DOI: 10.1590/1413-81232018242.04782017

Bolsa Família Programme and the reduction of child mortality in the municipalities of the Brazilian semiarid region

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Abstract *In 2003, the Brazilian federal government launched the Bolsa Família Programme (Programa Bolsa Família - PBF), a widespread conditional cash transfer to poor households when they comply with conditions related to health and education. A longitudinal ecological study using panel data from 1,133 municipalities of the Brazilian semiarid region was performed. The main goal was to assess the effect of the PBF on child mortality (CM) in the semiarid region of Brazil during the period of 2004-2010. Associations were estimated using a multivariate linear regression for the panel data with fixed effects. The child mortality rate (CMR) was considered the dependent variable, adjusted for relevant social and demographic covariates, and for the effect of the largest primary healthcare scheme in the country through the Family Health Strategy (FHS). The PBF and the FHS played significant roles in reducing CM, increasing prenatal consultations, reducing illiteracy rates, lowering fertility levels, and decreasing the number of individuals living in households with inadequate access to water supplies and sanitation. In conclusion, the PBF had a positive impact on reducing CM levels; its impact was boosted by the intervention of other social and demographic factors.*

Key words *Child mortality, Cash transfer programme, Brazilian semiarid*

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Introduction

Income inequality in Brazil is among the highest in the world[1]. To overcome this situation, conditional cash transfer programmes have been created with the purpose of crediting federal government monetary values to poor families, provided that the parents or guardians comply with certain specific conditions, usually with a focus on health, education, and social welfare[2-4].

The Bolsa Família Programme (Programa Bolsa Família - PBF), created in Brazil in 2003, is one of the largest in terms of conditional cash transfers in the world and reached high coverage over the last decade as a programme of the social and popular safety network. All 5,565 Brazilian municipalities were reached, and approximately 13.4 million families were registered by 2011. The PBF is intended for extremely poor families, families considered poor with children, young people up to the age of 17, and pregnant and lactating women.

The semiarid region is one of the largest beneficiaries of the PBF in Brazil and is the largest in the world in terms of area (982,563.3 km²) and population density (23.06 inhabitants/km^2) with 22 million people in 2010. It is composed of nine states, including 1,133 municipalities, and is considered the least developed region in the country because it is affected by serious social and economic problems[5].

Studies have associated the expansion of the PBF with the reduction of poverty and income inequality; additionally, a set of factors related to the biological condition of the child and the mother, the environmental conditions and the social relations that organize the life of the people are associated with PBF expansion. These studies have provided evidence that cash transfer programmes, such as the PBF, favour the increased use of preventive health services and consequently reduce the levels of illness and death among children. Thus, they reduce social and regional inequalities and lead to a convergence of these levels in the regions[1,6,7].

In this context, child mortality (CM), which is an important indicator of child health, stands out as one of the main problems faced by the government, particularly in regions such as the Brazilian semiarid.

In Brazil, the reduction in CM has intensified since 1960, when the child mortality rate (CMR) was 117.0/1,000 live births. Since then, the CMR has decreased to 50.2/1,000 live births in 1980 and to 16.7/1,000 live births in 2010[8]. However, Brazil has much work to do to reach the levels of the most developed regions in the world, with rates of approximately five deaths of children under one year of age per 1,000 live births, as recommended by the World Health Organization (WHO)[9].

Only three studies in Brazil have analysed the consequences of PBF interventions on CM, but none of them focused on the semiarid region[1,6,7]. Given this context, the present study considers the need to understand the processes that regulate the reduction of CM levels and the lack of studies related to the subject, with the main objective of evaluating the effects of the Bolsa Família Programme on CMRs of the Brazilian semiarid region in the period of 2004-2010.

Methods

Data and data sources

This longitudinal ecological study utilized the microdata of the 1,133 municipalities of the Brazilian semiarid region. A longitudinal database for the years 2004 to 2010 was created using Stata software version 12.0, which was used for data processing and analysis.

