are only an indirect measure of the effectiveness of primary care. Strengthening primary health care will require using various tools to assess and then improve access and quality. In particular, it will be important to assess the extent to which primary care services are able to provide comprehensive, person-focused, and integrated care, and to coordinate care provided by various levels of the health system.

## Conclusion

Our conclusions and policy recommendations show that Brazil's strategy of investing in the Family Health Program has resulted in substantial benefits. Going forward, there is a need to improve the quality of health data; identify problems in access to and quality of care; and further reduce the need for hospitalization for conditions that should have been avoided or prevented. These actions, taken together, have the potential not only to improve the Brazilian health system's efficiency, but also to improve the quality of people's lives. ■



A version of this paper was presented at the Hemispheric Meeting of the Social Protection and Health Network, Improving Chronic Disease Prevention and Management in Latin America and the Caribbean, in Santiago, Chile, September 30, 2010. This work was

directly supported by a grant from the Inter-American Development Bank. It benefited from a project financed by the Brazilian Ministry of Health. The authors thank Jacques Levin for data acquisition and advice; Frederico C. Guanaís for interpolated municipal-level covariates;

and Amanda Glassman and members of the Inter-American Development Bank working group on chronic disease in Latin America and the Caribbean for comments and suggestions on earlier versions of the manuscript.

