

Family health and conditional cash transfer in Brazil and its effect on tuberculosis mortality

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SUMMARY

BACKGROUND: Social protection can reduce poverty and act on the determinants of tuberculosis (TB).

OBJECTIVE: To evaluate the impact of the Family Health Strategy (FHS) and the Bolsa Família Programme on TB-related mortality in Brazil.

METHODS: This was an ecological study in which the units of analysis were Brazilian municipalities between 2001 and 2012. The principal independent variables were the levels of coverage of the primary health care system and the conditional cash transfer programme. The dependent variable was TB mortality rate (obtained from national databases). Descriptive analysis and negative binomial regression based on panel data using fixed-effects models were performed. Crude and adjust-

ed estimates were calculated for continuous and categorical variables.

RESULTS: A high FHS coverage was significantly associated with a reduction in the TB mortality rate (RR 0.80, 95%CI 0.72–0.89). An increase in the coverage of the Brazilian cash transfer programme was significantly associated with a reduction in the TB mortality rate (RR 0.87, 95%CI 0.81–0.96).

CONCLUSION: FHS and the Bolsa Família conditional cash transfer programme had a positive impact on the TB mortality rate in Brazil. Public policies should include economic support combined with health promotion.

KEY WORDS: social conditions; health conditions; social protection effects; public health policies

CONDITIONAL CASH TRANSFERS and primary health care programmes can reduce poverty-related diseases such as tuberculosis (TB).^{1,2} Although TB is a curable disease, the morbidity and mortality rates associated with it remain high worldwide, particularly in developing countries.^{3,4} The number of individuals who became infected with TB in 2015 is estimated at 10.4 million, with 1.4 million recorded deaths. Brazil forms part of a group of 22 high TB burden countries, and contributes an estimated 33% of the cases in the Americas.⁵

Annual trends in epidemiological indicators in Brazil have shown a decreasing incidence rate of TB, which fell from 37.9 per 100 000 population in 2007 to 32.4 in 2016. The mortality rate fell from 2.6 to 2.2/100 000 between 2006 and 2015.⁶

In Brazil, two important initiatives were implemented with the aim of guaranteeing health care and social protection: the Family Health Strategy (FHS) and the *Bolsa Família* Programme (BFP), respectively. The FHS, a community-based health model designed to provide primary health care, financed by the

Brazilian Ministry of Health, was implemented in 1994. The programme covers around 56.4% of the country's population and is the access route recommended for TB patients for treatment in the primary, secondary and tertiary care sectors.^{7,8} The BFP, initiated in 2004, was intended to minimise the risks and conditions of social vulnerability through the direct transfer of income and by providing access to the public service network to guarantee health, education, food security and social assistance for families in poverty (defined as a monthly per capita income of >USD35–70) or extreme poverty (defined as a monthly per capita income of ≤USD35).⁹ Financed by the Ministry of Social Development, it has become a central pillar in recent Brazilian social policies aimed at combating poverty, with about 14 million families benefiting in 2014.¹⁰

Several studies have highlighted the positive impact of the expansion of primary health care, particularly the FHS, on the health conditions of the Brazilian population. A reduction in social inequality¹¹ and in the ailments that afflict the poorest populations, such

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as infectious^{12,13} and chronic diseases,¹⁴ has been reported. However, only one study has reported a decrease in the TB mortality rate following improved access to health services.¹⁵

The conditional cash transfer programme has had a positive impact on the care of the most vulnerable groups. The positive effects include improvements related to social conditions, income inequality,¹⁶ education,¹⁷ malnutrition and food insecurity,¹⁸ a decrease in the number of new cases of infectious diseases and related deaths, and an increase in rates of early detection and cure.^{1,2,19,20}

The effect of these programmes on TB mortality has not yet been shown. The objective of the present study was to evaluate the effect of the FHS and the BFP on TB mortality in Brazil.

