# The Combined Effects of the Expansion of Primary Health Care and Conditional Cash Transfers on Infant Mortality in Brazil, 1998–2010

Frederico C. Guanais, PhD

*Objectives.* I examined the combined effects of access to primary care through the Family Health Program (FHP) and conditional cash transfers from the *Bolsa Familia* Program (BFP) on postneonatal infant mortality (PNIM) in Brazil.

*Methods.* I employed longitudinal ecological analysis using panel data from 4583 Brazilian municipalities from 1998 to 2010, totaling 54 253 observations. I estimated fixed-effects ordinary least squares regressions models with PNIM rate as the dependent variable and FHP, BFP, and their interactions as the main independent variables of interest.

*Results.* The association of higher FHP coverage with lower PNIM became stronger as BFP coverage increased. At the means of all other variables, when BFP coverage was 25%, predicted PNIM was 5.24 (95% confidence interval [CI] = 4.95, 5.53) for FHP coverage = 0% and 3.54 (95% CI = 2.77, 4.31) for FHP coverage = 100%. When BFP coverage was 60%, predicted PNIM was 4.65 (95% CI = 4.36, 4.94) when FHP coverage = 0% and 1.38 (95% CI = 0.88, 1.89) when FHP coverage = 100%.

*Conclusions.* The effect of the FHP depends on the expansion of the BFP. For impoverished, underserved populations, combining supply- and demand-side interventions may be necessary to improve health outcomes. (*Am J Public Health.* 2013;103:2000–2006. doi:10.2105/AJPH.2013.301452)

Income inequality in Brazil is among the highest in the world, and major inequalities of health status across socioeconomic levels are pervasive despite improvements associated with an expansion in health and social programs since the late 1990s.[1,2] In 1988, a newly drafted federal constitution mandated universal access to health care, leading to the creation of the Unified Health System. The main driver of the early implementation of the Unified Health System was expansion of primary health care, mainly through the Family Health Program (FHP) introduced in 1994. Currently, the FHP has 109.3 million registered users (57.3% of the Brazilian population). The program finances primary care services by teams of health professionals composed of physicians, nurses, technicians, and community health agents serving specific catchment areas. Previous studies have found evidence that, between 1990 and 2004, the FHP reduced levels of infant mortality, ambulatory care–sensitive hospitalization, and adult mortality.[3–8]

In 2001, the federal government introduced conditional cash transfer (CCT) programs, which provide cash to poor families if they comply with regular school attendance and growth monitoring. In 2003 CCT programs were overhauled, and the *Bolsa Familia* Program (BFP) was created. Unlike its predecessors, the BFP included a specific health services utilization component: the program required younger children and their mothers to use preventive care services. The expansion of BFP coverage was very rapid; it included 11 million families by 2006 and peaked at 13 million in 2010.

Currently, families enrolled in the BFP receive a monthly cash transfer, averaging US$75.25, and 92% of registered beneficiaries are women. The requirement for participation is uniform across the country and depends on household income per capita and the number and ages of family members. The maximum family income per capita for eligibility is US$70.25 per month. Studies have associated the expansion of the BFP with reduction in poverty and income inequality, positive nutritional outcomes in children, and improvements in school attendance.[9,10] In other countries, similar programs are associated with the increased use of preventive services and improved anthropometric and nutritional outcomes.[11–13]

Previous studies argue that the association between primary health care services on the supply side and CCT programs on the demand side should improve health outcomes.[13,14] Low-income families are likely to experience stronger barriers to access to health care services; however, providing cash and requiring families to use preventive care will probably not improve health status if services are unavailable. Despite theoretical expectations, the relationship between the supply- and demand-side aspects of primary health care has not been sufficiently tested in the literature.