## NOTES

- 1 Bindman AB, Grumbach K, Osmond D. Preventable hospitalizations and access to health care. *JAMA*. 1995; 274:305–11.
- 2 Magan P, Otero A, Alberquilla A, Ribera JM. Geographic variations in avoidable hospitalizations in the elderly, in a health system with universal coverage. *BMC Health Serv Res*. 2008;8:42.
- 3 Bermúdez-Tamayo C, Márquez-Calderón S, Rodríguez del Águila MM, Perea-Milla López E, Ortiz Espinosa J. [Organizational characteristics of primary care and hospitalization for the main ambulatory care sensitive conditions]. *Aten Primaria*. 2004;33(6):305–11. Spanish.
- 4 Caminal Homar J, Casanova Matutano C. [Primary care evaluation and hospitalization due to ambulatory care-sensitive conditions: conceptual framework]. *Aten Primaria*. 2003;31(1):61–5. Spanish.
- 5 Elias PE. [Public health care policy in Brazil: the Brazilian society and the construction of universality in the Brazilian health system]. *Cien Saude Colet*. 2008;13(Suppl 2):2023–6. Portuguese.
- 6 Ministério da Saúde, Departamento de Atenção Básica. *Números da Saúde da Família* [data on family health] [Internet]. Brasília: The Ministry; 2010 [cited 2010 Oct 7]. Portuguese. Available from: <http://200.214.130.35/dab/abnumeros.php#numeros>
- 7 Aquino R, de Oliveira NF, Barreto ML. Impact of the Family Health Program on infant mortality in Brazilian municipalities. *Am J Public Health*. 2009;99(1):87–93.
- 8 Macinko J, Marinho de Souza M de F, Guanaís FC, da Silva Simões CC. Going to scale with community-based primary care: an analysis of the Family Health Program and infant mortality in Brazil, 1999–2004. *Soc Sci Med*. 2007;65(10):2070–80.
- 9 Guanaís F, Macinko J. Primary care and avoidable hospitalizations: evidence from Brazil. *J Ambul Care Manage*. 2009;32(2):115–22.
- 10 Ministério da Saúde. *Saúde Brasil 2007: uma análise de situação de saúde* [Health in Brazil 2007: an analysis of the health situation]. Brasília: Ministério da Saúde, Secretaria de Vigilância em Saúde; 2007. Portuguese.
- 11 Ministério da Saúde. *Saúde Brasil 2008: uma análise de situação de saúde* [Health in Brazil 2008: an analysis of the health situation]. Brasília: Ministério da Saúde, Secretaria de Vigilância em Saúde; 2008. Portuguese.
- 12 Moura EC, Malta DC, de Moraes Neto OL, Monteiro CA. [Prevalence and social distribution of risk factors for chronic noncommunicable diseases in Brazil]. *Rev Panam Salud Publica*. 2009;26(1):17–22. Spanish.
- 13 Instituto Brasileiro de Geografia e Estatística. *Pequisa de orçamentos familiares 2008–2009*. Rio de Janeiro: IBGE; 2010.
- 14 Ministério da Saúde. *Prevenção clínica de doenças cardiovasculares, cerebrovasculares e renais* [Clinical prevention of cardiovascular, cerebrovascular, and renal diseases] [Internet]. Brasília: Ministério da Saúde; 2006 [cited 2010 Nov 5]. (Cadernos de Atenção Básica No. 14). Portuguese. Available from: <http://bvsms.saude.gov.br/bvs/publicacoes/abcd14.pdf>
- 15 To access the Appendix, click on the Appendix link in the box to the right of the article online.
- 16 Baptista EKK, Marcon SS, Souza RKT. Avaliação da cobertura assistencial das equipes de saúde da família às pessoas que faleceram por doenças cerebrovasculares em Maringá, Paraná, Brasil [Evaluation of the coverage of care by family health teams of people who died from cerebrovascular disease in Maringá, Paraná, Brazil]. *Cad Saude Publica*. 2008;24(1):225–9. Portuguese.
- 17 Souza MLP, Garnelo L. “É muito difícil!”: etnografia dos cuidados a pacientes com hipertensão e/ou diabetes na atenção básica, em Manaus, Amazonas, Brasil [“It’s really hard!”: Ethnographic study of care for patients with hypertension and/or diabetes in primary care in Manaus, Amazonas, Brazil]. *Cad Saude Publica*. 2008;24(Suppl 1):91–9. Portuguese.
- 18 Macinko J, Almeida C, de Sa PK. A rapid assessment methodology for the evaluation of primary care organization and performance in Brazil. *Health Policy Plan*. 2007; 22(3):167–77.
- 19 Elias PE, Ferreira CW, Alves MC, Cohn A, Kishima V, Escrivão A Jr., et al. *Atenção básica em saúde: comparação entre PSF e UBS por estrato de exclusão social no município de São Paulo* [Basic care in health: a comparison between the Family Health Program and the Basic Health Unit, by level of social exclusion in the municipality of São Paulo]. *Cien Saude Colet*. 2006; 11(3):633–41. Portuguese.
- 20 Alfradique ME, Bonolo P de F, Dourado I, Lima-Costa MF, Macinko J, Mendonça CS, et al. [Ambulatory care-sensitive hospitalizations: elaboration of a Brazilian list as a tool for measuring health system performance (Project ICSAP—Brazil)]. *Cad Saude Publica*. 2009; 25(6):1337–49. Portuguese.
- 21 We used *International Classification of Diseases*, Tenth Revision (ICD-10), codes to identify patients’ primary condition at discharge. We examined diabetes (E10–E14), hypertension (I10–I11), stroke (I63–I67, I69, and G45–G46), asthma (J45–J46), chronic obstructive pulmonary disease (J40–J44), and other cardiovascular disease including angina and acute myocardial infarction (I20, I21, I50, and J81).
- 22 In all analyses, we used 5,506 of the 5,507 total municipalities in 1999 because one municipality lacked data for several indicators.
- 23 Instituto Brasileiro de Geografia e Estatística. *Projeção da população do Brasil por sexo e idade 1980–2050: revisão 2008* [Projection of the Brazilian population by sex and age, 1980–2050: 2008 revision] [Internet]. Rio de Janeiro: IBGE; 2008; [cited 2010 Nov 5]. (Estudos y Pesquisas, Informação Demográfica e Socioeconômica No. 24). Portuguese. Available from: [http://www.ibge.gov.br/home/estatistica/populacao/projecao\\_da\\_populacao/2008/projecao.pdf](http://www.ibge.gov.br/home/estatistica/populacao/projecao_da_populacao/2008/projecao.pdf)
- 24 Our data on municipalities came from the Brazilian Institute for Geography and Statistics (IBGE) and the Brazilian Institute for Applied Economic Research (IPEA) in the Ministry of Finance.
- 25 Guanaís FC, Macinko J. The health effects of decentralizing primary care in Brazil. *Health Aff (Millwood)*. 2009;28(4):1127–35.
- 26 Sayrs LW. *Pooled time series analysis*. Thousand Oaks (CA): Sage; 1989.
- 27 We used the negative binomial instead of a Poisson model because of the presence of overdispersion—or a