METHODS

Design and study population

This was an ecological study conducted between 2001 and 2012, in which the Brazilian municipalities represented the unit of analysis. The quality of vital statistics (births and deaths) records was evaluated in 5506 municipalities using the following indicators of adequacy: age-standardised mortality ratio (SMR), relative mean deviation for the SMR, ratio between the recorded number and the estimated number of live born infants, relative mean deviation of the birth rate, and the proportion of deaths due to unknown causes.^{13,21} Based on this analysis, data recording was assumed to be adequate in 1614 municipalities.

The following information sources were used: the official mortality database (*Sistema de Informações sobre Mortalidade*, SIM) for deaths resulting from all forms of TB (A15–A19) in accordance with the International Classification of Diseases, 10th revision (ICD-10); the notifiable diseases database (*Sistema de Informação de Agravos de Notificação*, SINAN) for the number of notified cases according to the type of entry, situation of closure, and coinfection with the human immunodeficiency virus (HIV); the database of the Ministry of Social Development for the number of families receiving and the number eligible for the conditional cash transfer programme; the basic health care data system (*Sistema de Informação da Atenção Básica*, SIAB) for the number of individuals registered with the FHS Programme; the Hospital Information System (*Sistema de Informações Hospitalares do Sistema Único de Saúde*, SIH) for cases of TB who were hospitalised; and the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*, IBGE) for demographic and socio-economic variables from the 2000 and 2010 population censuses.

The principal independent variables were the annual coverage provided by the FHS in the municipalities (the ratio of the number of individuals

registered with the programme to the number of inhabitants in the municipality, multiplied by 100) and the target population of the conditional cash transfer programme (the ratio of the number of families receiving the benefit to the number of eligible families in the same municipality, multiplied by 100). Next, the coverage of the primary health care programme stratified according to tertiles of distribution (first tertile, $\geq 0\%$ – $<43.5\%$; second tertile, $\geq 43.55\%$ – $<90.75\%$; third tertile, $\geq 90.75\%$), and that of the conditional cash transfer programme (stratified according to its target population coverage) was categorised as $<30\%$ (low), $\geq 30\%$ and $<70\%$ (intermediate) or $\geq 70\%$ (high).^{13,22}

The dependent variable was the mortality rate for all forms of TB. This was measured by the number of TB-related deaths divided by the population of the municipality per 100 000 population.

The covariables used in the analyses were selected based on a review of the literature,^{23–25} taking into consideration the availability of data, relevance and association with TB mortality. This resulted in the following covariables being selected: illiteracy rate, unemployment rate, mean per capita income in the municipality, Gini index, proportion of people living in poverty, proportion of males aged ≥ 50 years, rate of TB-HIV coinfection, rate of loss to follow-up (LTFU), proportion of individuals restarting TB treatment after LTFU, rate of relapse after anti-tuberculosis treatment, and rate of hospitalisation for all forms of TB.

Statistical analysis

Data for the municipalities selected for inclusion were collected from different databases, organised and analysed in a single panel database or in longitudinal data models combining cross-sectional and longitudinal data.²⁶ First, the number of deaths was described and the annual mortality rate for TB in the study municipalities was calculated.

To verify the association between coverage by the FHS and BFP and the TB mortality rate, data were analysed in a negative binomial regression analysis using a fixed-effects model. As the dependent variable under analysis was a sum, it was assumed that all values would consist of non-negative whole numbers corresponding to a given number of events during an interval of time, and that there was an overdispersion of these, thus ruling out the possibility of using the Poisson model. From a statistical point of view, the choice of the fixed-effects model was based on the Hausman test, and is the method most commonly used to evaluate political interventions in public health.²⁷

Continuous and categorised models were constructed to analyse the effect of the primary health care programme on TB mortality between 2001 and 2012. The effect of the conditional cash transfer

Table 1 Number of deaths and TB mortality rate in Brazil and in selected municipalities, Brazil, 2001–2012

