Evaluation of the impact of the Family Health Program on infant mortality in Brazil, 1990–2002

James Macinko, Frederico C Guanais, Maria de Fátima Marinho de Souza

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See end of article for authors' affiliations

Correspondence to: Professor J Macinko, Department of Nutrition, Food Studies, and Public Health, New York University, 35 West 4th Street, 12th Floor, New York, NY 10012-1172 USA; james.macinko@nyu.edu

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Objective: To use publicly available secondary data to assess the impact of Brazil's Family Health Program on state level infant mortality rates (IMR) during the 1990s.
Design: Longitudinal ecological analysis using panel data from secondary sources. Analyses controlled for state level measures of access to clean water and sanitation, average income, women's literacy and fertility, physicians and nurses per 10 000 population, and hospital beds per 1000 population. Additional analyses controlled for immunisation coverage and tested interactions between Family Health Program and proportionate mortality from diarrhoea and acute respiratory infections.
Setting: 13 years (1990–2002) of data from 27 Brazilian states.
Main results: From 1990 to 2002 IMR declined from 49.7 to 28.9 per 1000 live births. During the same period average Family Health Program coverage increased from 0% to 36%. A 10% increase in Family Health Program coverage was associated with a 4.5% decrease in IMR, controlling for all other health determinants ($p<0.01$). Access to clean water and hospital beds per 1000 were negatively associated with IMR, while female illiteracy, fertility rates, and mean income were positively associated with IMR. Examination of interactions between Family Health Program coverage and diarrhoea deaths suggests the programme may reduce IMR at least partly through reductions in diarrhoea deaths. Interactions with deaths from acute respiratory infections were ambiguous.
Conclusions: The Family Health Program is associated with reduced IMR, suggesting it is an important, although not unique, contributor to declining infant mortality in Brazil. Existing secondary datasets provide an important tool for evaluation of the effectiveness of health services in Brazil.

The Brazilian unified health system (Sistema Único de Saúde or SUS in Portuguese) was created and structured on the principles of universal coverage and health as a right of all citizens, with an emphasis on decentralisation, equity, community participation, integration, shared financing among the different levels of government, and complementary participation by the private sector.[1,2] It was loosely patterned after the National Health Services of European countries like the United Kingdom.[3] Since 1990, Brazil has undergone considerable health reforms to implement this ambitious vision. The process of decentralisation, in particular, has advanced rapidly within the realm of primary health care.

The Family Health Program (Programa Saúde da Família or PSF in Portuguese) can be considered the main government effort to improve primary health care in Brazil. The PSF provides a broad range of primary health care services delivered by a team composed of one physician, one nurse, a nurse assistant, and (usually) four or more community health workers. In some places, the team also includes dental and social work professionals.[4,5] Each team is assigned to a geographical area and is then responsible for enrolling and monitoring the health status of the population living in this area, providing primary care services, and making referrals to other levels of care as required. Each team is responsible for an average of 3450 and a maximum of 4500 people. Physicians and nurses typically deliver services at health facilities placed within the community, while community agents provide health promotion and education services during household visits. As of 2004, the programme covered about 66 million people—nearly 40% of the entire population.[6]

Despite the considerable investments in the PSF programme to date, there has been little research into the extent to which these innovative features are associated with changes in health status at the national level while adequately controlling for other factors known to affect health.[7–11]

The objective of this study is to use publicly available datasets to evaluate the impact of the PSF on infant mortality over time, while controlling for other health determinants. We examine the period 1990–2002 because it includes three distinct periods: pre-PSF implementation (1990–1994), early PSF development (1995–1998), and late PSF expansion (1999–2002).

METHODS

The unit of analysis is the state. The state was used because reliable ecological data were available for the time period examined, there is a lower likelihood of random fluctuations in mortality and population size than there would be at a smaller level of analysis, and using state level aggregate data can attenuate possible ''crossover'' effects encountered when smaller units of analysis are used for measuring availability of medical care and mortality.[12] Including individual level data on PSF and non-PSF users would be desirable, but there is no existing dataset containing all the necessary variables for each state and year.