- lack of equivalence between the data mean and its variance, which is a key assumption of the Poisson model. We adjusted for age by including age-specific population rates to offset this overdispersion. Allison PD. Fixed effects regression models. Los Angeles (CA): Sage; 2009.
- 28 Wooldridge JM. Econometric analysis of cross section and panel data. Cambridge (MA): MIT Press; 2002.
  - 29 Gelman A, Hill J. Data analysis using regression and multilevel/hierarchical models. New York (NY): Cambridge University Press; 2007.
  - 30 Rocha R, Soares R. Evaluating the impact of community-based health interventions: evidence from Brazil's Family Health Program [Internet]. Bonn: Institute for the Study of Labor (IZA); 2009 [cited 2010 Nov 5]. (IZA Discussion Paper No. 4119). Available from: <http://ftp.iza.org/dp4119.pdf>
  - 31 The resulting regression (5,506 municipalities times nine years, or 49,554 data points) had an  $R^2$  value of 0.15 and the following results: political party of mayor to the political left (−1.61; 95 percent confidence interval, −2.75 to −0.46;  $p = 0.001$ ); percentage of municipal budget devoted to health and social services (0.307; 95 percent confidence interval, 0.25 to 0.36;  $p < 0.001$ ).
  - 32 Instituto Brasileiro de Geografia e Estatística. A panorama da saúde no Brasil: acesso e utilização dos serviços, condições de saúde e fatores de risco e proteção à saúde [The panorama of health in Brazil: access to and utilization of services, health conditions, and risk and protective factors for health]. Rio de Janeiro: IBGE; 2010. Portuguese.
  - 33 Although there were fluctuations in supply in some municipalities for some years, as of 2006 the Ministry of Health was providing each program team with essential drugs.
  - 34 Lemos SM, Crisóstomo M, Caminha C, Bessa VM, Teixeira Leite M. Utilização de diretrizes clínicas e resultados na atenção básica à hipertensão arterial [Use of clinical directives and results in basic care for arterial hypertension]. Cad Saude Publica. 2009;25(9):2001–11. Portuguese.
  - 35 Murray CJL, Dias RH, Kulkarni SC, Lozano R, Stevens G, Ezzati M. Improving the comparability of diabetes mortality statistics in the US and Mexico. Diabetes Care. 2008;31(3):451–8.
  - 36 Elias E, Magajewski F. A atenção primária à saúde no sul de Santa Catarina: uma análise das internações por condições sensíveis à atenção ambulatorial, no período de 1999 a 2004 [Primary health care in the south of Santa Catarina: analysis of admissions for ambulatory care-sensitive conditions, in the 1999–2004 period]. Rev Bras Epidemiol. 2008;11(4):633–47. Portuguese.
  - 37 Henrique F, Calvo MC. Avaliação do Programa Saúde da Família nos municípios do Estado de Santa Catarina, Brasil [Assessment of the Family Health Program in municipalities in Santa Catarina State, Brazil]. Cad Saude Publica. 2008;24(4):809–19. Portuguese.
  - 38 Aquino R, Barreto ML. [The Family Health Program in Brazil and the adequacy of its coverage indicator]. Cad Saude Publica. 2008;24(4):905–14. Portuguese.
  - 39 Ministério da Saúde. Cadastro Nacional de Estabelecimentos de Saúde (CNES) [National roster of health establishments] [Internet]. Brasília: The Ministry; 2010 [cited 2010 Nov 5]. Portuguese. Available from: <http://www2.datasus.gov.br/DATASUS/index.php?area=0204&id=11663>

## ABOUT THE AUTHORS: JAMES MACINKO, INES DOURADO, ROSANA AQUINO, PALMIRA DE FATIMA BONOLO, MARIA FERNANDA LIMA-COSTA, MARIA GUADALUPE MEDINA, EDUARDO MOTA, VENEZA BERENICE DE OLIVEIRA & MARIA APARECIDA TURCI



**James Macinko** is an associate professor at New York University.

A group of US and Brazilian coauthors write in this month's *Health Affairs* about how a major expansion of primary care in Brazil has contributed to reduced hospitalizations for chronic illness. The paper was the result of a collaboration that began in 2005 with meetings organized by the Primary Health Care Unit of the Brazilian Ministry of Health.