Year	TB-related deaths in Brazil <i>n</i>	Deaths in study municipalities (<i>n</i> = 1614) <i>n</i>	Annual TB mortality rate in Brazil /100 000	TB mortality rate in study municipalities (<i>n</i> = 1614) /100 000
2001	5249	2297	3.1	3.6
2002	5048	2149	2.9	3.4
2003	4843	2007	2.8	3.1
2004	4838	2002	2.7	3.1
2005	4602	1868	2.5	2.9
2006	4721	1882	2.5	2.9
2007	4612	1781	2.5	2.8
2008	4756	1908	2.5	2.9
2009	4690	1877	2.5	2.8
2010	4568	1801	2.4	2.7
2011	4460	1780	2.3	2.3
2012	4316	1758	2.2	2.1

TB = tuberculosis.

programme on TB mortality was evaluated between 2004 and 2012. The ratios of the mortality rates or risk ratios (RRs) were calculated to estimate the association between coverage by the interventions, together with their respective 95% confidence intervals (95% CIs).

The best model was chosen based on the method proposed by the Akaike Information Criterion (AIC), with the objective of selecting a model that would be well-adjusted with statistically significant explanatory variables. The model with the lowest AIC is considered the model with the best fit.²⁸ Data were stored and analysed using Stata v13.0 (StataCorp, College Station, TX, USA).

The Ethics Committee of the Institute Research for Collective Health of the Federal University of Bahia, Salvador, Brazil, approved the study protocol.

RESULTS

A total of 5249 deaths resulting from all forms of TB was registered in 2001, decreasing to 4316 in 2012. The TB mortality rate declined by 30%, from 3.1 to 2.2 cases/100 000 in Brazil. The same trend was found for the 1614 municipalities selected, with a decline in the mortality rate from 3.6 to 2.1/100 000 over the same period (Table 1).

In the municipalities selected, a significant expansion occurred in the mean coverage provided by the FHS, which increased from 37.1% in 2001 to 79.4% in 2012 (Figure 1). A similar expansion was found in relation to the mean coverage provided by the BFP in the poor and extremely poor populations, which increased from 62.3% in 2004 to 87.1% in 2012 (Figure 2).

From 2001 to 2012, the illiteracy rate in Brazil fell

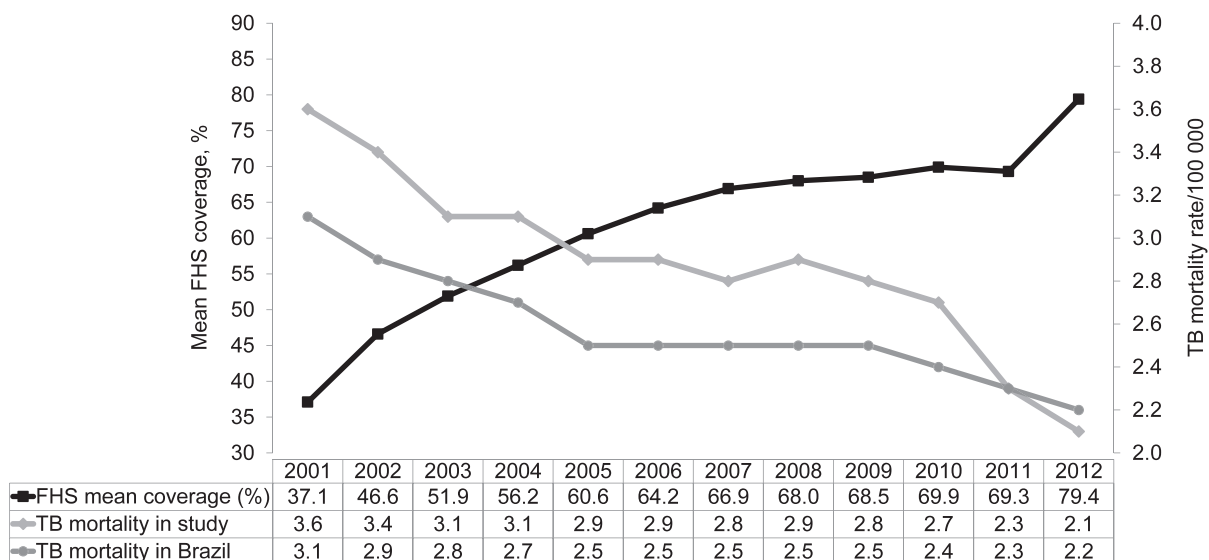


Figure 1 Mean coverage of the FHS (%) and TB mortality rate (per 100 000 population) in selected municipalities, Brazil, 2001–2012. FHS = Family Health Strategy; TB = tuberculosis.