Data on infant mortality and other outcomes, PSF coverage (the proportion of the state population served by the PSF programme), and health resources are from the Brazilian Ministry of Health's web site.[13] Data on other health determinants are based on yearly population surveys conducted by the Brazilian Institute of Geography and Statistics

Abbreviations: IMR, infant mortality rate; PSF, Programa Saúde da Família; ARI, acute respiratory infections; VIF, variance inflation factor

Table 1 Mean values for Brazilian States 1990–2002 (n = 27)

Variable	Statistic	Year 1990	1996	2002	Change 1990–2002
Infant mortality rate (per 1000 live births)	mean	49.71	36.22*	28.91†	−20.79‡
	(SD)	(20.32)	(14.90)	(11.36)	
Coverage of Family Health Program (%)	mean	0.00	1.82*	36.06†	36.06‡
	(SD)	–	(3.08)	(17.90)	
Households with access to clean water supply (%)	mean	62.47	75.41*	82.13†	19.66‡
	(SD)	(21.82)	(17.59)	(15.07)	
Households with access to sewerage (%)	mean	39.73	47.57	54.05†	14.32‡
	(SD)	(23.26)	(23.73)	(21.44)	
Income per capita (in constant 2001 R$)	mean	284.26	307.58	323.72	39.46
	(SD)	(134.86)	(114.01)	(124.5)	
Female illiteracy rate (%)	mean	22.11	16.94*	13.60†	−8.51‡
	(SD)	(10.71)	(8.52)	(6.84)	
Fertility (average number children per woman)	mean	3.35	2.75*	2.40†	−0.95‡
	(SD)	(0.84)	(0.54)	(0.49)	
Physicians per 10000 population	mean	0.82	0.97*	1.07†	0.25‡
	(SD)	(0.55)	(0.62)	(0.66)	
Hospital beds per 1000 population	mean	3.06	3.01	2.40†	−0.65‡
	(SD)	(1.00)	(0.81)	(0.55)	
Nurses per 10000 population	mean	2.31	3.01*	4.74†	2.42‡
	(SD)	(2.55)	(2.51)	(2.21)	
Proportionate mortality from diarrhoea (% of all deaths of children under 5 years)	mean	12.27	7.32*	4.83†	−7.44‡
	(SD)	(4.20)	(2.98)	(2.47)	
Proportionate mortality from ARI (% of all deaths of children under 5 years)	mean	9.48	7.44*	5.32†	−3.49‡
	(SD)	(2.50)	(2.13)	(1.57)	
Immunisation coverage (TB)¶ (% of children under 5)	mean	NA	104.68	113.01†	13.27†
	(SD)	–	(14.68)	(8.48)	
Immunisation coverage (measles)¶ (% of children under 5)	mean	NA	76.10	96.59†	20.49†
	(SD)	–	(14.09)	(12.14)	

*Significant difference 1996 compared with 1990 ($p<0.05$). †Significant difference 2002 compared with 1996 ($p<0.05$). ‡Significant difference 2002 compared with 1990 ($p<0.05$). ¶Immunisation coverage may exceed 100%. NA, data not available; ARI, acute respiratory infections.

(IGBE) and developed for state level representativity by the Institute of Applied Economic Research (IPEA).[14 15]

The infant mortality rate (IMR) (expressed as the number of deaths of children under 1 year of age per 1000 live births in the same year) is used as the dependent variable. We use IMR in this study because the improvement of child health is a PSF programme priority. We use estimates of IMR that are adjusted for underreporting of child deaths in some areas of the country.[16 17]

Independent variables known to influence infant mortality include socioeconomic conditions (proportion of the population with access to adequate water supply and adequate sanitation installations, and income per capita in 2001 inflation adjusted Brazilian reais) women's development indicators (proportion of women over 15 who are illiterate, and the average number of children per woman), and health services indicators (physicians and nurses per 10 000 population, and hospital beds per 1000).[18 19]

About 10% of independent variable data were missing for one or two years for some states. Missing data were imputed using linear interpolation from within state time series.[20] Sensitivity tests using dummy variables to represent the pattern of missing values suggested that the they could be treated as missing at random.[21]