Important decreases in infant mortality in Brazil and expansions of both the FHP and the BFP occurred between 1998 and 2010 (a figure illustrating this trend is available as a supplement to the online version of this article at http://www.ajph.org), but, to my knowledge, no study has examined whether these events are related. Recent official data state that infant mortality fell from 29.7 deaths per 1000 live births in 2000 to 15.6 deaths per 1000 live births in 2010. Most of this reduction is associated with improvements in postneonatal infant mortality (PNIM) rates (infants dying between ages 28 and 364 days), which is likely associated with primary care services.[15]

Infant mortality is an interesting indicator because of the intrinsic importance of the concept it captures and because it correlates with medical care and socioeconomic development. The experience of Brazil provides a unique set of circumstances to test how enhanced access to medical services and expansion of poverty alleviation measures interact in the reduction of infant mortality.

I examined the combined effects of community-based primary health care provided through the FHP and the CCTs the BFP provided for the reduction of the PNIM rate in Brazil from 1998 to 2010. I conducted a longitudinal ecological analysis of publicly available administrative data at the municipal level from 1998 to 2010.

## METHODS

Municipalities are the smallest political and administrative units in Brazil and are responsible for providing primary care. In 2010, the populations of the 5564 municipalities in Brazil ranged from 805 to 11.25 million. I included 4583 municipalities (82.4% of the total) in this study. I excluded 449 municipalities located in the north region because of unavailability of covariate data, as the national household sample survey did not represent the rural population in this area until 2003. I excluded 533 municipalities because of the low quality of vital statistics previous studies reported.[16]

### Data, Data Sources, and Imputation

The main dependent variable in this study is PNIM rate. I studied postneonatal mortality instead of infant mortality because of its higher amenability to primary health care through clinical measures, such as immunizations, control of diarrhea and acute respiratory infections, and provision of basic information to parents.[17,18] Prenatal care consultation per pregnancy was a dependent variable. Mortality and prenatal care consultation data are available from the Ministry of Health. I drew population data from the official census bureau.

The main independent variables were coverage of the FHP and the BFP and their interactions. FHP data are publicly available from the Ministry of Health. I calculated coverage by dividing the number of people registered with a family health team by the number of residents. BFP data are publicly available from the Ministry of Social Development. I calculated coverage by dividing the number of beneficiaries by the number of residents. As a monitoring tool for coverage and access, the Brazilian government routinely uses the annual proportion of population that health programs serve.[19]

I included control variables associated with infant health.[20–22] I calculated fertility rate by dividing the number of annual births by the number (100) of resident women aged 15 to 49 years. I obtained access to clean water, education, and earnings data at the municipal level from the 2000 and 2010 censuses. For 1998, 1999, and 2001–2009, I obtained these 3 variables through an interpolation algorithm derived from the following formula[23]:

$$(1)\quad X_{M,2000+t} = X_{M,2000+t-1} \times e^{\left(\frac{\ln\left(X_{S,2000+t}\right)-\ln\left(X_{S,2000+t-1}\right)}{\ln\left(X_{S,2010}\right)-\ln\left(X_{S,2000}\right)}\right)\times\left(\ln\left(X_{M,2010}\right)-\ln\left(X_{M,2000}\right)\right)},$$

where X is the variable to be interpolated, M is the municipal level, S is the state level, 2000 is the year of the first and 2010 the second of 2 consecutive censuses, and t varies from 1 to 9 for intercensus years.

I drew statistics on hospital beds per capita from the Ministry of Health and statistics on health expenditures by municipal governments from the Ministry of Finance; they are adjusted for inflation with the extended national consumer price index.[24]

### Statistical Analyses

I estimated fixed-effect ordinary least squares regression models at the municipal level covering all years from 1998 to 2010 with the PNIM rate as the dependent variable. I included all variables shown in Table 1 in the models. Results for the Hausman test indicate that the fixed-effects model is a more appropriate specification over random effects.[25] I conducted all analyses with Stata software.[26]

The FHP and the BFP are the main independent variables of interest. I compared PNIM rates in municipalities with different levels of FHP coverage and BFP coverage across time. Considering the universal nature of Brazil's health system, the FHP can serve the poor and nonpoor alike, and this should result in diminishing impacts of coverage on PNIM if the poor are reached first. For this reason, I included a squared term for the FHP in the model. For the BFP, because coverage is focused on the poor, diminishing impacts are less likely and I included only a linear term. Variables constructed from the multiplication of the FHP and the BFP capture interactive effects.