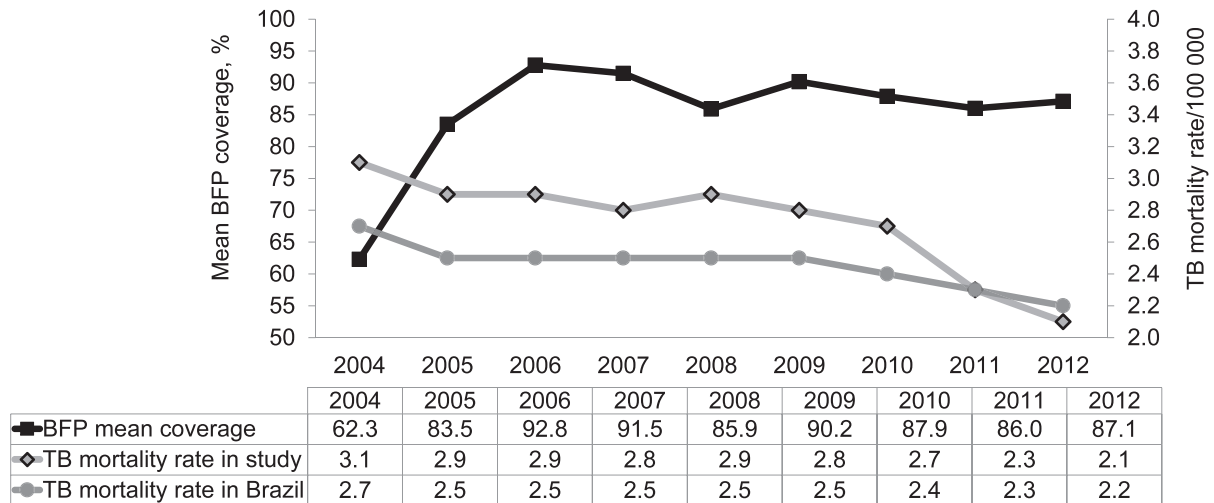


Figure 2 Mean BFP coverage (%) and TB mortality rate (per 100 000 population) in selected municipalities, Brazil, 2004–2012. BFP = Bolsa Família Programme; TB = tuberculosis.

to 14.9% and the unemployment rate to 5.6% in the last year. The mean household income per capita by municipality increased to around USD246. The epidemiological indicators of TB showed an increase from 2.5% to 5.2% in the rate of HIV-TB coinfection, while the LTFU rate was 5.4%, retreatment after LTFU 2.9%, and the rate of relapse following treatment 4.5% in 2012. The rate of hospitalisation for all forms of TB was 7.4/100 000 in 2012. Finally, the proportion of males aged ≥ 50 years was 10.6% (Table 2).

In municipalities in which FHS coverage was between 43.6% and 90.8% (represented by the second tertile) or $\geq 90.8\%$ (represented by the third tertile), a statistically significant reduction occurred in the TB mortality rate following adjustment for covariables (RR 0.84; 95%CI 0.79–0.89 and RR 0.80; 95%CI 0.72–0.89, respectively) for 2001–2012 (Table 3).

In the crude and adjusted models, analysis of the association between the coverage provided by the BFP in the municipality and TB-related mortality

showed that in those municipalities in which coverage was $\geq 70\%$, the TB mortality rate fell (RR 0.88, 95%CI 0.79–0.97) during 2004–2012 (Table 4). Covariables that may have affected the association according to the literature and those found to be statistically significant in explaining the phenomenon were retained in the final model.