Statistical analyses

This study is a longitudinal analysis that uses panel data from all 27 Brazilian federative units (composed of the 26 states and the federal district, Brasília) for every year between 1990 and 2002. The study uses a fixed effects specification to correct for serial correlation of repeated measures and to control for time invariant unobserved or unobservable state characteristics.[22] An alternative approach, the random effects model, was rejected because of results of the Hausman test ($p<0.001$) that tested correlation between the regressors and error terms.[22]

One advantage of the fixed effects model over cross sectional analyses is that it is able to control for unmeasured time invariant characteristics of the state (such as geography, historical disadvantages, or local cultural practices) that might influence health outcomes.[23] We also include a year specific effect to control for unmeasured time variant characteristics such as new developments in technology or changes in national health policies that would affect all states during the period of the study. The disadvantage of the fixed effects approach is that the results obtained are conditional on the data used to estimate them; that is, results cannot be generalised to other years or states not included in the study.[23]

We performed a number of sensitivity tests including using robust (Huber/White/sandwich) standard errors, using Prais-Winsten regression to control for potential heteroskedasticity and AR-1 autocorrelation, and transforming the dependent variable to a logarithmic scale.[24] To control for potential multicollinearity, we transformed explanatory variables with high (over 10) variance inflation factors (VIFs) into dummy variables representing high (over 75th centile) values. The models with transformed models reduced average VIFs to less than six. We also tested models that weighted states by the number of live births. None of these alternative specifications significantly affected the sign, significance, or main conclusions reached with the fixed effects models, suggesting that the results presented here are robust.

To compare how variables changed over time, we calculate the mean values and standard deviations for 1990, 1996, and 2002 as well as the total change for each variable from 1990 to 2002. Differences in mean values between time periods were assessed using *t* tests. Results of regression models are presented as a series of nested models. The *F* test is used to assess whether the inclusion of an additional set of independent variables improved regression models. To compare the magnitude of the effects of the main explanatory variables on IMR, we present their marginal effects. This

Table 2 Results of fixed effects regression models of infant mortality rates for the 27 states of Brazil, 1990–2002

Variable	Model 1	Model 2	Model 3	Model 4
Family Health Program	−0.219**	−0.184**	−0.152**	−0.171**
(% of population)	(0.023)	(0.022)	(0.021)	(0.021)
Water access	–	−0.218**	−0.107**	−0.109**
(% population)	–	(0.039)	(0.04)	(0.040)
Sewerage access	–	0.037	0.038	0.051
(% population)	–	(0.028)	(0.026)	(0.026)
Mean income	–	0.011*	0.018**	0.015**
(in constant R$)	–	(0.005)	(0.005)	(0.005)
Female illiteracy	–	–	0.662**	0.630**
(% women >15 years)	–	–	(0.105)	(0.104)
Fertility	–	–	2.439**	2.378**
(mean number children/woman)	–	–	(0.866)	(0.881)
Physicians	–	–	–	−1.735
(per 10000 population)	–	–	–	(0.527)
Nurses	–	–	–	−0.423
(per 10000 population)	–	–	–	(0.239)
Hospital beds	–	–	–	−1.735**
(per 1000 population)	–	–	–	(0.527)
Constant	49.706**	58.697**	27.037**	35.465**
	(0.531)	(2.633)	(4.788)	(5.306)
Observations	351	351	351	351
Number of states	27	27	27	27
R^2 (within)	0.868	0.882	0.901	0.905
F test (model 2 *v* model 1)	–	12.07**	–	–
F test (model 3 *v* model 2)	–	–	29.46**	–
F test (model 4 *v* model 3)	–	–	–	4.53**

Standard errors in parentheses. Year and state fixed effects not shown. *Significant (p<0.05); **significant (p<0.01).