The unit sought to stimulate interest in evaluating the government's investment in strengthening primary health care under the nation's Family Health Program. The collaboration that resulted among an international group of experts led to the development and official recognition of a national list of hospitalizations in Brazil that may have been prevented by primary health care.

A half-dozen publications related to the topic followed, as did the involvement of both Brazilian and US students in master's theses and field projects. "Our collaboration required cross-institutional learning that paid off through the establishment of formal ties between universities to increase student and faculty exchanges and develop research and training collaborations," says Macinko, an associate professor of public health and health policy at New York University (NYU) and director of the NYU global master of public health program.

Macinko, who has a doctorate in health and social policy from Johns Hopkins University, was a Fulbright Fellow in Brazil. He was also a Robert Wood Johnson Foundation Health and Society Scholar at the University of Pennsylvania. His research focuses on the impact of health policy reforms, tools to evaluate primary care performance, and the role of health systems in creating or reducing health disparities.



**Inês Dourado** is an associate professor at the Public Health Institute, Federal University of Bahia.

Inês Dourado is an associate professor and a researcher at the Public Health Institute, Federal University of Bahia, in Brazil. She is a physician, with a master of public health degree from the University of Massachusetts, Amherst, and a doctorate in epidemiology from the University of California, Los Angeles. Her current research focuses on the epidemiology of infectious diseases and evaluating control programs.



**Rosana Aquino** is an associate researcher at the Public Health Institute, Federal University of Bahia.

Rosana Aquino has a master of public health degree and a doctoral

degree in epidemiology from the Federal University of Bahia, where she is an associate researcher at the Public Health Institute. She is a physician whose current research focuses on primary health care, policy and program evaluation, and the effectiveness of health promotion interventions.



**Palmira de Fátima Bonolo** is an associate professor at the Federal University of Ouro Preto.

Palmira de Fátima Bonolo is an associate professor of medicine at the Federal University of Ouro Preto, in Brazil. She holds a doctorate in public health from the Federal University of Minas Gerais, in Brazil. She leads a research group in primary health care.



**Maria Fernanda Lima-Costa** is a professor at the Oswaldo Cruz Foundation's René Rachou Research Institute.

Maria Fernanda Lima-Costa is a professor of epidemiology at the René Rachou Research Institute, Oswaldo Cruz Foundation, and an associate professor of epidemiology at the medical school, Federal University of Minas Gerais, both in Belo Horizonte, Brazil. She is a physician and has a master of science degree in clinical medicine and a doctorate in epidemiology

and tropical medicine, all from the Federal University of Minas Gerais. She was a Fulbright Fellow at the Johns Hopkins Bloomberg School of Public Health and a World Health Organization Fellow at the London School of Hygiene and Tropical Medicine.



**Maria Guadalupe Medina** is an associate researcher at the Public Health Institute, Federal University of Bahia.

Maria Guadalupe Medina is an associate researcher at the Public Health Institute, Federal University of Bahia. A physician, she holds master's and doctoral degrees in public health from the Federal University of Bahia. Her current research focuses on primary health care, policy and program evaluation, and evaluation of health promotion interventions.



**Eduardo Mota** is an associate professor and director of the Public Health Institute, Federal University of Bahia.

Eduardo Mota is an associate professor and director of the Public Health Institute, Federal University of Bahia. He also is a physician, and he received a master of public health degree from Harvard University and a doctorate in clinical medicine from the Federal University of Bahia. His teaching has focused on epidemiologic methods; in research, he focuses on health information systems, health policy and program evaluation, and maternal and child health.



**Veneza Berenice de Oliveira** is an associate professor at the Federal University of Minas Gerais.

Veneza Berenice de Oliveira is an associate professor at the medical school of the Federal University of Minas Gerais. She is also a researcher at the Center for Public Health Education (NESCON). She completed her graduate education at the Federal University of Minas Gerais, from which she received a master's degree in demography and a doctoral degree in public health.



**Maria Aparecida Turci** is researcher at NESCON, Federal University of Minas Gerais.

Maria Aparecida Turci is a researcher at NESCON, Federal University of Minas Gerais. She is a dentist, with a master of public health degree from the Federal University of Minas Gerais. She is currently superintendent of health services at the Contagem Municipal Health Secretariat. Her professional experience has been in health services administration and the implementation of primary care-based health systems in several Brazilian cities.