The CMR was defined as the dependent variable of the study. Although there are restrictions related to the reliability of CM estimates obtained from the Atlas of Human Development in Brazil, which was developed in partnership with the João Pinheiro Foundation (Fundação João Pinheiro - FJP), the Institute of Applied Economic Research (Instituto de Pesquisa Econômica Aplicada - IPEA) and the United Nations Development Program (UNDP), they were considered a satisfactory proxy of their levels for municipalities. For these institutions, the indicator cannot be calculated directly from the data of the Demographic Census, and indirect techniques are used to obtain it because most of the municipalities in the semiarid region do not have reliable vital statistics. For this purpose, the mortality pattern of the state to which the municipalities surveyed belonged was adopted to obtain levels of CM[10,11].

The main independent variable was the PBF coverage. For this purpose, the databases of the Ministry of Social and Agrarian Development[12] were used. PBF coverage was obtained from the quotient between the number of beneficiaries and the number of residents in the municipality.

The other independent selected variables were based on the literature, particularly those

describing significant relationships with CM[1,6,7]. Based on data from the Ministry of Health, coverage of the Family Health Strategy (FHS) and prenatal consultations (percentage of pregnant women who had 7 or more doctor visits) were obtained[13,14]. Through the Atlas of Human Development in Brazil, the following socioeconomic variables were accessed: total fertility rate (TFR); illiteracy rate (15 years or older); percentage of people with inadequate water supply and sewage; activity rate; and percentage of the urban population[10,11].

Because some information was obtained from the databases of the Demographic Censuses of 2000 and 2010, the annual values from 2004 to 2009 were calculated by linear interpolation, which is considered the simplest among interpolation methods. This method consists of the interconnection between consecutive values, by a straight line, obtained by a polynomial function (1st degree polynomial). There are other methods of interpolation, and the choice depends on the adequacy to the data: quadratic (2nd degree polynomial), Lagrange (nth degree polynomial)[15] and segmented interpolation – useful when the function to be interpolated has derivatives of high numerical value in some region of the interpolation interval[16].

Preliminary checks suggested that the most appropriate alternative to the expected increase or decrease rates of the variables was the linear interpolation method. Thus, this method was adopted for the variables CMR, TFR, illiteracy rate (15 years or older), percentage of people with inadequate water supply and sanitary sewage, activity rate and percentage of urban population.

Because a database with secondary data was used, which is freely accessible online, the absence of a study approval request to the Research Ethics Committee is justified.

Statistical analysis

After adjustment of the model, the stepwise process was used with $p < 0.05$ to select the independent variables to compose the final model. At this stage, the variables that were not significant were eliminated from the study, namely, activity rate and percentage of the urban population.

For the analysis of the association of CMR with the selected variables and to obtain the final model, a multiple linear regression for panel data was used. Once the Hausman specification test was performed to select the appropriate model, fixed or random effects, the former model was chosen. The models with fixed effects for panel data, in addition to the error term, include a second term to control unobserved time-invariant characteristics, such as sociocultural, historical and geographical characteristics of each municipality. These models have been well established in the literature and allow correlations between the time-invariant term and the independent variables of the model, becoming, in general, more robust for the analysis of the impact of interventions[17].

Results

Table 1 shows the descriptive statistics (minimum, maximum, mean, median and standard deviation) for the municipalities of the Brazilian semi-arid region for the selected indicators (2004 and 2010). The mean and median of the indicators presents the annual variation during the study period.

In 2010, the highest CMR (45.4/1,000 live births) was found in the municipality of Olivença in the state of Alagoas, whereas in 2004, the highest CMR was that of the Jucati municipality in Pernambuco. On average, for all municipalities, the CMR decreased by 13.3/1,000 live births during the six-year period, corresponding to a mean annual reduction of approximately 2.2/1,000 live births. The standard deviation of this indicator also decreased, demonstrating a lower level dispersion.

The average coverage of the PBF in the municipalities increased from 38.1% (2004) to 54.3% (2010). The municipality of Capitão Gervásio Oliveira, in the state of Piauí, presented the highest PBF coverage (84.4%) in 2004. In 2010, the highest coverage was observed for the municipality of Guaribas in Piauí. Meanwhile, the mean FHS coverage in municipalities reached 70.4% in 2004 and 91.3% in 2010. Universal coverage (100%) in the semiarid region was achieved in 440 out of 1,133 municipalities in 2004 and in 768 municipalities (approximately 68%) in 2010.