Table 3 Sensitivity tests for fixed effects regression models of infant mortality rates for the 27 states of Brazil, 1990–2002

	Interaction effects	Immunisation coverage†	Lagged PSF (−1 year)	Stratified by region (N, NE ; S, SE, CW)	
Variable	Model 5	Model 6	Model 7	Model 8‡	Model 9§
Family Health Program	−0.143**	−0.087**	–	−0.142**	−0.047**
(% of population)	(0.021)	(0.014)	–	(0.025)	(0.015)
Family Health Program	–		−0.194**	–	–
(1 year lag)	–		(0.023)	–	–
Access to clean water	−0.103**	−0.114**	−0.116**	−0.097*	0.007
(% population)	(0.039)	(0.040)	(0.040)	(0.042)	(0.034)
Sewerage access	0.038	0.061**	0.059*	0.052	−0.002
(% population)	(0.026)	(0.019)	(0.025)	(0.028)	(0.021)
Mean income	0.012*	0.017**	0.017**	0.003	0.002
(in constant R$)	(0.005)	(0.005)	(0.005)	(0.006)	(0.003)
Female illiteracy	0.545**	0.509**	0.505**	0.385**	0.139
(% women >15 years)	(0.102)	(0.092)	(0.099)	(0.112)	(0.095)
Fertility	1.877*	0.625	2.785**	4.635**	3.718**
(mean number children/woman)	(0.859)	(0.898)	(0.913)	(1.147)	(1.132)
Physicians	−1.886	−0.719	−0.272	−5.966**	1.117
(per 10000 population)	(1.427)	(1.001)	(1.337)	(2.067)	(0.693)
Nurses	−0.422	0.133	−0.327	−0.434	0.523**
(per 10000 population)	(0.232)	(0.207)	(0.229)	(0.307)	(0.119)
Hospital beds	−1.416**	−1.634**	−2.017**	0.006	−0.790*
(per 1000 population)	(0.531)	(0.482)	(0.521)	(0.614)	(0.342)
High diarrhoea mortality	0.993*	–	–	–	–
(⩾10% of child deaths)	(0.471)	–	–	–	–
PSF×diarrhoea interaction	−0.136**	–	–	–	–
	(0.036)	–	–	–	–
High ARI mortality	−1.659**	–	–	–	–
(⩾9% of child deaths)	(0.465)	–	–	–	–
PSF×ARI interaction	0.265	–	–	–	–
	(0.195)	–	–	–	–
Tuberculosis immunisation	–	−0.001	–	–	–
(% of children covered)	–	(0.010)	–	–	–
Measles immunisation	–	−0.008	–	–	–
(% of children covered)	–	(0.010)	–	–	–
Constant	39.859**	35.846**	35.645**	76.133**	38.206**
	(5.201)	(5.531)	(5.316)	(6.583)	(5.297)
Observations	351	225	324	208	143
Number of states	27	27	27	16	11
R^2 (within)	0.913	0.899	0.902	0.944	0.979

Standard errors in parentheses; year and state fixed effects not shown. *Significant (p<0.05); **significant (p<0.01). †Covers the period 1994–2002 only (because of missing immunisation data). ‡Results for the 16 states in the north and north east regions only. §Results for the 11 states in the south, south east, and central west regions only.

Table 4 Marginal effects of main explanatory variables†

Independent variable	Marginal effects: percentage change in infant mortality associated with a 10% increase in the independent variable‡
Family Health Program (% of population covered)	−4.56** (−5.68 to −3.44)
Water access (% population covered)	−2.92** (−5.01 to −0.84)
Hospital beds (per 1000 population)	−1.35** (−2.16 to −0.55)
Female illiteracy (% women >15 years who are illiterate)	16.82** (11.38 to 22.26)
Fertility (mean number children/woman)	1.78** (0.49 to 3.08)
Mean income (in constant R$)	1.11** (0.37 to 1.85)

95% Confidence intervals errors in parentheses. **Significant ($p<0.01$). †Based on final model (model 4 from table 2); non-significant variables and fixed effects not shown. ‡Marginal effects evaluated at the mean of all other independent variables (predicted IMR = 37.441).

statistic represents the percentage change in IMR given a 1% change in the independent variable when all other values set at their mean.[25]

We also assessed several potential pathways by which the PSF might influence IMR. Each of these pathways has a particular limitation so they are presented separately from the main analyses. Firstly, it is possible that reduction in IMR could be attributable to improvements in immunisations independent of the PSF programme, so we test a model that includes childhood immunisation (measles and tuberculosis vaccinations). However, immunisation data are only available after 1995.