**TABLE 1—Statistics for Brazilian Municipalities Included in the Study Sample: 1998, 2000, 2005, 2010**

| Variables | 1998, Mean (SD) | 2000, Mean (SD) | 2005, Mean (SD) | 2010, Mean (SD) |
|---|---|---|---|---|
| Postneonatal mortality (deaths/1000 live births) | 9.045 (8.771) | 7.392 (6.568) | 5.207 (3.872) | 4.008 (3.112) |
| Prenatal care consultations (consultations/pregnancy) | 3.046 (3.820) | 3.276 (2.549) | 5.362 (2.936) | 6.699 (4.017) |
| Family Health Program (proportion of population covered) | 0.061 (0.148) | 0.138 (0.226) | 0.399 (0.320) | 0.496 (0.327) |
| *Bolsa Familia* Program (proportion of population covered) | 0.000 (0.000) | 0.000 (0.000) | 0.218 (0.156) | 0.254 (0.181) |
| Has access to clean water supply (proportion of population) | 0.788 (0.207) | 0.795 (0.210) | 0.829 (0.194) | 0.849 (0.163) |
| Has primary education or less (proportion of population) | 0.665 (0.131) | 0.635 (0.136) | 0.554 (0.137) | 0.496 (0.127) |
| No regular earnings from employment (proportion of population) | 0.396 (0.136) | 0.341 (0.094) | 0.280 (0.084) | 0.297 (0.086) |
| Fertility rate, aged 15–49 y (no. births/100 women) | 7.089 (1.756) | 6.721 (1.453) | 5.774 (1.478) | 5.161 (0.891) |
| Hospital beds (beds/1000 population) | 3.183 (2.808) | 2.996 (2.611) | 2.607 (1.959) | 2.485 (1.704) |
| Municipal government health expenditures (constant 2010 US$, per capita) | 107.54 (65.30) | 114.81 (132.88) | 142.82 (67.82) | 222.35 (89.80) |

*Note.* The sample size was n = 4583 municipalities.

**TABLE 2—Fixed-Effects Regression Models: Brazil, 1998–2010**

| | Postneonatal Infant Mortality Rate, b (95% CI) | | | | |
|---|---|---|---|---|---|
| Independent Variables | Model 1[a] | Model 2[a] | Model 3[a] | Model 4[a] | Model 5[a,b] |
| FHP coverage (proportion of population) | 1.277*** (-1.760, -0.794) | 2.751*** (1.619, 3.883) | | 1.707** (0.613, 2.801) | 3.326*** (1.988, 4.664) |
| FHP squared | | -4.274*** (-5.333, -3.214) | | -1.246* (-2.364, -0.129) | -1.360* (-2.492, -0.228) |
| BFP coverage (proportion of population) | | | -9.663*** (-10.608, -8.719) | -5.528*** (-7.021, -4.035) | -4.855*** (-6.337, -3.373) |
| Interaction, FHP × BFP | | | | -9.535*** (-14.769, -4.301) | -10.312*** (-15.539, -5.086) |
| Interaction, FHP squared × BFP | | | | 5.249* (0.387, 10.111) | 5.827* (0.961, 10.694) |
| Has access to clean water supply (proportion of population) | -6.748*** (-8.522, -4.975) | -5.968*** (-7.672, -4.264) | -2.565** (-4.239, -0.892) | -2.086* (-3.755, -0.417) | -2.289** (-3.955, -0.623) |
| Has primary education or less (proportion of population) | -9.407** (-15.957, -2.857) | -9.471** (-16.051, -2.891) | -5.700* (-10.793, -0.607) | -5.931* (-11.114, -0.747) | -5.728* (-10.954, -0.501) |
| No regular earnings from employment (proportion of population) | 5.462*** (3.207, 7.716) | 4.736*** (2.557, 6.915) | 1.204 (-0.609, 3.018) | 1.077 (-0.746, 2.899) | 2.344* (0.381, 4.307) |
| Interaction, FHP × no earnings | | | | | -4.843*** (-7.553, -2.133) |
| Fertility rate, aged 15–49 y (births/100 women) | -0.269*** (-0.393, -0.145) | -0.276*** (-0.398, -0.153) | -0.333*** (-0.446, -0.220) | -0.348*** (-0.460, -0.235) | -0.348*** (-0.460, -0.235) |
| Hospital beds (per 1000 population) | -0.049 (-0.108, 0.011) | -0.056 (-0.114, 0.002) | -0.032 (-0.082, 0.018) | -0.038 (-0.088, 0.013) | -0.035 (-0.085, 0.016) |
| Municipal government health expenditure, per capita (in 2010 US$ x 1000) | 1.185 (-0.452, 2.823) | 1.179 (-0.376, 2.733) | 0.665 (-0.394, 1.723) | 0.717 (-0.348, 1.783) | 0.642 (-0.388, 1.672) |
| $R^2$ | 0.3665 | 0.3692 | 0.3868 | 0.3880 | 0.3884 |