DISCUSSION

This is the first study to evaluate the effect of the implementation of the FHS and the BFP on TB-related mortality. An increase in the coverage of the primary health care programme had a significant association with reduction of TB mortality, by 16% and 20%, while the high coverage of the conditional cash transfer programme contributed to a reduction in mortality by 12%.

TB-related morbidity and mortality are directly associated with individual and social life conditions, such as sex, age, TB-HIV coinfection, income, unemployment and education.^{29,30} Nevertheless, the

Table 2 Mean annual proportion of study covariables, Brazil, 2001–2012

Variables	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Percentage difference 2001–2012
	%	%	%	%	%	%	%	%	%	%	%	%	%
Illiteracy rate	20.3	19.8	19.30	18.8	18.3	17.8	17.3	16.8	16.3	15.8	15.4	14.9	-26
Unemployment rate	9.9	9.5	9.1	8.7	8.3	7.9	7.5	7.1	6.7	6.3	5.9	5.6	-43
Mean household income per capita per municipality, USD	163.6	170.3	177.1	183.9	190.6	197.4	204.2	2111.0	217.7	224.5	231.3	238.0	+45
TB-HIV coinfection rate	2.5	2.7	3.0	3.2	3.3	3.5	4.1	4.1	4.8	4.7	5.1	5.2	+51
LTFU rate	6.0	6.2	5.4	6.8	4.8	4.8	4.9	5.4	5.2	5.1	5.5	5.4	-10
Retreatment after LTFU rate	3.2	3.2	2.6	3.2	2.7	2.6	2.5	2.6	2.6	2.6	3.2	2.9	-9
Recurrence rate	3.9	5.0	4.6	4.7	4.4	4.7	4.2	4.1	4.5	4.5	4.8	4.5	+15
TB hospitalisation rate	10.8	11.3	11.9	11.3	10.1	9.1	8.4	9.3	7.1	7.2	7.6	7.4	-31
Proportion of males aged >50 years	8.4	8.4	8.4	8.4	8.4	8.4	9.8	9.8	10.2	10.6	10.6	10.6	+26

TB = tuberculosis; LTFU = loss to follow-up.

Table 3 Association between the TB mortality rate and Family Health Strategy coverage in selected municipalities, Brazil, 2001–2012

	Mortality rate	
	Crude models RR (95%CI)	Adjusted models RR (95%CI)
Family Health Strategy coverage		
1st tertile (≥ 0 – $< 43.5\%$)	1	1
2nd tertile (≥ 43.55 – $< 90.75\%$)	0.82 (0.77–0.87)	0.84* (0.79–0.89)
3rd tertile ($\geq 90.75\%$)	0.77 (0.69–0.85)	0.80* (0.72–0.89)
Unemployment rate ≥ 6.625 (%)	—	1.15* (1.10–1.20)
Mean household income per capita per municipality ≥ 197.17 , USD	—	0.91 (0.80–1.04)
TB-HIV coinfection rate $\geq 10\%$	—	0.97 (0.93–1.01)
LTFU rate $\geq 5\%$	—	1.02 (0.96–1.08)
Retreatment after LTFU rate $\geq 5\%$	—	1.04 (0.99–1.09)
TB recurrence rate $\geq 5\%$	—	1.10* (1.06–1.5)
TB hospitalisation rate $\geq 35/100\ 000$	—	1.16* (1.10–1.21)

* $P \leq 0.05$.

TB = tuberculosis; RR = risk ratio; CI = confidence interval; USD = US dollar; HIV = human immunodeficiency virus; LTFU = loss to follow-up.

positive effect of both the primary health care and the conditional cash transfer programmes remained even after adjustment for these factors.

In view of these results, the mechanisms involved in reducing TB mortality should be clearly understood. Primary health care and conditional cash transfer programmes act directly on the social determinants of the disease: primary health care is associated with individual and collective conditions (suspicion and diagnosis of cases, treatment and supervision of treatment adherence, monitoring of contacts, prophylactic actions such as bacille Calmette-Guérin vaccination and the treatment of latent infection, and educational actions within the community),^{4,8} while conditional cash transfer programmes are associated with socio-economic conditions^{31,32} (income, habitation, diet, education and access to health servic-

es)^{33,34} that affect beneficiaries' quality of life, resulting in improvements in social conditions.