The average coverage for prenatal consultations increased from 31.3% (2004) to 50.6% (2010). In 2004, the municipality of Berilo, in the state of Minas Gerais, reached the highest coverage (94.80%). In 2010, the highest coverage (98.18%) was reached in the municipality of Itaiçaba in the state of Ceará.

The mean TFR ranged from 2.8 to 2.2 during the years 2004 and 2010. In 2004, the lowest TFR (1.9) was observed for the municipality of São

Table 1. Descriptive statistics for the municipalities of the Brazilian semiarid region, according to selected indicators, 2004 and 2010.

Indicators	Minimum		Maximum		Mean		Median		Standard deviation	
	2004	2010	2004	2010	2004	2010	2004	2010	2004	2010
Child mortality rate (‰)	18.9	13.4	74.3	45.4	39.6	26.3	39.0	25.2	7.8	5.6
Coverage of PBFa (%)	0.3	24.3	84.4	84.6	38.1	54.3	38.3	54.1	10.4	8.8
FHSb coverage (%)	0.0	0.0	100.0	100.0	70.4	91.3	86.3	100.0	34.9	17.1
Pre-natal consultationsc (%)	2.5	6.5	94.8	98.2	31.3	50.6	28.2	50.0	16.7	17.8
Total fertility rate	1.9	1.4	5.0	3.7	2.8	2.2	2.7	2.2	0.4	0.3
Illiteracy rate (≥ 15 years)d (%)	11.9	9.1	50.6	44.4	32.8	27.8	32.7	27.7	6.4	5.8
Inadequate water supply/sewagee (%)	0.0	0.0	63.7	66.5	18.8	17.1	16.0	14.5	12.2	12.2

Source of basic data: United Nations Development Program (UNDP), Ministry of Social and Agrarian Development (Ministério do Desenvolvimento Social e Agrário - MDSA) and Ministry of Health (MH).

[a]Coverage of the Bolsa Família Programme; [b]Coverage of the Family Health Strategy; [c]Coverage of the number of prenatal consultations; dIlliteracy rate - 15 years or more; [e]Percentage of people with inadequate water supply and sewage.

João do Jaguaribe in the state of Ceará, and the highest (4.9) was observed in Canapi, state of Alagoas, corresponding to a total amplitude of 3 children on average per woman in the reproductive period within the semiarid region. In 2010, the municipality of Triunfo, in Pernambuco state, presented the lowest (1.4) TFR value, whereas the highest (3.7) occurred in the municipality of Pureza, in Rio Grande do Norte state. The total amplitude was reduced to an average of 2.3 children per woman in 2010.

The average value of the illiteracy rate (15 years or older) decreased from 32.8% in 2004 to 27.8% in 2010. The municipality of Feira de Santana, in the state of Bahia, had the lowest illiteracy rate in 2004 (11.9%), which further decreased to 9.1% in 2010. The highest illiteracy rate was reported in the municipality of Casserengue, in Paraíba state, at 50.6% in 2004, and in the municipality of Alagoinha do Piauí, in 2010, at 44.4%. The average percentage of individuals living in households with inadequate access to water and sanitation decreased from 18.8% (2004) to 17.1% (2010). In 2004, the highest value (63.7%) for the indicator was found in the municipality of Vertente do Lério in the state of Pernambuco. In 2010, the municipality of Santa Cecília, in Paraíba state, occupied this position with 66.5%.

The multiple linear regression model (Table 2) provides the effects of government programmes (PBF and FHS) on CM, controlled for sociodemographic and health covariates. According to the Hausman test, the models with random effects (H_0) were rejected, that is, the fixed-effect model better explained the variations in CMR.

The modelling revealed that all the indicators shown in Table 2 were significant at the $p \leq 0.03$ level, and most were significant at $p < 0.001$. Both PBF and FHS showed a significant negative association with CMRs. Similarly, a significant association with prenatal consultations was observed. However, there was a significant positive association with the illiteracy rate, people with inadequate water supply and sewage and the fertility rate. A square term for FHS was included in the model (Table 2) because the universal coverage of the Brazilian health system includes people of all income levels without distinction, and this results in a reduction of coverage effects on the CMR if poor people are affected first.