*Note.* BFP = *Bolsa Familia* Program; CI = confidence interval; FHP = Family Health Program. Postneonatal infant mortality rate is the dependent variable. The FHP, the FHP squared, the BFP, their interactions, and other covariates are the independent variables (estimated b and 95% CI). The sample size was n = 4583 municipalities (54 253 observations). For all models, municipalities are represented by the subscript i and years are represented by the subscript t, $\alpha_i$ are dummy variables for all but 1 municipality, $\lambda_t$ are dummy variables for all but 1 year, and $\varepsilon_{i,t}$ is a population error term.

[a]All models are fixed-effects ordinary least squares regressions, adjusted for clustering of observations at the municipal level, and observations are weighted by population size. In addition to variables shown on the table, all models included year dummy variables and a constant term, which are not shown because of space limitations.

[b]Full specification of the population model in column 5 is given by the following equation: $PNIM_{i,t} = \beta_0 + \beta_1 fhp_{i,t} + \beta_2\left(fhp^2_{i,t}\right) + \beta_3 bfp_{i,t} + \beta_4\left(fhp_{i,t} \times bfp_{i,t}\right) + \beta_5\left(fhp^2_{i,t} \times bfp_{i,t}\right) + \beta_6 water_{i,t} + \beta_7 educ_{i,t} + \beta_8 noearn_{i,t} + \beta_9 noearn_{i,t} \times fhp_{i,t} + \beta_{10} fert_{i,t} + \beta_{11} beds_{i,t} + \beta_{12} expen_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t}$.

*$P < .05$; **$P < .01$; ***$P < .001$.

The regressions controlled for accepted determinants of child survival, such as access to safe water and level of education, fertility, hospital beds, and health expenditures.[27–29] Municipality dummy variables controlled for all characteristics that are specific to each municipality and that did not change during the period of analysis. I included year dummy variables in all models, controlling for secular trends that affect all municipalities simultaneously.