The FHS has been reported to have a positive effect on mortality rates among infants aged < 5 years in the municipalities with high coverage ($> 70\%$), reducing the mortality rate in this age group by 13%.¹³ In terms of overall child mortality, this reduction was 22%.²² For every 10% increase in FHS coverage, a decrease of 4.5% in child mortality was observed.¹² Other studies have shown that the family health care programme reduced mortality due to cardiovascular and cerebrovascular diseases by respectively 21% and 18%.¹⁴

The BFP has been shown to reduce child mortality; a reduction of 17% was found in the mortality rate among children aged < 5 years in the municipalities in which the coverage of the conditional cash transfer

Table 4 Association between the TB mortality rate, Bolsa Família Programme and Family Health Strategy coverage, in select municipalities, 2004–2012

	Mortality rate	
	Crude models IRR (95%CI)	Adjusted models IRR (95%CI)
Bolsa Família Programme coverage target population		
Low (≥ 0 – $< 30\%$)	1	1
Intermediate (≥ 30 – $< 70\%$)	0.87 (0.80–0.95)	0.87* (0.79–0.97)
High ($\geq 70\%$)	0.87 (0.81–0.95)	0.88* (0.79–0.97)
Family Health Strategy coverage		
2 nd tertile (≥ 71.65 – $< 98.92\%$)	—	0.92 (0.84–1.00)
3 rd tertile ($\geq 98.92\%$)	—	0.89* (0.81–0.97)
Illiteracy rate ≥ 13.85	—	0.99 (0.81–1.22)
Mean household income per capita per municipality ≥ 197.17 , USD	—	0.89 (0.74–1.08)
TB-HIV coinfection rate $\geq 10\%$	—	1.01 (0.96–1.06)
LTFU rate $\geq 5\%$	—	0.99 (0.93–1.07)
Retreatment after LTFU rate $\geq 5\%$	—	0.99 (0.94–1.05)
TB recurrence rate $\geq 5\%$	—	1.11* (1.06–1.17)
TB hospitalisation rate $\geq 35/100\ 000$	—	1.14* (1.07–1.20)

* $P \leq 0.05$.

TB = tuberculosis; IRR = incident rate ratio; CI = confidence interval; USD = US dollar; HIV = human immunodeficiency virus; LTFU = loss to follow-up.

programme had been consolidated (>32% or 100% in the previous 4 years).³⁵ The joint effect of the primary health care and conditional cash transfer programmes has also been highlighted in a study in which greater coverage by these two programmes in the municipality led to significantly reduced child mortality rates.¹⁹ The results of a retrospective cohort study showed a positive association between the conditional cash transfer programme and the TB cure rate in Brazil,¹ with an improvement in TB mortality rates. Those studies emphasise that TB control is not just the result of programme-based actions, but also the effect of intersectoral actions that in turn may play a role in minimising some social factors that affect mortality due to the disease.^{31,32}

One of the limitations of the present study was the use of interpolation and extrapolation methods to estimate annual values of the covariables not covered in the study period based on known census values. Use of secondary data represents another potential limitation, as the selection of the variables from the database is already established and does not guarantee the quality of the data collected in terms of coverage, completeness and validity. To reduce this bias, a decision was made to include the municipalities in which the quality of records of vital statistics was good, which led to more reliable results and a consequent improvement in internal validity. Although there are differences in the geographic and socio-economic characteristics in Brazilian regions, it should be noted that we performed similar analyses including all Brazilian municipalities, and these produced similar effect estimates.