Discussion

CMR levels have declined over the study period for all municipalities in the semiarid region, but they are still considered high by international standards. The lowest value observed in 2010 was not lower than two digits (13.4) per 1,000 births, as recommended by the WHO, but it should be highlighted that CMRs decreased in all the municipalities during the study period[9]. The lower standard deviation of the values in relation to the average suggests a trend of homogenization of levels throughout the semiarid region. In fact, this is an expected trend when there is room for reduction, but it is important to note that this occurred in a short time because it was in the semiarid municipalities.

PBF coverage increased sharply. By the end of 2010, the PBF had exceeded the pre-set coverage

Table 2. Fixed-effects regression model for the association between the child mortality rate and selected indicators for the municipalities of the Brazilian semiarid, 2004-2010.

Indicators	Model		
	Coefficient	IC (95%)	P-value
PBF coverage (%)	-0.034	-0.041 -0.027	0.001
FHS coverage (%)	-0.012	-0.023 -0.002	0.020
Prenatal consultations (%)	-0.025	-0.030 -0.020	0.001
Total fertility rate	4.224	3.793 4.655	0.001
Illiteracy rate (≥15 years)	1.803	1.751 1.856	0.001
Inadequate water supply/sewage (%)	1.029	0.012 0.047	0.001
FHS2	0.001	0.000 0.001	0.026
R^2 (*within*)		0.832	

Source of basic data: Programa das Nações das Unidas para o Desenvolvimento (PNUD), Ministério do Desenvolvimento Social e Agrário (MDSA) e Ministério da Saúde (MS).

target of 11 million Brazilian families (48,441,100 people) by more than two million; in fact, the coverage target had already been reached by 2006[12]. The PBF conditions of the PBF encourage families to seek preventive health care for the most vulnerable groups, with important effects on the health of pregnant women and children. Therefore, the PBF relied on existing service networks for its support, such as the FHS, to comply with beneficiaries' health conditions. In 2010, the FHS had reached universality (100%) for most of the municipalities of the Brazilian semiarid region. Nevertheless, some municipalities had a coverage of 0.0%, but one cannot fail to observe a significant improvement in this indicator. The average coverage of the FHS in municipalities has increased continuously, reaching 70.4% in 2004 and 91.3% in 2010.

The linear regression model with fixed effects revealed a negative and statistically significant association between BPM and the CMR for the Brazilian semiarid region. Thus, it corroborated some results of previously published studies[1,6,7]. Some positive impacts on children's health can be credited to compliance with the conditions imposed on PBF beneficiaries. At least once every six months, children under the age of seven years must receive medical care focused on the prevention, detection and combat of diseases that occur during early childhood: malnutrition, diarrhoea, anaemia and weight incompatible with height[18].

By maintaining the coverage of the PBF and the FHS, it is possible that the reduction in the CMR will continue; however, until reaching the levels of more advanced countries such as Japan and Sweden, at approximately 2 ‰, there remains considerable room to improve. Thus, programmes such as Bolsa Família are still capable of making a difference in maintaining the reduction of CM in Brazil and particularly in regions such as the semiarid region. Paes-Sousa et al.[19] studied municipalities of the Brazilian semiarid region and confirmed that the beneficiary families of the PBF prioritize the purchase of food for children to comply with conditions of the programme. Nutritional care is essential for the prevention of numerous diseases that can lead to child death, among them, malnutrition[1,20-23].

The statistical evidence showed the importance motivated by public actions, such as the PBF, which aims to combat two major problems in the country: poverty and high levels of CM. Constant government interventions, including measures that minimize the income gap experienced by the population, are important allies in combating CM. In addition, it is essential that the income of the people increases and that a better distribution of income exists.

Given the importance of BFG in reducing CM, some points should be considered. Managers must examine the adequacy of health infrastructure in municipalities to conditional cash transfer programmes because programme expansion depends on the availability of services offered by health systems, due to the imposition of conditions on beneficiaries. The use of public social services depends on the country's ability to meet the demand[19].