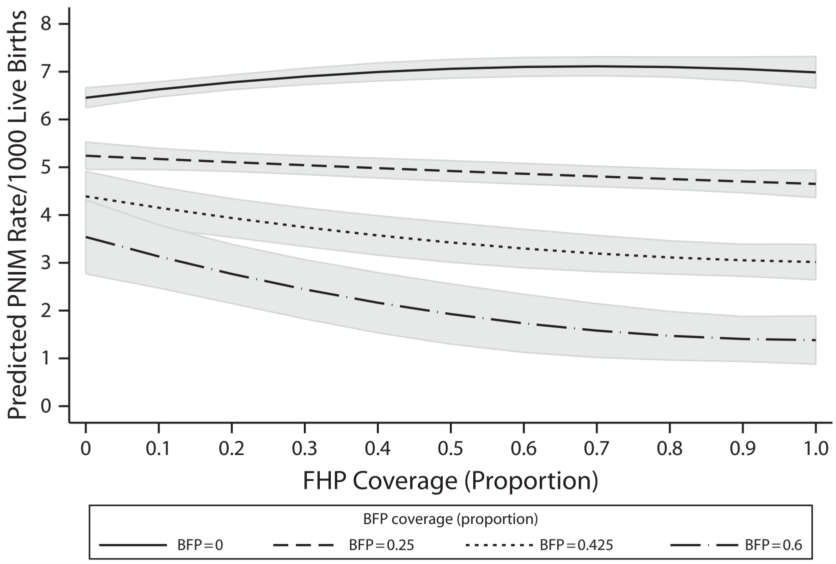
As a follow-up analysis, I stratified the models by region, with both PNIM rate and prenatal consultation rates as dependent variables to assess the use of preventive services associated with the FHP and the BFP and to quantify the heterogeneity of effects across regions.[30–32] I estimated 4 separate regression models for the northeast, southeast, south, and center west regions (I did not include the north region, which does not overlap with the northeast region). According to 2010 census data, the northeast region is the poorest region, where approximately 30% of the population and 60% of Brazil's poor live.

Two additional steps increased the robustness of the analysis. First, I adjusted all models for the clustering of observations at the municipal level, thus correcting for the possibility of serially correlated outcomes in municipalities over time.[33] Second, I adjusted the importance of the observations in the model by population size using Stata's aweight option, which multiplies all variables by the square root of the specified weight.

## RESULTS

Table 1 shows descriptive statistics calculated for the study sample from 1998 to 2010. During this period, the postneonatal mortality rate declined from 9.05 to 4.01 deaths per 1000 live births, average prenatal care consultations rose from 3.05 to 6.70 visits per pregnancy, FHP coverage increased from 6.1% to 49.6%, and BFP coverage reached 25.4%. On average, access to clean water, level of education, and earnings improved, and fertility declined. Other indicators of health services were mixed: hospital beds per capita declined, whereas municipal government health expenditures increased.

Over time, the correlation among the main variables described in Table 1 changed. The




*Note*. BFP = *Bolsa Familia* Program; FHP = Family Health Program. Predictive margins calculated for parameter estimates from model 5. Shaded areas represent 95% confidence intervals.

**FIGURE 1—Predictive margins of postneonatal infant mortality (PNIM) rate by Family Health and *Bolsa Familia* program coverage: Brazil, 1998–2010.**

correlation between PNIM and the FHP decreased from 0.1772 in 1998 ($P<.001$) to 0.0108 in 2010 ($P=.479$); the correlation between PNIM and BFP coverage decreased from 0.3447 in 2003 ($P<.001$) to 0.1149 in 2010 ($P<.001$); the correlation between prenatal care and the FHP increased from 0.1518 in 1998 ($P<.001$) to 0.5210 in 2010 ($P<.001$); and the correlation between prenatal care and BFP coverage increased from 0.2528 in 2003 ($P<.001$) to 0.4658 in 2010 ($P<.001$).

In Table 2, the estimation of fixed-effects regression models for the study sample provides more details about the complex pattern of effects and interactions of the FHP and the BFP on PNIM rate, controlling for covariates of health status. Model 1 indicates that higher levels of FHP coverage were associated with lower PNIM ($b_{FHP}=-1.277$; $P<.001$), whereas the nonlinear specification of model 2 suggests that the effect grew with higher levels of FHP coverage ($b_{FHP}=2.751$; $P<.001$, and $b_{FHP^2}=-4.274$ ; $P<.001$). Model 3 shows that higher coverage of the BFP was also associated with lower PNIM ($b_{BFP}=-9.663$; $P<.001$). When both programs were included in the same equation, as shown in model 4, the effects were partially associated with each program ($b_{FHP}=1.707$; $P<.010$, $b_{FHP^2}=-1.246$ ; $P<.050$, and $b_{BFP}=-5.528$; $P<.001$), and the statistically significant interaction terms suggest program interdependence ($b_{FHP\times BFP}=-9.535$; $P<.001$, and $b_{FHP^2\times BFP}=5.249$ ; $P<.050$). Model 5 includes an interaction between FHP and no earnings from income ($b_{FHP\times no\ earnings}=-4.843$; $P<.001$), which shows an additional association between higher FHP and lower PNIM for poor populations.