Secondly, deaths from diarrhoea and from acute respiratory infections (ARI) are important determinants of IMR in developing countries.[26] To test the impact of PSF expansion on these pathways we created dummy variables representing states in the highest 75th centile of under 5 year old deaths from both of these conditions (called "high diarrhoea deaths" and "high ARI deaths", respectively). We then created interaction terms between these binary variables and PSF coverage to test if PSF expansion was associated with changes in mortality from these conditions.

To assess temporality, we test the PSF variable with a one year lag—that is, we estimate the effect of a previous year's PSF coverage on this year's IMR.

Finally, because there are great differences in economic development, education, and infrastructure between the poorer north and north eastern regions of Brazil, as compared with the south, south east, and central west regions, we present analyses stratified by region (the poorer northern regions compared with the richer southern ones) to test whether the PSF effect might differ between them.

RESULTS

Table 1 presents descriptive statistics. By 2002, the IMR had declined to nearly half its 1990 rate and immunisation coverage reached over 95%. The PSF began expansion in the mid-1990s and covered more than a third of the Brazilian population by 2002. Child deaths from diarrhoea in 2002 were only a third of the 1990 rate, and deaths from acute respiratory infections were halved during the same period. Overall socioeconomic conditions also improved, although by 2002 barely 50% of the population had access to modern sewerage systems. Average income fluctuated each year and there was no significant increase over time. There was considerable progress in women's development: female illiteracy declined by a third, as did the average number of children per woman. Absolute rates of illiteracy are still high at 13%. In terms of health inputs, physicians and nurses increased significantly, while the average number of hospital beds declined slightly.

Table 2 presents the results of the fixed effects analyses. Model 1 shows the bivariate relation between PSF and IMR: the larger the proportion of the state's population served by the PSF, the lower the expected IMR. Model 2 adds socioeconomic covariates to model 1. PSF coverage remains significant and negatively associated with IMR. In terms of covariates, access to water is negatively associated with IMR, while income is positively associated with it. Sewerage is not significant. The *F* test is statistically significant suggesting that addition of these covariates improves the explanatory power of model 2 over model 1.

Model 3 adds a set of variables related to women's health. Both female illiteracy and fertility rates are positively associated with infant mortality. The PSF coefficient remains significant and negative, and socioeconomic variables remain stable. Based on the results of the *F* test, model 3 is considered superior to the previous models.

Model 4 includes health system covariates. Physician and nurse supply are not significantly associated with IMR, but hospital beds per 1000 is associated. There is no change in any other covariate and PSF remains similar in magnitude, direction, and statistical significance. Results of the *F* test show that model 4 is superior to any previous models. The R^2 is 0.90 suggesting that the model explains up to 90% of the within state variation in IMR.

Table 3 presents sensitivity tests that further explore the relation between PSF and IMR at the state level. Model 5 tests the interaction terms between PSF coverage and states with high proportionate mortality from diarrhoea and ARI. The coefficient for high diarrhoea mortality is positive and significant, suggesting that states with higher proportionate mortality from diarrhoea also have higher IMR. The interaction variable for PSF×diarrhoea is significant and negative suggesting that as PSF coverage increases, the contribution of diarrhoea to infant mortality decreases. The results for ARI present a different pattern: states with a higher proportion of deaths from ARI also have lower IMR and the interaction between PSF coverage and ARI was not significant.

What is already known about the topic

There is evidence that comprehensive primary health care services can have a significant impact on improving child health, but most of this evidence does not assess longitudinal trends at the national level.

Model 6 tests the extent to which immunisation coverage contributes to lower IMR. The results show that increased vaccination coverage for BCG and for measles is not associated with IMR at the state level. The inclusion of immunisation rates into the model did not change the direction or significance of the PSF variable.

Model 7 tests a one year lagged PSF variable to assess whether a prior year's expansion in PSF coverage affects IMR in the following year. The lagged PSF variable is negative and significant and of a slightly higher magnitude than the contemporaneous PSF variable, suggesting a temporal relation between PSF coverage and reductions in IMR.

Models 8 and 9 present analyses stratified by geographical region. In model 9 (north), PSF coverage, access to clean water, and physicians per capita were associated with lower IMR, whereas female literacy and fertility has a positive association. In model 10 (south), PSF coverage and hospital beds were associated with lower IMR, while nurses per capita were associated with higher IMR.