There is a belief that the beneficiary families of the PBF would have more children; however, this belief is not confirmed by some authors[19,24,25]. Evidence shows that women beneficiaries of PBF increased their use of contraceptive methods, which would contribute to the decline of fertil-

ity[24]. The mean and median TFR demographic indicators showed a rapid decline in the period. The mean value for 2010 (2.2) was very close to the level of population replacement, set at 2.1. Some municipalities in the semiarid region reached a TFR equivalent to those of São Paulo (1.66), Rio de Janeiro (1.68) and Santa Catarina (1.71) states. The municipalities of Triunfo and Frei Miguelinho, both in the state of Pernambuco (1.4), and Brumado in Bahia state (1.5), for example, already presented levels below the replacement rate and were comparable with the TFR of developed countries such as Italy (1.4), Japan (1.4) and Spain (1.5).

Social and health conditions of the population improved during the study period (2004-2010) in the region when the decreases in illiteracy rates and the percentage of people with inadequate water supply and sewage were considered. The advance in education can be highlighted as a fundamental tool to help reduce poverty and income inequality, which affects a significant percentage of individuals living in the semiarid region of Brazil, assuming that this condition is transmitted from generation to generation.

In recent decades, advances have been observed in studies investigating the relationships between how a society is organized and developed and the health situation of its population[26,27]. It is complex to list the elements that are capable of certifying whether health will be achieved[28]. Carvalho[29] states that economic and social conditions decisively influence the health conditions of people and populations.

For Buss and Pellegrini Filho[27], the Social Determinants of Health (SDH) can be investigated by analysing the relationships between population health, inequalities in living conditions and the degree of development of the network of connections and associations between individuals and groups. The fight against health disparities requires governments to act on SDH[30,31], stressing the impact that health and social support systems can produce, particularly in contexts of persistent social inequality in areas such as the Brazilian semiarid region[32,33].

In 2006, the National Commission on Social Determinants of Health (Comissão Nacional sobre Determinantes Sociais da Saúde - CNDSS) was created in Brazil. The CNDSS is a reflection of the worldwide movement around the SDH organized by the WHO, which in 2005 created the Commission on Social Determinants of Health[27]. In 2011, the World Conference on SDH was held in Brazil and contributed to emphasize the importance of the discussions and the fight against social inequities on the health of the Brazilian population.

The R^2 (within) of the fixed effects model was considered satisfactory and was explained by 83.2% of the internal association between the covariates and the CMR. With government interventions against social and economic inequality implemented in Brazil on a large scale in the same period (2004 to 2010) and in the same areas, particularly in the semiarid region, it is opportune to explore the joint effects. In this sense, it is worth highlighting the importance of using panel data to evaluate the association between government programmes and health as an alternative to the use of classic cross-sectional data. In this way, causal inference obtains stronger evidence when panel data are used in relation to transverse data[17].

Conclusion

Because the PBF establishes conditions that are the responsibility of programmes such as the FHS, it depends greatly on those programmes for its success. Thus, the cash transfer programme (PBF) and the guarantee of access to public health services (FHS) by the population played a significant role in the reduction of CM, which was a result of the increased coverage of both programmes. Government interventions, increased coverage of prenatal consultations and reduced fertility levels have contributed significantly to the reduction of CM in the Brazilian semiarid region. To maintain this reduction, the following measures must be reinforced: reduction of illiteracy of persons aged 15 years or older and greater attention to water supply and sanitation conditions in households.

To ensure that programmes actually reduce inequality and poverty in the Brazilian semi-arid region, it will be important to carefully monitor the impact of programmes and ensure the maintenance and improvement of public health infrastructure. Thus, the impact that the PBF has on the reduction of CM levels in the semiarid region will be better evidenced in a positive way, noting that this impact has been enhanced by the intervention of other factors. In addition, the rates have been reduced in the last decade at a faster rate than in any other time before the implantation of the PBF in 2004.

This study showed that the reduction in CM will occur from the performance of several sec-

tors. In turn, by establishing the provision of a minimum regular income for poor families under certain conditions, important advances were made in essential areas of the life of the people of the semiarid region, resulting in a significant reduction in CMR levels.

Collaborations

ESA Silva and NA Paes participated in the design of the study, literature review, methodology design, results generation, data interpretation and writing. NA Paes conducted the final review of the article. The authors approve the final version of the text.

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Article submitted 27/07/2016
Approved 19/03/2017
Final version submitted 21/03/2017