Figure 1 provides a better visualization of the results, using the estimated coefficients of model 5 in Table 2. I plotted predictive margins for different levels of coverage of FHP and the BFP associated with PNIM using Stata's MARGINS and MARGINSPLOT commands, and the resulting graph is shown in Figure 1. Because BFP coverage is less than 60% for 95% of the observations, I used this as the upper limit for the BFP range in Figure 1.

Figure 1 shows that, for the period under consideration, reduction of PNIM depended on both the FHP and the BFP: for municipalities with low levels of BFP coverage, the association between FHP coverage and PNIM was weaker; as BFP coverage increased, the association between FHP coverage and lower PNIM became more important. Average trends shown in Figure 1 can be described as follows. At the means of all other variables, for a municipality where BFP coverage was 25%, when the FHP was not present, predicted PNIM was 5.24 (95% confidence interval [CI] = 4.95, 5.53), and when FHP coverage reached 100%, predicted PNIM was 3.54 (95% CI = 2.77, 4.31). For a municipality where BFP coverage was 60%, when FHP coverage was not present, predicted PNIM was 4.65 (95% CI = 4.36, 4.94), and when FHP coverage reached 100%, predicted PNIM was 1.38 (95% CI = 0.88, 1.89).

In Table 3, results show that the northeast region benefited most from the effects of the programs. Both the magnitude of the coefficients and the precision of the estimates were larger for the sample restricted to the northeast compared with the national sample, whereas the functional form did not change considerably.

An additional set of regional regressions was estimated, with prenatal visits per pregnancy as the dependent variable to examine the pathways through which the programs may be generating an impact on health outcomes. The results show that the northeastern region was the only one in which higher FHP coverage, BFP coverage, and their interaction were all significantly associated with higher averages of prenatal visits per pregnancy.

## DISCUSSION

Between 1998 and 2010, the massive expansion of the FHP's primary health care services, CCTs from the BFP, and their interaction were associated with a reduction of PNIM in Brazil. Most of the benefits seem to have been concentrated in the poorest, northeast region of the country. Increases in prenatal consultation rates create a picture consistent with this interpretation. In the northeast, the association between the FHP, the BFP, and an expansion in the usage of prenatal care services was stronger than was the case in other regions.

It is possible that the programs were implemented in places where reductions in PNIM were already occurring. The resulting endogeneity of FHP and BFP variables would weaken the case for causality, but that does not seem to be the case. A previous study analyzed in detail the possible endogeneity between the