CONCLUSION

The health interventions resulting from the primary health care programme and interventions in the social context through the conditional cash transfer programme were shown here to have the potential to improve TB mortality indicators. These interventions represent important changes in the living conditions of the population, such as improving access to health and affecting the social determinants of TB. These findings may add to the debate on the articulation of current public policies with respect to health, planning of individual and collective actions regarding health promotion, as well as the prevention, diagnosis and treatment of TB. Indeed, not only is expansion of the coverage of these programmes in the municipalities linked to improvements in quality of life, the structuring and organisation of the network of health services and direct transfer of income can also contribute to better treatment adherence, an increase in cure rates and, consequently, a reduction in the number of deaths.

The positive effect of the interventions in reducing TB-related mortality observed in our study reinforc-

es the need to maintain investment in universal implementation of social and health policies. Other studies are needed to increase knowledge on the mechanisms involved in TB mortality. Individualised studies also need to be conducted to establish causal associations.

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Conflicts of interest: none declared.

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R É S U M É

CONTEXTE : La protection sociale peut réduire la pauvreté et agir sur les déterminants de la tuberculose (TB).

OBJECTIF : Evaluer l'impact d'une Stratégie de Santé familiale (FHS) et du programme *Bolsa Família* sur la mortalité liée à la TB au Brésil.

MÉTHODES : Etude écologique dans laquelle les unités d'analyse ont été les municipalités du Brésil entre 2001 et 2012. Les principales variables indépendantes ont été les niveaux de couverture du système de soins de santé primaires et le programme de transfert d'espèces conditionnel. La variable dépendante a été le taux de mortalité de la TB, obtenu des bases de données nationales. Une analyse descriptive a été réalisée et une régression négative binomiale pour les données du panel avec des modèles à effets fixes. Les estimations brutes et

ajustées ont été calculées pour les variables continues et catégorielles.

RÉSULTATS : Une couverture élevée de la FHS a été significativement associée à une réduction du taux de mortalité de la TB (risque relatif [RR] 0,80 ; IC95% 0,72–0,89). Un accroissement de la couverture du programme brésilien de transfert d'espèces a été significativement associé à une réduction du taux de mortalité de la TB (RR 0,87 ; IC95% 0,81–0,96).

CONCLUSION : Il y a eu un impact positif de la FHS et du programme de transfert d'espèces conditionnel du *Bolsa Família* sur le taux de mortalité au Brésil, avec des effets indépendants. Les politiques publiques devraient inclure un soutien économique associé à la promotion de la santé.

R E S U M E N

MARCO DE REFERENCIA: La protección social puede disminuir la pobreza y tener un efecto sobre los determinantes de la tuberculosis (TB).

OBJETIVO: Evaluar la repercusión de la *Estrategia de Salud de la Familia* (FHS) y del programa *Bolsa Família* sobre la mortalidad relacionada con la TB en el Brasil.

MÉTODOS: Fue este un estudio ecológico cuyas unidades de análisis fueron los municipios brasileños y se llevó a cabo del 2001 al 2012. Las principales variables independientes fueron el grado de cobertura de la atención primaria de salud y los programas de transferencias monetarias condicionadas. La variable dependiente fue la tasa de mortalidad por TB, obtenida de las bases de datos nacionales. Se llevó a cabo el análisis descriptivo y la regresión binomial negativa de los datos en un conjunto único, con modelos de efectos

mixtos. Se calcularon las estimaciones brutas y ajustadas de las variables continuas y categóricas.

RESULTADOS: Una alta cobertura de la FHS se asoció de manera significativa con una disminución de la tasa de mortalidad por TB (riesgo relativo [RR] 0,80; IC95% 0,72–0,89). Un aumento en la cobertura del programa de transferencias monetarias condicionadas en el Brasil exhibió una asociación significativa con la reducción de la tasa de mortalidad por TB (RR 0,87; IC95% 0,81–0,96).

CONCLUSIÓN: Se observó una repercusión positiva de la FHS y el programa de transferencias monetarias condicionadas, *Bolsa Família*, sobre la tasa de mortalidad por TB en el Brasil, con efectos independientes. Las políticas públicas deben incluir el apoyo económico aunado a la promoción de la salud.