Table 4 presents the marginal effects of the main explanatory variables included in the final model (model 4 in table 2). Marginal effects have been multiplied by 10 to give a measure of the percentage change in infant mortality associated with a 10% increase in the independent variable. Controlling for all other covariates, a 10% increase in PSF coverage was associated, on average, with a 4.6% decrease in IMR. Improving water access by 10% was associated with a 3% reduction, and increasing hospital beds only a 1.35% reduction. Female illiteracy was the most important determinant of infant mortality: decreasing female illiteracy by 10% could reduce IMR by a greater amount than all other variables combined. Higher fertility and income per capita had a modest, positive association with IMR.

DISCUSSION

The analyses presented here suggest that PSF coverage is independently associated with reductions in IMR: an increase in PSF coverage by 10% was associated with an average 4.6% decrease in IMR, controlling for other health determinants. Previous studies have emphasised the role of water supply, living conditions, and women's education on improving child health outcomes in Brazil.[27 28] Our results confirm these findings, but suggest that expansion of the PSF programme adds an important complementary explanation for the decrease in infant mortality in Brazil seen since the programme began in the mid-1990s.

Previous studies found no significant association between availability of physicians and reductions in child mortality, a result confirmed by our analyses. This finding could be in part because the number of physicians per capita is not necessarily associated with increased provision of primary health care. Most physicians in Brazil are specialty trained and thus provide services to a more limited population than would a primary care provider.[29] The finding of no relation between nurses and IMR reductions was not expected given

What this study adds

- This is the first study to assess the impact of Brazil's Family Health Program on infant mortality at the national level.
- The main determinants of infant mortality in Brazil include: primary care and hospital bed availability, clean water, income, women's literacy, and fertility.
- Family Health Program coverage was a significant contributor to improvements in infant mortality rates.

Policy implications

- A broad based approach to improving child health, with primary health care at its core, can make considerable improvements in health outcomes.
- Publicly available secondary datasets could be used more fully in Brazil to asses the effectiveness of public policies at the national and state levels.

that nurses are increasingly being deployed in primary care settings, and are the clinical backbone of the PSF.[9] One explanation is that the PSF effect could be related more to how health workers are deployed (that is, as a community based, integrated, multifunctional team) rather than the total number of health workers providing care.

The result that availability of hospital beds was associated with lower IMR is consistent with the fact that an important component of IMR is neonatal mortality (mortality within the first month of life); an outcome strongly influenced by the availability and quality of care during and after delivery, special care for low birthweight babies, and some aspects of prenatal care.[30] The other component of IMR, post-neonatal mortality, is more strongly associated with preventive and primary care such as breast feeding, oral rehydration therapy, immunisations, and treatment of respiratory and other infections.[31] Neonatal mortality has been linked to increased pre-term and low birthweight births and has become a more significant contributor to IMR in Brazil as post-neonatal mortality declined.[32 33] The PSF would be expected to have a direct influence on post-neonatal mortality, as well as indirect effect on neonatal mortality through promotion of maternal health and nutrition, initiation of prenatal care, and identification and referral of potentially high risk births to specialists.[34]

The finding of a positive association between income and IMR is surprising given the importance of socioeconomic development to improvements in IMR. In the case of Brazil, the observed relation probably reflects an increase in income inequalities, which are associated with higher child mortality.[35 36]

In the region stratified analyses, the effect of the PSF is reduced for the more developed south, south east and central west regions where IMR has been lower relative to the north and north east. The PSF variable is nevertheless negative and significant for both regions. Interestingly, physician supply became a significant predictor of lower IMR in the north and north east, probably reflecting the shortage of physicians in this area: physicians per 10 000 averaged 2.6 in the north region compared with 10.6 in the south east.[9]

This study explored several pathways through which the PSF might influence child health. The first of these is through reduction of deaths attributable to diarrhoea. The results of the interaction terms suggest that as PSF coverage increases, the contribution of diarrhoea deaths to IMR tends to decrease, suggesting one potential mechanism of PSF action.