**TABLE 3—Fixed-Effects Regression Models: Brazil, 1998–2010**

| Independent Variables | Postneonatal Infant Mortality Rate, b (95% CI) | | | | Prenatal Visits per Pregnancy, b (95% CI) | | | |
|---|---|---|---|---|---|---|---|---|
| | Northeast | Southeast | South | Center West | Northeast | Southeast | South | Center West |
| FHP coverage (proportion of population) | 5.600*** (2.763, 8.437) | 1.529* (0.301, 2.756) | −0.233 (−1.576, 1.110) | 1.674 (−1.303, 4.651) | 2.249*** (1.675, 2.824) | 1.336** (0.512, 2.160) | 1.734*** (1.080, 2.388) | 2.732*** (1.604, 3.859) |
| FHP squared | −4.602** (−7.475, −1.730) | −1.575* (−2.865, −0.286) | −0.139 (−1.648, 1.370) | −1.980 (−4.951, 0.990) | | | | |
| BFP coverage (proportion of population) | −4.547** (−7.384, −1.711) | −2.258 (−4.887, 0.371) | −4.872*** (−7.439, −2.306) | 3.902 (−2.703, 10.507) | 2.541* (0.371, 4.711) | −6.583* (−12.166, −1.000) | −4.615* (−8.184, −1.046) | −5.565 (−13.410, 2.281) |
| Interaction, FHP × BFP | −11.730** (−19.544, −3.916) | −13.261** (−22.609, −3.913) | −11.236* (−21.078, −1.395) | −22.838 (−46.647, 0.971) | 2.393** (0.834, 3.951) | 4.522* (0.920, 8.124) | 5.990*** (3.229, 8.752) | 8.233* (0.113, 16.354) |
| Interaction, FHP squared × BFP | 7.591* (0.579, 14.603) | 11.660** (3.048, 20.273) | 12.945** (3.141, 22.749) | 20.967* (0.853, 41.081) | | | | |
| $R^2$ | 0.4394 | 0.2606 | 0.2388 | 0.3017 | 0.6471 | 0.4565 | 0.5555 | 0.6645 |
| No. observations | 16 450 | 18 808 | 14 286 | 4684 | 16 443 | 18 790 | 14 286 | 4684 |
| No. municipalities | 1480 | 1545 | 1151 | 406 | 1480 | 1545 | 1151 | 406 |

*Note*. BFP = *Bolsa Familia* Program; CI = confidence interval; FHP = Family Health Program. Postneonatal infant mortality or prenatal visits per pregnancy rate are the dependent variables. The FHP, the FHP squared, the BFP, their interactions, and other covariates are the independent variables (estimated b and 95% CI). All models are fixed-effects ordinary least squares regressions adjusted for clustering of observations at the municipal level and weighted by population size. Full specification of population models for PNIM is given by the following equation:

$$\mathrm{PNIM}_{i,t} = \beta_0 + \beta_1 \mathrm{fhp}_{i,t} + \beta_2\left(\mathrm{fhp}_{i,t}^2\right) + \beta_3 \mathrm{bfp}_{i,t} + \beta_4\left(\mathrm{fhp}_{i,t}\times \mathrm{bfp}_{i,t}\right) + \beta_5\left(\mathrm{fhp}_{i,t}^2\times \mathrm{bfp}_{i,t}\right) + \beta_6 \mathrm{water}_{i,t}$$
$$+\beta_7 \mathrm{educ}_{i,t} + \beta_8 \mathrm{noearn}_{i,t} + \beta_9 \mathrm{fert}_{i,t} + \beta_{10} \mathrm{beds}_{i,t} + \beta_{11} \mathrm{expen}_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t}.$$

Full specification of the population models for prenatal visits is given by the following equation:

$$\mathrm{Pren}_{i,t} = \beta_0 + \beta_1 \mathrm{fhp}_{i,t} + \beta_2 \mathrm{bfp}_{i,t} + \beta_3\left(\mathrm{fhp}_{i,t}\times \mathrm{bfp}_{i,t}\right) + \beta_4 \mathrm{water}_{i,t} + \beta_5 \mathrm{educ}_{i,t}$$
$$+\beta_6 \mathrm{noearn}_{i,t} + \beta_7 \mathrm{fert}_{i,t} + \beta_8 \mathrm{beds}_{i,t} + \beta_9 \mathrm{expen}_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t}.$$

For all models, municipalities are represented by the subscript i and years are represented by the subscript t, $\alpha_i$ are dummy variables for all but 1 municipality, $\lambda_t$ are dummy variables for all but 1 year, and $\varepsilon_{i,t}$ is a population error term. Coefficients on year dummies and constant term are not shown.
$^*P < .05$; $^{**}P < .01$; $^{***}P < .001$.

FHP and infant mortality, concluding that there were no such preexisting trends.[3] The BFP expanded very rapidly and reached national coverage in less than 3 years, also suggesting that adoption of the program is not related to preexisting trends in municipalities where the program was implemented.

Previous studies focusing on the 1990s and early 2000s document the effect of the FHP on the reduction of PNIM.[3–8] This study from 1998 to 2010 indicates that the acceleration of the effect of FHP coverage on the reduction of infant mortality in more recent years depended on the expansion of the BFP. These results suggest that the introduction of CCTs in Brazil is an important factor in additional reductions in infant mortality.

The association between higher levels of CCTs with lower infant mortality seems to have worked both through the direct expansion of the BFP and through the interactive effect, which improved the effectiveness of the primary care services the FHP provided. In the first of these 2 pathways, additional income may have contributed to an improvement in social determinants of health, such as daily living conditions.[34] Indeed, estimated results show an association between low income and further reductions in PNIM following expansion of primary health care services. In the second pathway, the conditions of the BFP may have improved the uptake of preventive services the FHP supplied.

Results confirm earlier evidence that the FHP contributed to the reduction of the PNIM rate in Brazil and add new evidence that CCTs from the BFP may have helped to overcome important barriers to some forms of primary health care because of low family income.[35]

## Policy Implications

I have observed programs covering more than 100 million people over 13 years, controlling for change in socioeconomic variables, unobserved fixed characteristics of municipalities, and secular trends. This is the first study, to my knowledge, to examine the combined effect of the scaling up of both a community-based primary health care program and a CCT program and to document the complementarity of the 2 interventions for improved child health outcomes.

The results provide evidence that a combination of supply- and demand-side interventions may be needed to generate a strong impact on health outcomes for impoverished, underserved populations. The analyses of interactions of the 2 programs show that financial incentives are associated with increased use of health services, especially in the poorer regions and for poorer populations. Thus, even when there are high levels of access to primary health care, other determinants of service usage need to be addressed, particularly for populations of lower income.

### Limitations

A limitation in my analysis is the use of ecological data at the municipal level rather than person-level data. It may be that those who the programs under analysis served are not the same people who are experiencing improvements in health status. It may also be that the exclusion of the municipalities in the north region introduces a bias in the results. However, this exclusion is likely to have resulted in an underestimation of the impact of the programs, because the north and northeast regions have the highest poverty rates and are more likely to benefit from expansion of primary health care and CCTs.

I obtained the results of this study from the comparison of municipalities with wide variation in population size. It has been documented that smaller municipalities are more likely to have data limitations because of inadequate reporting.[16] I controlled for this possibility by weighting all regressions by population, which gives more importance to observations from larger municipalities and which I recommend for analyses at the observed means of the data.

From an evaluation viewpoint, some limitations should be noted. The adoption of the programs may have taken place in those municipalities where PNIM was already declining, leading to endogeneity in FHP and BFP variables. It may also be the case that the results are explained by an omitted time-variant characteristic at the municipal level. Average program coverage data may also be hiding important variations, for example, variations in the clinical practices of health professionals at the local level. Therefore, further research is needed with more in-depth data about the characteristics of the health facilities, services, and professionals at the primary care level.

### Conclusions

In the context of reduction of infant mortality in Brazil, although there is important progress in postneonatal deaths, more research is needed on the evolution and determinants on the neonatal side. Early neonatal mortality is closely associated with the quality of hospital services provided at birth and the referral structure for complex cases. Neonatal hospital care is outside the main scope of both the FHP and the BFP, and its provision requires a different set of policies. Studies on the trends of neonatal mortality are needed as inputs for policy design and implementation to ensure continuous improvement of infant health in Brazil.

### About the Author

*Frederico C. Guanais is with the Social Protection and Health Division, Inter-American Development Bank, Washington, DC.*

*Correspondence should be sent to Frederico C. Guanais, PhD, Health Lead Specialist, Inter-American Development Bank, Social Protection and Health Division, 1300 New York Avenue, NW, Mail Stop E-0605, Washington, DC 20577 (e-mail: fredericog@iadb.org). Reprints can be ordered at http://www.ajph.org by clicking the "Reprints" link.*

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### Human Participant Protection

This study was exempt from review because it involved the collection and study of existing, publicly available data in which individuals cannot be identified directly or through identifiers linked to the individuals.

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