The results from the ARI variables are more complex. The interaction term is not significant, but the dummy variable for "high ARI mortality" was significant and negative, suggesting that higher ARI mortality was associated with lower IMR. It may be that ARI deaths happen more frequently in children older than 1 year; we might have found a positive relation with the PSF if our outcome variable had been under 5 mortality rather than IMR. Regional differences may also help to explain this finding. An examination of the data by state shows that diarrhoea was persistently a larger problem in the north and north eastern parts of the country, while ARI seems to have been a larger problem in south, south east and central western regions in early and mid-late 1990s (where IMR was lower overall). But then in the late 1990s the proportion of ARI deaths declined rapidly in the south and overall rates became similar for both regions. This heterogeneous trend may not have been accurately captured in the regression analyses.

The fact that immunisation rates were not significant predictors of IMR was expected given the already high levels of coverage (over 90%) in most states.

Limitations

Because this study was carried out using ecological measures, we could not directly test whether the reductions in IMR occurred within families that visited the Family Health Program; to make that claim would be to commit an ecological fallacy. We believe there is a plausible causal chain linking PSF participation with better child health. There is evidence that Family Health Program clients regularly receive health education about breast feeding, use of oral rehydration therapy, immunisation, and infant growth monitoring.[7] There is also evidence that the PSF can provide quality primary care that is comprehensive, family oriented, longitudinal, and community oriented.[37] In a study of the PSF in eight large urban centres, more than three quarters of clients interviewed believed that child health services were of good quality and that the PSF was responsible for improvements in the health of the neighbourhood and their family.[7] Participation in the PSF programme within these large municipalities was associated with improved immunisation rates, breast feeding rates, and maternal management of diarrhoea and respiratory infections.[38] Preliminary evidence suggests that the PSF programme decreases financial barriers to access.[39] Finally, several studies have shown that in areas where the PSF or similar programmes have been implemented, infant mortality has actually declined.[11 40]

Although the results presented here seem to be robust to a number of different specifications, several limitations merit discussion.

Firstly, ecological analyses are prone to omitted variable problems. That is, there could be some latent, unmeasured variable (such as malnutrition) that is confounding the apparent relation between PSF and IMR. In this case, the existence of such a variable is unlikely given that we used a full model of health determinants, included state fixed effects to control for time invariant unobserved characteristics of states, included year fixed effects to control for unobserved factors that affect all states in each given year, and tested several pathways and alternative explanations. The high R^2 values of the regression models suggest that they do a good job explaining the variation in IMR.

Secondly, the implementation of the PSF can differ greatly from municipality to municipality and the programme itself has evolved over time. PSF expansion has not necessarily occurred in the most deprived municipalities and the distribution of PSF coverage is not uniform within states.[43] External factors, such as the availability of pharmaceuticals or access to needed specialty or hospital care can also undermine potential health gains derived from this model of primary care delivery.[41 42] Our study could not control for these limitations.

Conclusions

This study has shown the use of ecological analyses using publicly available secondary data for the evaluation of public health programmes. Despite the limitations presented by these analyses, they have the benefit of providing timely, policy relevant information on the performance of the Family Health Program at the national level. The results showed that PSF expansion, along with other socioeconomic developments, were consistently associated with reductions in infant mortality. The policy implication is that a broad based approach to improving child health, with primary health care at its core, can make considerable improvements in outcomes. To more fully inform policy, future studies should assess the cost effectiveness of PSF expansion, its impact on adult health and equity, and estimate impacts at other levels of analysis (for example, municipal and individual levels).

Authors' affiliations

J Macinko, Department of Nutrition, Food Studies, and Public Health, New York University, USA
F C Guanais, Robert F Wagner Graduate School of Public Service, New York University
M Marinho de Souza, Faculty of Medicine, University of São Paulo and University of Cuiabá; Secretariat of Health Surveillance, Ministry of Health of Brazil

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APHORISM OF THE MONTH

No evidence of proof is not evidence of no proof

This simple fact can be of major significance in risk communication, as evidenced in the BSE saga. Public health practitioners spend a lot of time communicating to each other through journals such as this, but do we spend enough time getting the messages right to empower the public to deal with the risks of every day life?

JRA